ASIAN CARP ACTION PLAN

Asian Carp Regional Coordinating Committee

2017

Asian Carp Action Plan for Fiscal Year 2017

December 2016

Asian Carp Regional Coordinating Committee

Contributing Members:

Illinois Department of Natural Resources
Illinois Environmental Protection Agency
Indiana Department of Natural Resources
Michigan Department of Natural Resources
Michigan Office of the Great Lakes
Minnesota Department of Natural Resources
New York Department of Environmental Conservation
Ohio Department of Natural Resources
Pennsylvania Department of Environmental Protection
Pennsylvania Fish and Boat Commission
Wisconsin Department of Natural Resources
Ontario Ministry of Natural Resources and Forestry
Québec Ministère de la Forêt, de la Faune et des Parcs
U.S Department of Commerce - National Oceanic and Atmospheric Administration
U.S. Department of Agriculture – Natural Resources Conservation Service
U.S. Army Corps of Engineers
U.S. Coast Guard
U.S. Department of Transportation/Maritime Administration
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey
National Parks Service
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 Regional Coordinating Committee's (ACRCC) 2017 Action Plan contains the portfolio of over 60 high-priority strategic activities planned for implementation in the coming year. The Action Plan serves as a foundation for the work of the ACRCC partnership — a collaboration of 27 U.S. and Canadian federal, state, provincial, and local agencies and organizations — to achieve its mission of preventing the introduction and establishment of Asian carp in the Great Lakes.

Developed annually since 2010, the Action Plan, formerly titled the Asian Carp Control Strategy Framework, has evolved to incorporate advances in the scientific body of knowledge on Asian carp population status, life history, and risk; and the latest developments in detection, prevention, and control capabilities. The 2017 Action Plan builds upon prior Asian carp strategies by applying "lessons learned" and using an adaptive management approach. It further supports the principles of Integrated Pest Management through development and implementation of an array of synergistic tools and techniques. Many of these actions target a specific Asian carp behavior or life stage to achieve the maximum collective impact on fish populations. These actions are intended to dramatically reduce the Asian carp populations at locations near the electric barrier, resulting in a reduced threat of dispersal towards the Great Lakes.

A significant addition to the ACRCC's strategic approach in 2016 and carried forward in 2017 is new interagency contingency response plans developed specifically for potential rapid-response in the event of new detections of Asian carp of all life stages in upstream navigation pools and other select locations in the Illinois Waterway and Chicago Area Waterway System (CAWS). The 2017 Action Plan contains specific projects that support these new contingency plans, as well as activities identified in the Monitoring and Response Plan (MRP). Immediate actions to address any potential threat will be taken as direct in the contingency plan.

In addition, in Appendix C, this Action Plan includes a long-term planning horizon that can be used to inform future actions. The information below is not a commitment to funding. The FY 2017 proposed funding was generally determined by assuming flat from the FY 2016 enacted budget. All funding numbers included in this Action Plan are subject to final appropriations decisions.

The initiatives in this Action Plan fall under three focus areas.

1. PREVENTION

Pathway Closures & Control Measures- FY 2017 Actions

- Construction of the main building for permanent Barrier I is scheduled for completion in 2017.
- A feasibility study evaluating options and technologies that could be employed near the Brandon Road Lock and Dam to prevent the upstream transfer of Asian carp and other aquatic nuisance species toward the Great Lakes will continue. USACE will record the results of the study in a decision document with planning, engineering, environmental compliance and design analyses

and a recommendation that can be used as the basis for congressional authorization of a project for construction.

- USACE concluded that viable aquatic pathways exist at Ohio-Erie Canal and Little Killbuck Creek in Ohio that would allow the transfer of Asian carp between the Great Lakes and the Mississippi River Basins. Work to close these pathways is ongoing.
- The behavior and likelihood of occurrence of small fish near barges and in void spaces of barge tows on the Upper Illinois Waterway will be evaluated to better understand the potential risk of inadvertent entrainment and upstream transport through locks and the electric dispersal barrier.

2. DETECTION, MANAGEMENT AND CONTROL

Fishery Management- FY 2017 Actions

- Mass removal via contract fishing will continue, resulting in a reduction of the numbers of Silver and Bighead Carp in the upper Illinois Waterway downstream of the electric barrier.
- Multi-agency exercises to test response actions within the Contingency Response Plan will continue.
- Gear testing to increase capture rates underscoring the need for multiple gears for each life stage continues to be a goal of the Monitoring and Response Work Group (MRWG). Efforts will focus on small fish detections and effectiveness for management and control.
- Mass removal and monitoring of juvenile Asian carp will continue to detect and remove juvenile Asian carp and locational changes.
- Better understanding of the Black Carp threat through expansion of the Black Carp sampling program will continue in FY 2017, including other river segments where Black Carp have not previously been caught.
- Monitoring Grass Carp will continue to better understand the population dynamics within the Sandusky River and other Lake Erie tributaries. In addition, structured decision making workshops will be held to develop an adaptive management framework for Grass Carp control in Lake Erie.
- Opportunities for Asian carp processing and products development will be explored to better understand the economic development potentials of alternative uses of Asian carp. The end goal is to remove 20 to 50 million pounds of Asian carp per year from Illinois waterways to reduce the environmental impact of this invasive species.

Development of New Control Technologies and Strategies- FY 2017 Actions

- Testing complex sound at Brandon Road to assist the evaluation of configuration, operation, and maintenance information for longer deployments, and assessment of impacts to native fish will be undertaken.
- Studies of Carbon Dioxide (CO2), hot water, and ozone for use as control technologies will continue, including field testing and research related to the efficacy, implementation, and impacts of the use of CO2 as a non-physical barrier chemical to deter the movement of Asian carp.

- Refinement of a microparticle that has demonstrated high toxicity and selectivity toward Asian carp will continue.
- Work will continue to integrate application of fish feeding attractants with microparticle delivery to enhance consumption of the microparticles by Asian carp.
- Controls such as water jets and sound will be evaluated to address potential barge entrainment and mitigate any risk posed by this vector.

Monitoring and Assessment- FY 2017 Actions

- Enhanced monitoring above and below the electric barriers will be undertaken, including environmental DNA (eDNA) monitoring; conventional monitoring (electrofishing and netting) will continue with emphasis on zooplankton, larval, and small fish detection.
- Illinois River stock assessment/management alternatives will identify population dynamics of Asian carp to direct harvest and other control measures.
- Development of a web-enabled database and archive of Asian carp and other species collection data to inform Asian carp management will be initiated.
- Development and deployment of a real-time acoustic telemetry system of receivers and data visualization tools to inform integrated pest management for Asian carps will continue. Seasonal fixed and random site monitoring of the CAWS, upstream of the electrical dispersal barrier (as identified in the 2017 Monitoring and Response Plan) will continue in FY 2017.
- Continuing fixed, targeted, and random site monitoring downstream of the electric dispersal barrier continue with agency electrofishing and contracted netting efforts.
- Continued focus on eggs, larval, young-of-year, and juvenile Asian carp will take place through various agency netting and electrofishing operations.
- Population dynamics (stock assessment) and modeling will utilize contemporary data to inform removal strategies of Asian carp in the upper Illinois River to further maximize efforts.
- A comprehensive and complementary monitoring and response plan (including contingency actions) will remain in force for Asian carp in the CAWS and other waters of the Great Lakes.
- Due to Black Carp in the Middle Mississippi River being detected more frequently, traditional fisheries gears, commercial catches, microchemistry, ploidy analysis, and new environmental genetic tools will be used to evaluate the status of Black Carp within the waterways and will be monitored in FY 2017.
- Black and Grass Carp populations will be analyzed in targeted locations to better understand their status, distribution, and potential risk of invasion to the Great Lakes.
- Analyses and evaluation of Grass Carp in the Upper Illinois River will continue.
- Food Web Modeling to Support Risk Assessment of Asian carp in the Great Lakes will provide estimates of the economic and ecosystem impacts of Asian carp invading the Great Lakes.
- Ten additional eDNA hand-held kits will be made available to fish management agencies in 2017.

3. PROGRAM MANAGEMENT

Communication and Outreach- FY 2017 Actions

- *AsianCarp.us*, a centralized platform for inter-agency Asian carp communication efforts, will continue to expand content for the Ohio River and Upper Mississippi River basins, as well as additional information on other Asian carp species, such as Grass and Black Carp.
- Through strategic messaging and engagement, communications work will help key audiences have a greater understanding and appreciation for the ACRCC's purpose, function, current actions, and successes.

Interbasin Collaboration- FY 2017 Actions

- The U.S. Fish and Wildlife Service (USFWS) will continue to play a leadership role in the coordination between state and federal partners to develop and implement high-priority projects to support Asian carp management strategies outside the Great Lakes Basin, focusing on the Ohio River and Upper Mississippi River basins.
- Interbasin Coordination — Support for interbasin coordination between the ACRCC and other multijurisdictional basin wide partnerships in other parts of the nation to leverage available resources and to maximize conservation benefits will continue.

A full listing of FY 2017 action items, project descriptions, and intended outcomes is provided in Appendix B of the Action Plan.

1.0 INTRODUCTION

1.1 ABOUT THIS STRATEGY

The Asian Carp Regional Coordinating Committee's (ACRCC) Fiscal Year 2017 Action Plan contains the portfolio of over 60 high-priority strategic activities planned for implementation in the coming year. The Action Plan serves as a foundation for the work of the ACRCC partnership — a collaboration of 27 U.S. and Canadian federal, state, provincial, and local agencies and organizations — to achieve its mission of preventing the introduction and establishment of Asian carp in the Great Lakes.

The Asian Carp Control strategy has evolved to incorporate advances in the scientific body of knowledge on Asian carp population status, life history, and risk; and the latest developments in detection, prevention, and control capabilities. The 2017 Action Plan builds upon prior Asian carp strategies by applying lessons learned and using an adaptive management approach. It further supports the principles of Integrated Pest Management through development and implementation of an array of synergistic tools and techniques, many targeting a specific Asian carp behavior or life stage, to achieve the maximum collective impact on fish populations.

A significant addition to the ACRCC's strategic approach in 2016 and carried forward in 2017 is new interagency contingency response plans developed specifically for potential rapid-response in the event of new detections of Asian carp of all life stages in upstream navigation pools and other select locations in the Illinois Waterway and Chicago Area Waterway System (CAWS). The 2017 Action Plan contains specific collaborative projects that support these new contingency plans, as well as activities that are conducted by ACRCC agencies as the foundation of its ongoing early detection, monitoring, and control strategy.

In support of the strategy, Appendices A, B, and C of this Action Plan include a funding matrix, a description of each proposed action item, and a long-term planning horizon that can be used to inform future actions. The information below is not a commitment to funding. The FY 2017 proposed funding was generally determined by assuming flat from the FY 2016 enacted budget. All funding numbers included in this Action Plan are subject to final appropriations decisions.

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, the term "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 2017 Action Plan has been prepared by members of the 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 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.

Figure 1. ACRCC Quarterly Meeting, October 2016

1.4 PURPOSE

This Action Plan describes the strategies and proposed action items collaboratively developed to achieve the mission of the ACRCC and identifies the objectives and organizational structure of the binational partnership, including its work groups. It focuses heavily on efforts taken within the Chicago Area Waterway System (CAWS) and Illinois Waterways (IWW), but also captures efforts outside the CAWS that indirectly assist the efforts of the ACRCC. The Action Plan primarily addresses the threat of Bighead and Silver Carp as a result of their population status and distribution. However, the ACRCC members have more recently chosen to also develop approaches and activities to begin to address the growing threat of Grass and Black Carp (see Figure 2.). This approach will be further informed by results and recommendations from binational (U.S. and Canadian) ecological risk assessments currently being conducted for Grass and Black Carp in the Great Lakes when they are completed.

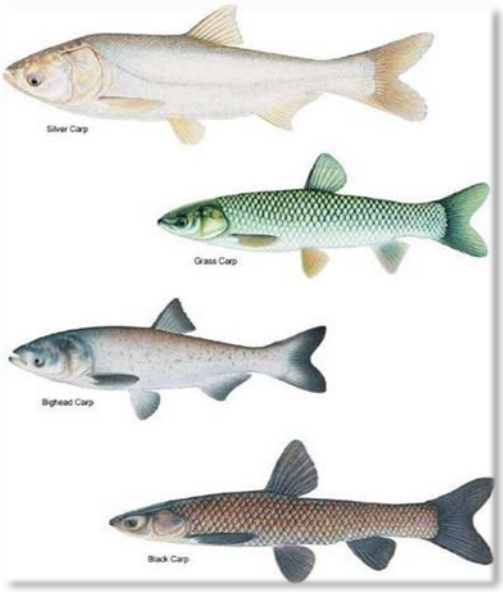


Figure 2. Silver, Grass, Bighead, and Black Carp.

In addition, the Action Plan supports the goals, strategies, and recommendations of the National Management and Control Plan for Bighead, Black, Grass, and

Silver Carp in the United States[1]. The Action Plan also serves to inform, though does not include, Asian carp prevention strategies being developed for other basins, such as the Upper Mississippi and Ohio River basins.

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

A. Promote collection of biological information on Asian carp, 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 development of technologies and methods that will result in the control and management of Asian carp; and the transferability of these new tools for use in the control of other invasive species, where possible.

D. Encourage the exchange of information between member agencies and stakeholders, and seek opportunities to transfer and further leverage control technologies developed as part of the Action Plan to other areas of the United States and Canada. Work under this objective by the ACRCC fulfills the coordination and notification requirements of the United States-Canada Great Lakes Water Quality Agreement.

E. Coordinate implementation and evaluate the effectiveness of collaborative Asian carp assessment, prevention and control measures, as described in the Action Plan.

The organizational structure of the ACRCC and its work groups is highlighted in Figure 3 below.

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

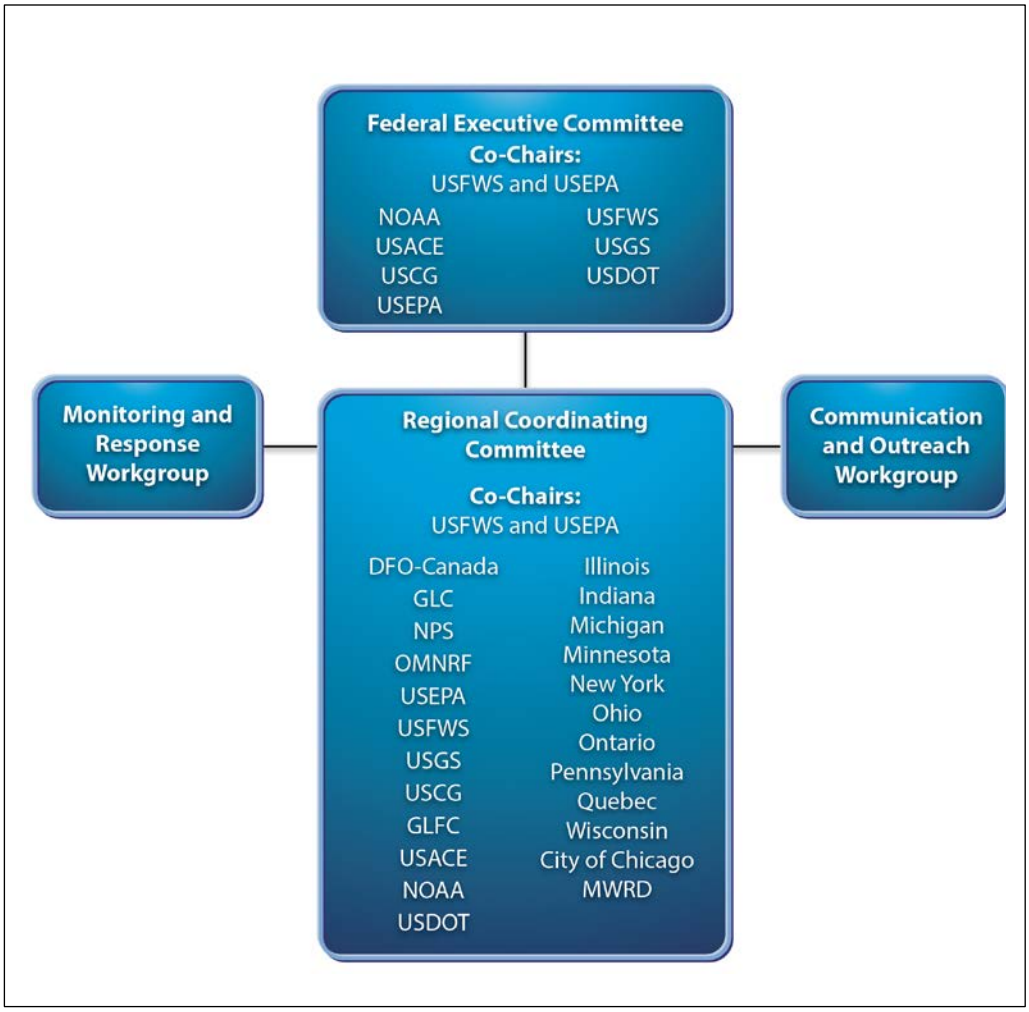


Figure 3. ACRCC Organizational Structure

1.5 BACKGROUND ON ASIAN CARP

While Asian carp remain a significant threat to North America's aquatic resources, no Bighead, Silver, or Black Carp have been collected or observed in the Great Lakes since 2000. On two separate occasions (1995 and 2000), adult Bighead Carp were collected from Sandusky Bay, Ohio in the western basin of Lake Erie. These fish represent the only documented collections of Bighead, Silver, or Black Carp in the Great Lakes. Since that time, intensive sampling has been conducted in the targeted locations in the Great Lakes and yielded no additional collections of these three species.

However, current data from Asian carp monitoring by resource agencies demonstrate the continued expansion of certain species in portions of the Mississippi River and Ohio River Basins. Additionally, new data demonstrate the establishment of a self-sustaining population of Black Carp in the middle Mississippi River near St. Louis, Missouri; as well as the presence of diploid (fertile) Grass Carp in Lake Ontario and Lake Erie, highlighting the evolving nature of the challenge posed by Asian carp. Accordingly, agencies are developing strategies and approaches to further address these additional species while continuing to focus on prevention of Bighead and Silver Carp population expansion and introduction.

Silver Carp were first imported into the United States in the early 1970s to control phytoplankton blooms in sewage lagoons and as a potential addition to fish production ponds. By 1975, Silver Carp were collected from Bayou Meto and the White River, Arkansas, and by 1981 collected from the White, Arkansas, and Mississippi Rivers in Arkansas. Silver Carp are now well established throughout much of the Mississippi River basin and are expanding in the Ohio River and other basins. In addition to concerns over ecological and related economic impacts, Silver Carp pose an additional threat to human safety, as they regularly jump out of the water when disturbed, particularly in response to outboard motors. Silver Carp was listed as Injurious under the Lacey Act in 2007, making it illegal to import or to transport live fish, including viable eggs or hybrids of the species, across state lines, except by permit for zoological, education, medical, or scientific purposes. Current records indicate Silver Carp collections from 22 states.

Bighead Carp were imported from eastern China to Arkansas in the 1970s to improve water quality in aquaculture ponds and sewage treatment lagoons. The fish, which can grow to 60 or more pounds, have since spread through the Mississippi River basin and have been collected as far north as Lake Pepin in Minnesota. The species was listed as Injurious under the Lacey Act in 2011. Current records indicate Bighead Carp collections from 28 states.

Grass Carp have historically been used by resource managers as a means of combating nuisance aquatic vegetation in ponds and lakes in the United States. Records indicate that, by the mid-1970s, this species had been stocked in at least 45 states. Although not considered widely established outside of the Mississippi River Valley (except in Texas), Grass Carp are now the most widespread species of Asian carp in North America (currently documented in 45 states and Puerto Rico, and the Provinces of Ontario and Quebec). Additionally, new information provides evidence of successful Grass Carp reproduction in the Sandusky River, a major tributary of the western basin of Lake Erie in Ohio.

Black Carp represent the fourth species of Asian carp imported into the United States in the early 1970s, likely in conjunction with the importation of one or more other Asian carp species. Black Carp grow to relatively large sizes and are longer lived than other species of Asian carp. As a molluscivore (feeds on mollusks and snails), its preference is to occupy benthic areas of rivers, making it suited for use as a desired biological control agent of snail populations in aquaculture ponds. Because of its known feeding ecology, its escape into the Mississippi River raised significant concern among resource managers for the long-term viability of the historical native mussel fauna in the Upper Mississippi River Basin, of which 70 percent are already imperiled or already extinct. Black Carp remains a preferred method of snail control in states with an established aquaculture industry. Requirements governing their management, use, and intrastate transportation vary from state to state. Since 2007, they have been listed as an Injurious species under the Lacey Act. A notable rise in Black Carp captures was seen in 2016, with a total of 26 captures to date (the highest-ever annual catch). Current records indicate Black Carp collections from 6 states.

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

Assessments of the risks posed by Asian carp and related management strategies are directly informed by the most current and accurate data on species distribution and range expansion over time. Figure 4 shows the relative abundance of Silver and Bighead Carp in distribution throughout the United States as of October 2015. This diagram demonstrates the dynamics of the expanding populations, with fish densities and evidence of reproduction (including larval fish) progressively reduced toward the upstream boundaries of range of occurrence. This and other monitoring information is critical to informing the most effective use of specific strategies for early detection/monitoring, as well as prevention and control.

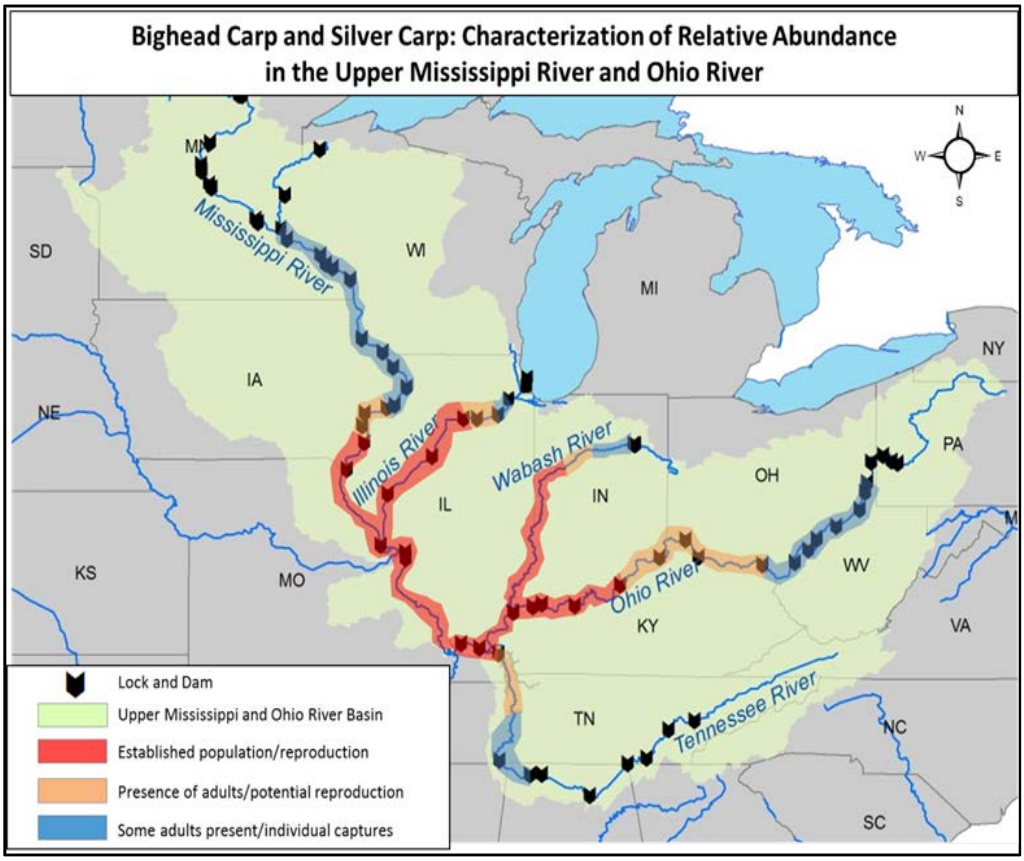


Figure 4. Bighead and Silver Carp Relative Abundance in the Upper Mississippi River and Ohio River

Figure 5 illustrates the documented occurrences of the individual species of Asian carp waters of the Midwest United States. Data were collected for development of the interagency Water Resources Reform and Development Act of 2014 (WRRDA) 2015 Report to Congress on Asian Carp, and was provided by state and federal agency partners. Analysis of the changes in geographic range of occurrences between reporting timeframes shows some additional range expansion over the timeframe. A more detailed summary of Asian carp monitoring and detection in the CAWS and upper IWW is provided in Section 1.6 of the Action Plan (Bighead and Silver Carp Population Status in the CAWS). These data demonstrate that: (1) the observed range of Silver Carp increased upstream in the Mississippi River, Tennessee River, and into Ohio River tributaries of Indiana; (*2) the observed range of Bighead Carp increased upstream in the Mississippi River and St. Croix River; (3) the observed range of Grass Carp did not increase in the Upper Mississippi River Basin or Ohio River Basin; however, diploid Grass Carp were detected in new locations in Lake Erie and Lake Ontario; and (4) the observed range of Black Carp increased in the Mississippi River, with the first-ever evidence of successful reproduction in the wild.

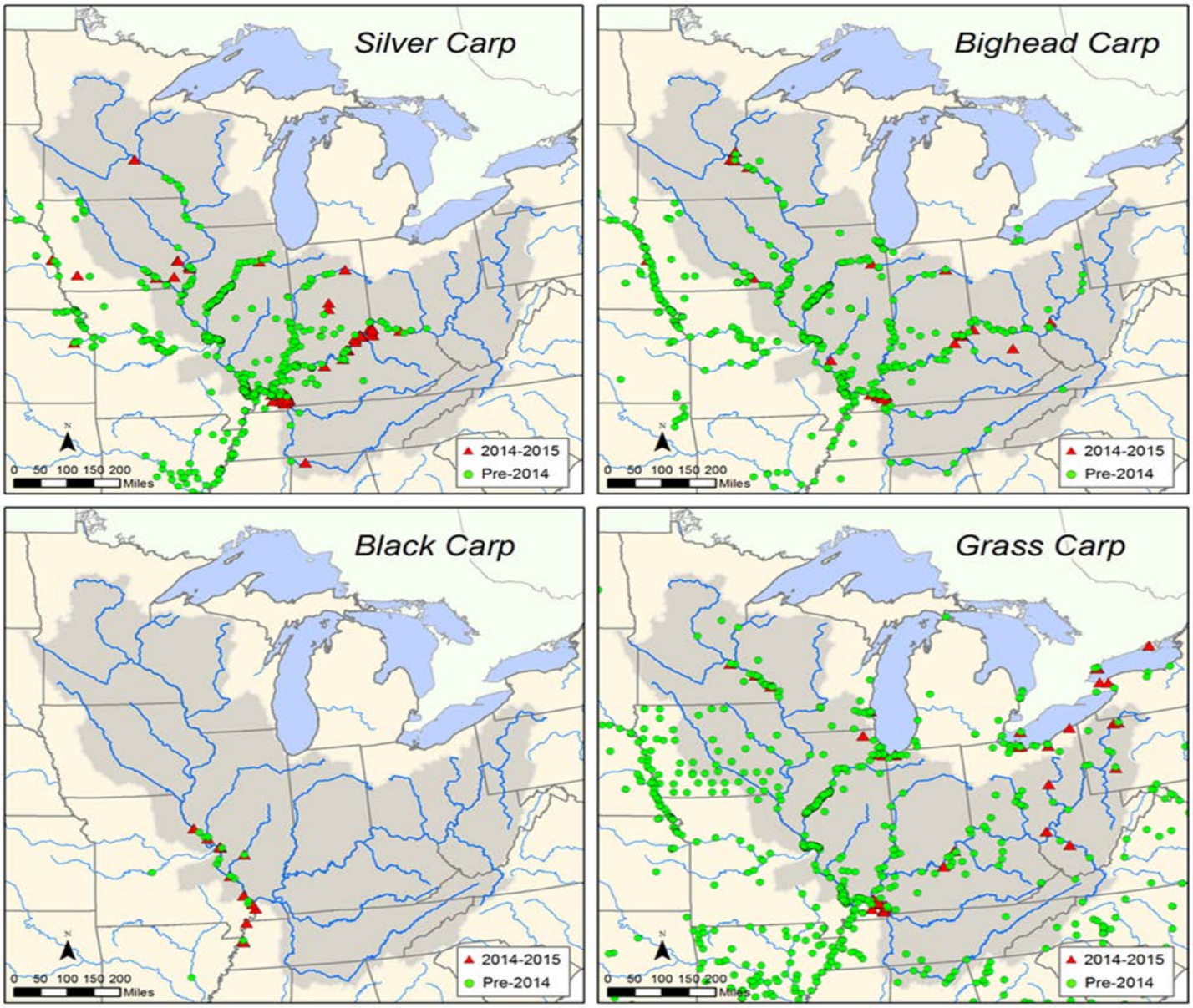


Figure 5. Recorded Occurrences of Silver, Bighead, Black, and Grass Carp before 2014 and from 2014 to 2015

Populations of Bighead and Silver Carp in the Illinois River are generally characterized by pool. For reference, Figure 6 illustrates the pools in the upper Illinois River.

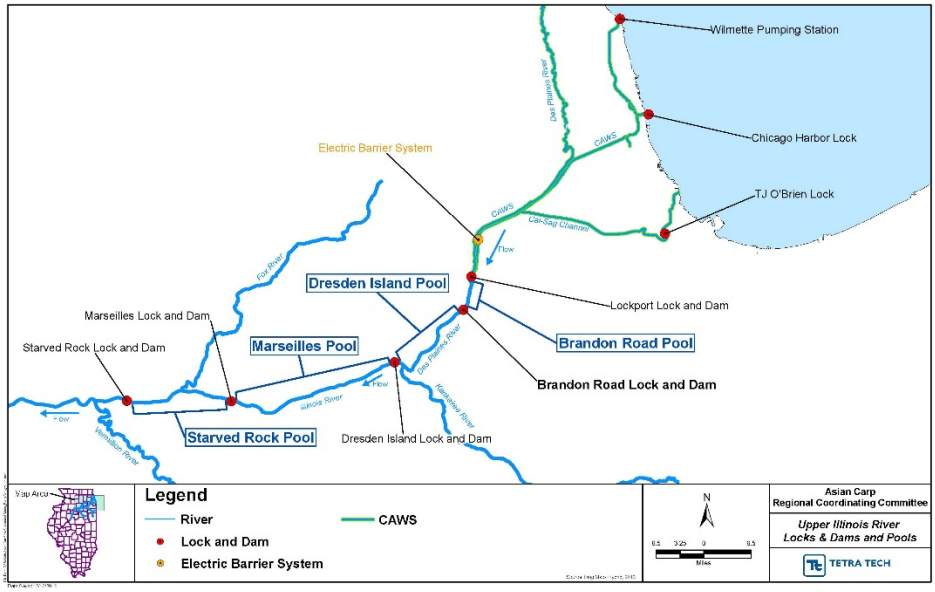


Figure 6. Map of Upper Illinois River

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

No Asian carp less than 6 inches were found above Starved Rock pool in 2016. However, as 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 smaller 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, 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 to 10.0 millimeters (mm) (0.33-0.39 inches) total length. Asian carp eggs (either Silver or Bighead Carp) were also identified from samples collected from Marseilles and Starved Rock pools of the Illinois River, as well as from downstream pools (LaGrange and Peoria). These detections are within areas that Bighead and Silver Carp have historically been captured; however, these were the first collection of larval fish upstream of Henry, Illinois (approximately 90 miles downstream on the Illinois River from this detection location in Dresden Island Pool). No additional Asian carp larvae were collected in this 90-mile stretch of the Illinois River in 14 sampling visits from April 2015 to September 2015. The Asian carp monitoring and harvest effort in Dresden Island Pool are illistrated in Figure 7 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.

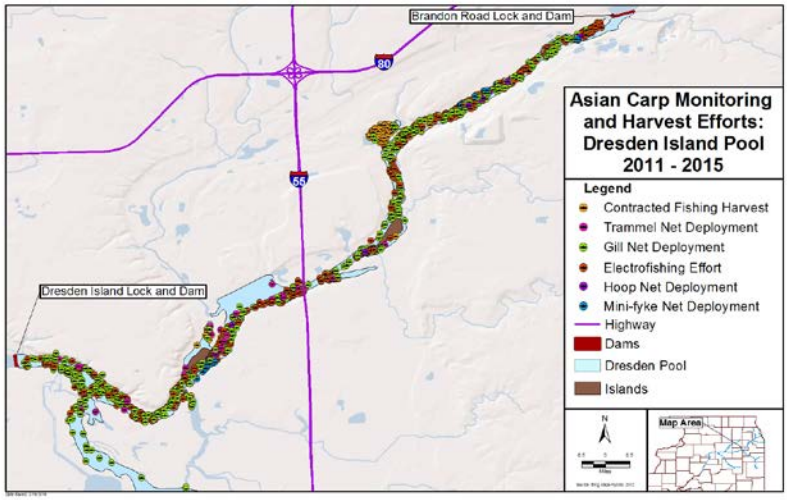


Figure 7. Monitoring and Harvest Efforts in Dresden Island Pool

Given the concern about these findings, the 2016 Monitoring and Response Plan included heightened efforts to detect such spawning events. Currently, the MRWG does not believe that either Asian carp species is likely established in the upper Illinois River. Monitoring efforts 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.

Most recently, relative abundance of Asian carp in Dresden Island Pool (the most upstream pool where they are found) has shown significant declines from 2012 to 2014. This reduction is most likely attributed to contracted fish removal efforts and determined using hydro acoustic surveys of the MRWG. Most recent surveys suggest relative abundance is being maintained at the lower levels. Additional removal efforts in these pools have been programed by MRWG starting in 2016 to further reduce carp populations. Total effort by contracted fishing was increased by 50 to 100 percent in the Starved Rock, Marseilles and Dresden Island pools starting in 2016.

As of fall 2016, MRWG concluded that the adult population front of Bighead and Silver Carp is approximately 47 miles and two lock structures from Lake Michigan in Dresden Island Pool. Three larval silver carp were captured during June 2015 in Dresden Island Pool as noted above, with no further detections since despite heightened surveillance. Predictive modeling suggested to MRWG agencies that it is unlikely these were produced in upstream locations and were most likely transported there by other means. No small fish (< 6 inches) have been detected in Dresden Island or Marseilles pools by MRWG efforts to date. While spawning of Asian carp and eggs have been noted in both Marseilles and Starved Rock pools, no larval fish have been detected in these pools. All life stages (eggs, larval, small Asian carp, and juvenile/adult Asian carp) have been detected in the lower three Illinois Waterway pools of Peoria, LaGrange, and Alton. These pools are over 100 miles away from Lake Michigan. This information is illustrated in Figure 8.

Monitoring & Response Plan

The Action Plan is based on the Monitoring and Response Plan (MRP), including a recently added section on contingency actions. This MRP uses the best science to help ACRCC members make the most effective management decisions under the Action Plan.

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

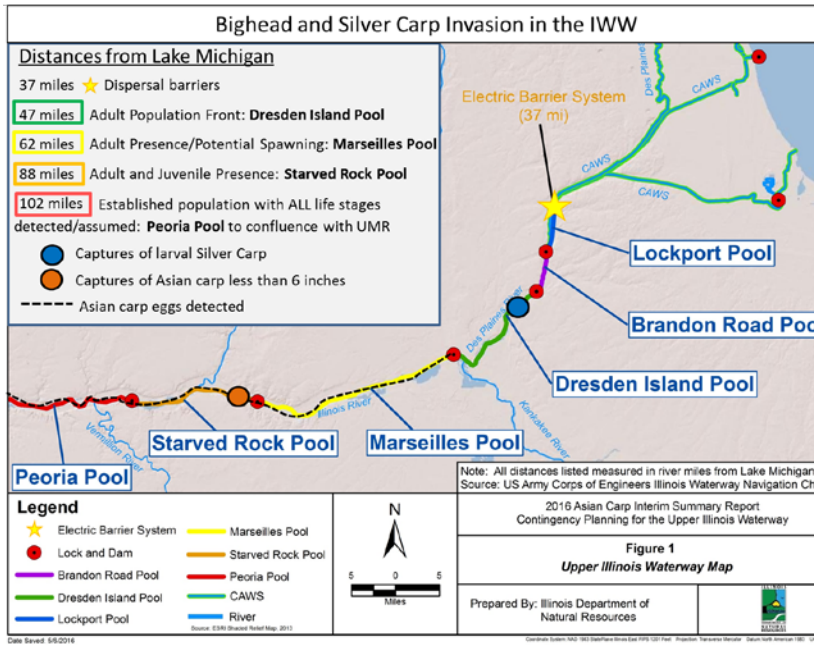


Figure 8. Bighead and Silver Carp in the IWW

In 2017, binational ecological risk assessments are expected to be completed for Grass Carp. A Black Carp risk assessment is also currently ongoing and expected to be completed in 2017. 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. The writing team for both assessments consists of Department of Fisheries and Oceans–Canada, Great Lakes Fishery Commission (GLFC), U.S. Geological Survey, and the U.S. Fish and Wildlife Service.

In 2016 the interagency MRWG prepared a Contingency Response Plan that describes specific actions within the five navigation pools of the Upper IWW - Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock Pools. This plan will be implemented to carry out response actions in the event a change is detected in the status of Asian carp in those pools that would indicate an increase in risk level. The MRWG has maintained a robust and comprehensive Asian carp monitoring program in the Contingency Response Plan area and will continue these efforts as the foundation for early detection capability in the IWW. Annual interim summary reports describing these efforts (including extent of monitoring and Asian carp detection probabilities) can be found at www.asiancarp.us. Based on this experience, MRWG is confident in its ability to detect changes to Asian carp status in the navigation pools in the upper IWW and respond accordingly.

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 effort has since evolved beyond a singular focus on the CAWS to now include other potential pathways for Asian carp introduction, including secondary pathways of AIS introduction as indicated in the Great Lakes and Mississippi River Interbasin Study (GLMRIS) report. The ACRCC's efforts are now binational and Great Lakes-basin wide in scope, encompassing 27 agencies and organizations in the United States and Canada. The ACRCC's efforts and mission are complementary to other interagency resource governance initiatives to address AIS threats in the Great Lakes, and the partnership strives to coordinate broadly and regularly with all entities.

2.1 2016 KEY EFFORTS COMPLETED OR UNDERWAY

Numerous key initiatives were addressed through the 2016 Asian Carp Action Plan. 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:

Figure 9. Completed Eagle Marsh Berm, 2016

Closure of Eagle Marsh Pathway – The aquatic pathway between the Great Lakes and Mississippi River basins at Eagle Marsh in Fort Wayne, Indiana, has been separated. The construction of a new earthen berm across the floodway at Eagle Marsh prevents the interbasin passage of Asian carp into Lake Erie from the Wabash River.

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 U.S. Geological Survey (USGS) led this effort, seeking 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 (CO_2) effects on fish behavior in open-water. Efforts were initiated by USGS and the U.S. Fish and Wildlife Service (USFWS) on the registration process for the use of CO_2 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 with USFWS, National Environmental Policy Act (NEPA), and all other regulatory requirements.

Microparticle Technology Development – Building on research through 2015, USGS refined microparticle formulations to target delivery of control agents to Asian carp. Laboratory studies were completed to improve antimycin-laden microparticle formulations to address delivery challenges and to improve efficacy. Controlled pond studies were conducted to assess antimycin microparticle uptake by Bighead Carp and Silver Carp in the presence of Grass Carp and Largemouth Bass. A larger-scale field trial was completed in the fall of 2016 to assess uptake of a non-toxic marker in identically formulated microparticles, facilitating initial assessments of microparticle delivery. Additional microparticle development will be ongoing in 2017.

Electric Barriers – USACE continued construction of an additional permanent electric barrier in the CAWS upstream of the existing Barrier II with increased capability to stop fish passage. The construction will continue in 2017.

Barge Entrainment – In 2016, USFWS coordinated with agency partners and industry to plan and conduct field studies to: (1) further examine the potential for entrainment, retention, and transport of early life stages (eggs/larvae) by barge traffic, (2) quantify barge entrainment and transport rates for wild fish in the Illinois Waterway and across the Electric Dispersal Barrier, (3) determine upper fish size thresholds for barge entrainment, (4) examine non-entrainment related pathways for fish passage at the electric dispersal barrier concurrent with barge passage (return currents/electrical sagging), and (5) examine non-entrainment related pathways for fish passage at the Electric Dispersal Barrier concurrent with barge passage (return currents/ electrical sagging), and (6) evaluate potential operational protocol mitigation procedures for discouraging barge entrainment and transport of fish. These studies are building on results from earlier evaluations that demonstrated the potential for small fish to be inadvertently entrained between transiting barges and transported through lock structures and across the electric dispersal barrier. Additionally, USACE investigated mitigation techniques to minimize the entrainment of fish and other organisms in a laboratory setting. Measures that appear to be effective in the laboratory will be field tested in 2017.

Young-of-Year and Juvenile Asian Carp Monitoring – In 2016, sampling for Young-of-Year (YOY) and juvenile Asian carp continued through netting and electrofishing operations, maintaining an emphasis on collecting important data for small Asian carp (less than 6 inches). Continued sampling for Asian carp of early life stage is planned for 2017 to further inform population status and inform management actions. In 2017, continued enhanced sampling for YOY and juvenile Asian carp will continue through netting and electrofishing operations as well as deployment of small meshed seines specifically documenting changes in these small Asian carp (less than 6 inches).

Figure 10. YOY Grass Carp, La Crosse Fish Health Center

Develop and Deploy New and Novel Gears – In 2016, ACRCC partners continued to develop, deploy, and assess the value of new, current gears as well as deployment methods for more effectively sampling Asian carp of various life stages, with an emphasis on improving detection of small fish (larval and juveniles) as well as maximizing removal. Novel ways of fishing the Great Lakes with fyke nets and further utilizing Chinese Unified fishing methods may increase these removal efficiencies.

eDNA Monitoring – In 2016, 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. Ten point-of-use Asian carp eDNA detection kits were deployed to law enforcement officers of three Great Lakes states. The detection kits will be used to detect the presence of Bighead Carp or Silver Carp DNA in baitfish.

National Asian Carp Control – USFWS increased its leadership role on interagency coordination for Asian carp prevention, as directed by Congress under the WRRDA. This role included providing funding for Asian carp management projects in support of strategies in both the Upper Mississippi River and Ohio River basins in 2016, with the goal of preventing upstream spread. This effort will continue in 2017 and out years, based on available resources.

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 Websites – The ACRCC web site, *www.asiancarp.us*, expanded its content to include information and actions dealing with Asian carp across the United States, to include 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. Additional content is being developed by the multi-agency Communication Workgroup that will allow for other medium to be used to share ACRCC findings and updates.

2.2 2017 KEY INITIATIVES

ACRCC initiatives for 2017 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, ACRCC is continuing its focus on development of control alternatives at Brandon Road Lock and Dam to further advance pathway closure opportunities. These key initiatives are highlighted below:

2.2.1 Pathway Closures and Control Measures

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

Operate 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 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 farther into the field. Three barriers (Demonstration, IIA, and IIB) are currently operated by

USACE. In addition, bar screens on sluice gates at Thomas J. O'Brien Lock and Dam were installed to impede entry of Asian carp to Lake Michigan. All potential impacts were considered to ensure public health and safety, and the purposes of these structures 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. In 2016, Barrier IIA was outfitted with an uninterrupted power supply (UPS) to ensure continuous delivery of power in the event of a utility power outage. In 2017, operation and maintenance of the barriers by USACE will continue, including regularly scheduled maintenance of the electric barriers. Additionally, an upgrade of Barrier IIA's cooling system is planned in 2017.

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 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.

Figure 11. Barrier I Construction, 2016

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. Three species of concern (Scud, Bighead Carp, and Silver Carp) are 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.

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, Policy Review, and NEPA review. In future years, the USACE plans submit an Agency Decision Milestone document, conduct more detailed engineering analysis of the Agency Decision Milestone Plan, complete a feasibility-level report, submit a Civil Works Review Board document for review, and publish a Chief's Report.

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.

In addition, USACE and USGS will be developing designs and plans for deployment of complex noise, carbon dioxide, and possibly other technology barriers of up to 7 days in the approach channel at the Brandon Road Lock and Dam.

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 (ODNR) has facilitated numerous meetings with the Medina Soil and Water Conservation District, U.S. Department of Agriculture Natural Resources Conservation Service, and the primary landowner. A consultant completed a preliminary investigation of closure options at the Little Killbuck Creek connection site. This study refined the closure options so that a final engineering study can be completed. The consultant for the final design was selected and the final engineering design will be completed by June 2017. During this period, ODNR will 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 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 a low risk for Skipjack Herring. There is no risk from transfer of AIS in the opposite direction. The ODNR and the USACE identified two primary areas of concern:

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

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. The designs for these measures has been completed. USACE plans to assist ODNR in completing all necessary environmental compliance, coordination requirements, and public outreach in preparation for construction. USACE will be the implementing agency for construction.

Addressing potential barge entrainment –In 2016, USFWS coordinated with USGS, USACE, other agency partners, and the maritime industry to plan and conduct new field studies to further examine the potential for entrainment, retention, and transport of early life stages (eggs/larvae) by barge traffic, quantify barge entrainment and transport rates for wild fish in the Illinois Waterway and across the electric dispersal barrier, determine upper fish size thresholds for barge entrainment, examine non-entrainment related pathways for fish passage at the USCE electric dispersal barrier concurrent with barge passage (return currents/electrical sagging), and evaluate potential operational protocol mitigation procedures for discouraging barge entrainment and transport of fish. These studies build on results from earlier field evaluations that demonstrated the potential for small fish to be entrained between transiting barges and transported. Trials conducted in 2015 investigated the likelihood that small fish could become trapped in the underwater spaces between commercial barges and inadvertently transported over various distances, through lockages, and across the USACE electric dispersal barrier. Results demonstrated that small fish can become entrained between barges and subsequently transported measurable distances (up to 9.6 miles), through a lock and dam system, and over the electric dispersal barriers. Using larvae and egg collections made by the USFWS in June of 2016, the USGS, using existing tools and data will begin to develop a decision support system to assess and manage the risk and possibility of Asian carp egg/larval entrainment and transport. Results from these studies conducted in 2016 are currently being finalized and evaluated.

In 2017, USFWS will continue to work with partner state and federal agencies and maritime industry representatives to identify and address other potential priority study needs, opportunities, and management options.

Also, in 2017, USGS will also initiate laboratory studies to assess the time to response of Silver and Bighead Carp to CO_2 to determine the time and concentration of CO_2 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.

Figure 12. Field Testing the use of Complex Sound to Move Asian Carp

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 USFWS and partnering agencies will be collaborating with maritime industry representatives to identify potential 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, as well as the upstream Dresden Island Pool. Efforts in 2017 will continue at 2016 levels:

- The scheduled intensity in 2016, and efficiencies gained by experience, has provided increases in catches, exceeding 1 million pounds removed in 2015 alone, and exceeding those expectations in 2017.
- Consistent and increased use of seines to further increase total removal efforts, including increased efforts to detect and remove small Asian carp.
- As Asian carp population abundance changes, nets configurations will be set to optimize removal efforts.
- Scheduling deployment of a Chinese unified fishing method in 2017 will build upon success of near 80 percent estimated removal from a backwater in 2016. This technique may assist in removal and detection efficiencies when deployed.

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, are 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 occurred in 2016, based on the increased detection rates of small fish (less than 6 inches in length) in the upper IWW during 2015; no Asian carp less than 6 inches were found above Starved Rock pool in 2016. Illinois Natural History Survey crews also increased surveillance efforts at the mouth of Kankakee River with multiple gears and increased frequency in 2016. Data processing 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 2016, the Paupier and a smaller electrified frame trawl (dozer trawl) were used to target areas suspected as nursery habitat and backwater sites where concentrations of juvenile Silver Carp were captured in 2015. Of the nearly 700 Silver Carp captured during these monitoring efforts, none were smaller than 6 inches, less than 1 percent were smaller than 8 inches, and the average length was over 20 inches. These catch rates in comparison to 2015 indicate a smaller year class in 2016.

In addition to monitoring juvenile Asian carp, in 2016 a standard river vessel was modified and successfully deployed and retrieved a purse-type seine in riverine environments. Deployments of the prototype net further informed design of the “Lampara” and “Danish” style purse seine nets. Efforts were halted during warm weather when techniques utilizing electricity were more successful at catching Asian carp but will resume with the falling water temperatures.

In 2017, the USFWS will continue work with appropriate partners to develop, adapt, and refine standard protocols for construction and use of small-mesh, lightweight, purse-type seines in the CAWS to target concentrations of juvenile Asian carp for removal. This size of carp is 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 the fish. Deploying these purse-type nets may be a better method for removing large numbers of small fish, potentially halting the advance of juvenile Asian carp toward the Great Lakes. Emphasis will be placed on developing these gears for use by a standard river vessel and crew to target concentrations of juvenile Asian carp as part of ongoing removal efforts. If effective, efforts will continue with these gears on an annual basis to remove concentrations of juvenile Asian carp.

2.2.3 MRWG Contingency Response Plan

In 2016 the MRWG identified a gap in their annual Monitoring and Response Plan to address specific response actions to be taken in the IWW in the event a change is detected in the status of Asian carp in that waterway system. Thus, in addition to the robust and comprehensive Asian carp monitoring program that focuses on monitoring, management, and response actions maintained by the MRWG, the

Contingency Response Plan further solidifies the coordination and communication processes for stakeholder agencies and outline specific scenarios that may trigger response actions to be taken considering the degree and location/pool of change detected.

The Contingency Response Plan describes specific actions within the five navigation pools of the IWW — Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock pools (river miles 327 down to 231) (see Figure 8, page 12 above). This plan will be implemented by the MRWG to carry out response actions in the event a change is detected in the status/risk considering all life stages of Asian carp in those pools.

The goal of the contingency plan is to provide a process to consider appropriate and specific response actions that fully consider available tools and the authorities of member agencies to implement actions. The intent is for the plan to be clear and easy to understand while allowing flexibility needed to ensure response actions fully address situation-specific issues. This plan will also provide for open and transparent communication with the public and special stakeholder groups.

Existing plans for responding to the collection of Asian carps or changing barrier operations have been in place since 2011 and provided guidance focused on potential actions that could be undertaken in and around the USACE electric barrier system and in the CAWS, upstream of the Lockport Lock and Dam (River Mile, RM 291). The ACRCC relies on electric barriers within the Chicago Sanitary and Ship Canal (CSSC) at Romeoville, IL, operated by USACE, as a key tool to prevent the establishment of Asian carp in the Great Lakes Basin. As a result, the Contingency Response Plan reduces pressure by Asian carp on the electric barriers.

The Contingency Response Plan expands the geographic scope of existing contingency planning efforts, as well as the scope of potential tools to be utilized in such an event. The plan also considers barrier operations and status and is complementary and additive to the existing response plan in the MRP. To effectively gauge the risk level of Asian carp, and potential response actions, in the target areas of the IWW the plan compares baseline data to changes in the following areas: (1) navigation pool, (2) life history, (3) relative abundance, (4) electric barrier functionality, and (5) other habitat characteristics.

Command and control of an Asian carp response in the IWW will be implemented under the MRWG. The Incident Command System (ICS) is a management system designed to enable effective and efficient incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure. The MRWG will utilize the ICS to manage response operations to maximize efficiency and ensure a standard approach across all participating agencies (Figure 13).

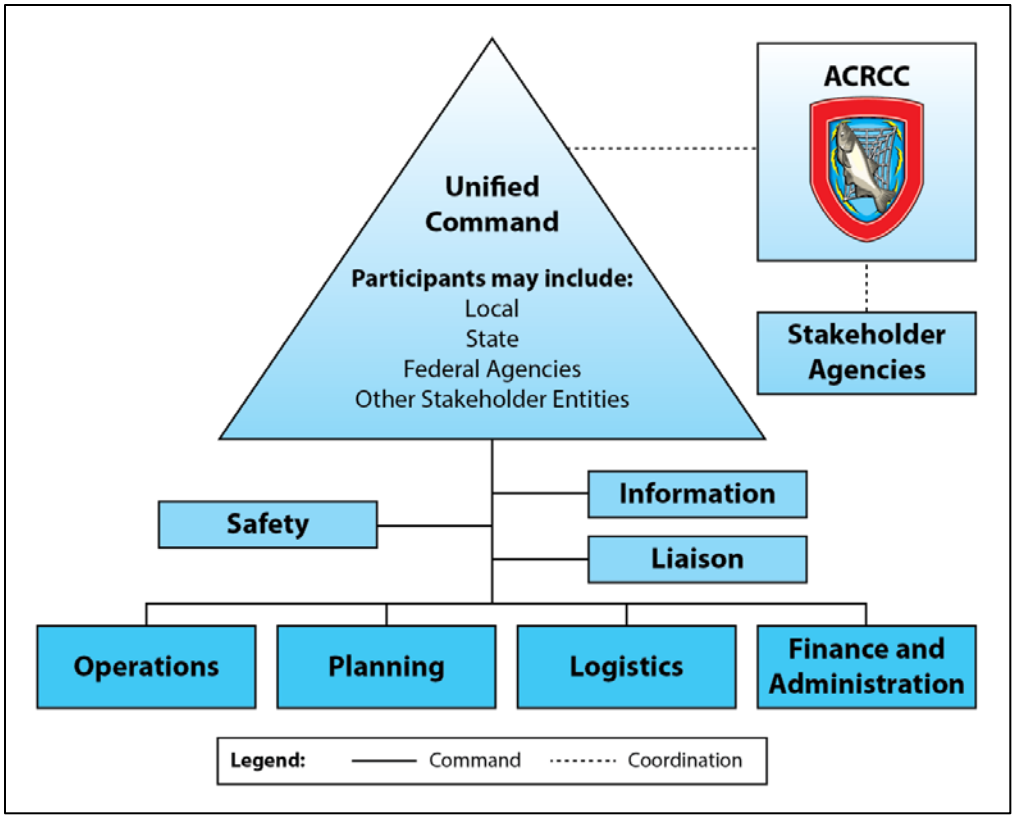


Figure 13. Unified Command Organization Structure

The plan is a living document that will evolve over time as information changes and additional tools are developed e.g., ozone, hot water, microparticles, water jets, pheromones/other attractants, CO_2, or other unspecified tools).

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

2.2.3 Development of New Control Technologies and Strategies

Figure 14. Laboratory Testing of Microparticle Effects on Asian Carp.

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 2017, 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 CO_2 microparticles, and complex sound, as identified below:

Carbon Dioxide (CO_2) – One candidate barrier chemical that has received a great deal of attention and shown promise based on preliminary results is CO_2. . In 2017, the USGS, USACE and other partners will develop comprehensive planning assessments for deploying CO2 at a lock and/or approach channel to deter Asian carp movement. USGS and partners will also conduct applied field studies to demonstrate potential management applications such as use for blocking Asian carp access to backwater areas of the Illinois River or to enhance Asian carp removal efforts. USGS will also publish a report and associated data describing the use of CO2 injected under-ice to enhance overwinter mortality of Asian carp. Studies with potential non-target species will continue in order to address USFWS Section 7 ESA-consultation requirements. The cost and efficacy of different CO_2 delivery systems will be examined to identify systems with utility for CO_2 field deployments. USGS will continue registration efforts with USFWS to initiate regulatory applications for Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 18 exemption and other required federal and state permits to allow agencies to implement a CO_2 barrier or to allow other uses of CO_2.

Microparticle – No current technology can specifically target Bighead or Silver Carp for control. 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. USGS scientists have finalized the formulation of a targeted toxin (antimycin) delivery system in the form of a coated micro-particle with high specificity for Bighead and Silver Carp to control or limit Asian carp while minimizing potential impacts on native species. Pond trials have been completed

and preliminary results indicate Bighead and Silver Carp mortality and no mortality of largemouth bass; and that the microparticles are not leaching the toxin when put in the water. Preliminary results also show that using algae as a food attractant enhances Asian carp consumption of microparticles. Studies were also initiated to develop a toxin delivery system for grass carp control. In 2017 scientists plan to conduct a large-scale field assessment of particles that will include a population assessment of invertebrates and vertebrates pre- and post-exposure to identify which species are likely to be impacted by the use of particle during a management action. A publication will be submitted on the results for the development and testing of the microparticle. This manuscript will include the development of the formulations, laboratory efficacy trials and the pond trials. USGS will work with USFWS and USEPA to complete the protocol for and initiate environmental fate studies of antimycin-incorporated microparticles, and to initiate USFWS Section 7 Endangered Species Act-consultation data in preparation for implementation of microparticles as a control tool in specific locations.

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 2017, 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. 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. Furthermore, in 2017 the USACE will be installing initial speakers and monitoring sound field produced for approximately 7 days to provide the modelers with information on how sound travels through the channel. Coordination and communication between USGS and USACE on engineering considerations — speaker location, power, monitoring equipment location, minimizing navigation impacts — will assist in moving this technology forward.

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. USGS research on Grass Carp is diverse, focusing primarily on understanding biology and hydrologic factors related to biology. A foundation of knowledge on biology and hydrologic drivers is being built that will provide managers with the information needed to formulate potential control and management strategies and tactics under the IPM framework. In 2016 scientists collected egg and larval samples for grass carp presence and the FluEgg simulation model was used to estimate spawning and hatching locations of Grass Carp eggs in the Sandusky River. Remote sensing imagery was used to detect and map where submerged aquatic vegetation (SAV – preferred food of grass carp) does/does not occur and generated maps for western Lake Erie. This work will continue in 2017 including completing maps of SAV for the eastern half of Lake Erie. Research papers will be published on age and growth of Grass Carp in the Great Lakes, and on potential spawning locations and movements of Grass Carp in the Great Lakes. A USGS stream gage was installed near the mouth of the Sandusky River that will provide essential hydraulic data including observations of velocity magnitude and direction which will be used to assess the performance of a hydraulic model that provides critical input to the FluEgg simulation model.

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 2017, 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 MRP) will continue in 2017. 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 2017 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 six 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 2017 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 – In 2017, USFWS will continue to conduct sampling for larval and juvenile Asian carp using netting and electrofishing operations. The collection of small fish, and their relative abundance in the Upper IWW, will continue to provide key information to

inform level of risk of Asian carp movement toward Lake Michigan and remains one of the primary focus for agency monitoring efforts.

Comprehensive Interagency eDNA Monitoring Program – In 2017, USFWS will continue to lead the comprehensive interagency eDNA monitoring program in support of actions identified in the ACRCC's current Monitoring and Response Plan, and in conjunction with standard gear sampling conducted in priority areas. These efforts will build upon eDNA sampling results from 2016 and prior years. In addition, analysis of samples collected from the IWW, CAWS, and other priority waters in 2017 will include additional analysis for the detection of Black Carp, after 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 increasing occurrence of Black Carp farther downstream in the Mississippi River basin middle Mississippi River near St. Louis, Missouri). In 2017, USGS will further develop their point of use eDNA testing kits.

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 and 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 2017, the ACRCC will continue to develop a model that will provide significant predictions 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 will use a diverse array of traditional and novel gears to sample all potential life stages of Asian carp species. In 2016, 4,891 eDNA water samples were collected and our traditional method work continued with no observation of Asian Carp. In 2017, 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.

Ecosystem Risk Assessments – NOAA will continue to model the potential risk of Asian carp (Bighead, Silver, Black, and Grass) on Great Lakes food webs. This will be accomplished by modeling how Asian Carp affect the food webs of the Great Lakes ecosystem. 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 (EwE) model assesses Asian carp effects on a whole lake scale, but

ignores effects of physical variables and doesn't include heterogeneity in predator prey dynamics over horizontal over vertical spatial scales. A spatially-explicit, individual-based bioenergetics model (IBM) 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. In 2017, NOAA will evaluate potential impacts to the Lake Ontario food web using an EwE model.

Contingency Planning 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 involved 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 continue to assess Grass Carp populations in the CAWS and IWW to better understand their status and potential for movement into 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, developed a new qualitative Polymerase Chain Reaction (qPCR) marker for use in Black Carp eDNA monitoring in 2016, following a validation trial in independent laboratories. An incentive program ($100 reward per fish) continues to be maintained under Illinois DNR's leadership, encouraging commercial fishermen to report and donate all wild-caught Black Carp for research. Collections made through this program provide critically needed data on Black Carp resulting from the historical lack of captures of this species in the wild. This incentive/bounty helps get information from the few fish that fisherman may otherwise just send to the market. In 2017, 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.

Figure 15. Black Carp Capture, Southern Illinois University

Opportunities for Additional Collaboration – In 2017, 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 – and more broadly address the threat region-wide, across multiple basins, where possible.

2.2.5 Communication and Outreach

The USFWS has hosted and administered *AsianCarp.us* website since 2011. In 2016, *AsianCarp.us* continued to be the ACRCC's central platform for public outreach and education. As the site administrator, USFWS maintains and develops the website, working toward a goal of increased visits from the public and stakeholders. Since first launched in 2011, the site has reached more than 120,000 unique visitors from around the world. Website highlights from the last year include 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, as well as promoting video content on the multimedia page. In 2017, the website will continue to be expanded to encompass emerging topics related to Asian carp such as Grass Carp and Black Carp issues and federal and state actions in the Upper Mississippi River and Ohio River basins, as outlined in the WRRDA. On-line outreach and communications will be augmented by implementing the ACRCC's first social media strategy. In FY17, National Park Service (NPS) will work with the ACRCC partners and teachers and begin a new project to develop Asian carp specific education materials, Asian carp "traveling trunks" and consolidate relevant education materials on the asiancarp.us website. The creation of a new strategic communications plan will also serve to extend the reach of ACRCC messaging and help key audiences develop a greater understanding and appreciation for the ACRCC's purpose, function, current actions, and successes.

The CAWS Advisory Committee works to engage stakeholders and reach consensus on solutions to prevent Asian carp from establishing populations or moving through the CAWS. The CAWS Advisory Committee includes diverse stakeholders working to build consensus and advance development of both interim control measures and a long-term solution to prevent the transfer of Asian carp and other AIS through Chicago-area waterways while maintaining current uses of the system. The committee includes 35 public and private stakeholders from the Chicago-Northwest Indiana area as well as regional stakeholders representing commercial, recreational, and environmental interests. A Resource Group supporting the committee includes U.S. and Canadian federal, state, and provincial agencies, tribal authorities, and regional agencies. The Advisory Committee was convened by the Great Lakes Commission in 2014 and is supported by a neutral facilitation team, with funding provided by the Asian Carp Action Plan and several regional foundations. It meets four times per year and receives reports from the ACRCC, USACE, USGS, USEPA and others working to prevent AIS transfer through the CAWS.

The Advisory Committee has issued consensus recommendations on the Brandon Road Feasibility Study and a framework for a long-term solution focused on a system of control points in the CAWS using AIS locks, consistent with the mid-system locations identified in the GLMRIS study. With support from its technical consultant, HDR Inc., it evaluated the risk of AIS transfer and impacts to navigation from potential AIS control measures and implications for water quality, flood risk management and other issues. The committee's work plan moving forward focuses on the analysis of hydrology, hydraulics, and water quality implications of deploying AIS controls in the CAWS; AIS lock treatment concepts; multijurisdictional financing options; nonstructural AIS control actions; impacts to maritime transportation from AIS controls in the CAWS; and how AIS affect the Great Lakes and Mississippi River. The Tentatively Selected Plan and eventual Chief's Report under the Brandon Road Feasibility Study will be a major focus of the committee in coming years. The Advisory Committee's products are available on line at http://glc.org/projects/invasive/chicago-waterway/.

2.2.6 Interbasin Collaboration

Coordination between agencies and organizations working to address Asian carp prevention continues to increase both within and between basinwide partnerships. WRRDA , called for enhanced interagency collaboration within the Ohio River and Upper Mississippi River basins for the purpose of preventing the expansion of Asian carp. The enactment of WRRDA has supported stronger interagency partnerships and increased collaboration between basinwide partnerships in the Upper Mississippi River and Ohio River basins, promoting a more regional approach to Asian carp management. Collaboration between these efforts and the ACRCC continues to expand, guided by the common goal of Asian carp prevention and control in the waterways of the Midwest United States. Strategies used by the basinwide partnerships share common objectives (e.g. development and implementation of new control tools; collection and use of current population monitoring data), offering opportunities for leveraging of resources, new knowledge and technology, and lessons learned on Asian carp management. 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. Strong interbasin collaboration continued in 2016 and is demonstrated in the U.S. Fish and Wildlife Service's Report to Congress: Summary of Activities and Expenditures to Manage the Threat of Asian carp in the Upper Mississippi and Ohio River Basins, which summarizes accomplishment and expenditures to manage Asian carp in the region. This collaborative document also identifies emerging research and technology with the potential for broad application across basins, as well as the most current status of all four Asian carp species.

Collaboration and coordination between basins will continue in 2017, based on available resources, 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. Actions include a comprehensive interbasin planning workshop including state and federal agencies and non-governmental organizations, planned for January 2017, to collectively develop a strategic and comprehensive approach to inform basin-specific annual workplans, including portfolios of high-priority prevention and control projects. Additionally, the partnerships will continue to work to identify and address potential pathways posing a risk as a vector of transfer for the introduction of Asian carp populations between basins. Interbasin coordination in 2017 will continue to include member agencies of the ACRCC, the Mississippi Interbasin Cooperative Resource Association, Upper Mississippi River Conservation Committee, Ohio River Fisheries Management Team, and other interagency collaborations currently engaged on Asian carp prevention.

2.3 ADDRESSING THE THREAT OF BLACK AND GRASS CARP

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

2.3.1 Addressing the Threat of Black Carp

Black Carp represent an emerging threat to aquatic resources in the river basins of the Midwest United States and the Great Lakes watershed. Historically, the species has been used by the private aquaculture industry to control snails in ponds primarily at facilities in the southcentral United States. In 2007, Black Carp was added as an Injurious species under the Lacey Act (https://www.fws.gov/policy/library/2007/07-5141.pdf) as a response to concerns over the high risk of introduction and establishment in the wild in the event of escape or release. This decision was informed by an assessment of the species' potential for impacting native aquatic species and ecosystems in United States waters. In spite of the addition of these regulations, Black Carp now represent an increasing threat. Recent collections of Black Carp, ranging in age from Young-of- the-Year (age 0) to adults from new locations in the Missouri River and Mississippi River basins, demonstrate that range expansion is occurring and that natural reproduction in the wild can now be documented. The increase in the number of Black Carp captures from the Mississippi River and tributaries since 2011 has raised concerns that this species is becoming established in these systems. Furthermore, data from 33 Black Carp collected from 2011 to 2015 (including two age-0 fish caught in November 2015) indicate that natural reproduction and recruitment to adulthood have occurred in the wild. In 2016 alone, 26 Black Carp were captured (USGS NAS Database), representing the highest number captured in a single year.

An interagency sampling effort focused specifically on detection of this species will launch in 2017 to address the expanding Black Carp population in the Mississippi River and tributaries. This effort will address the need for developing science-based monitoring to inform understanding of population status and level of risk and support potential management actions. Agency managers and biologists agree that more complete and current scientific information on Black Carp is critically needed to develop and implement the most comprehensive and effective management strategy for detection, prevention, and control. This needed information includes evaluations of geographic distribution and habitat use; population characteristics (relative abundance; timing, frequency, and location of reproduction; growth rates; and age at maturity) and diet (including preferences for individual mollusk species). Data gained from targeted Black Carp sampling will be critical for monitoring and assessing the risk of further increases in abundance and range expansion, evaluating their ecological impacts, and guiding initial development of containment and control strategies.

In response to this need, the ACRCC has convened an interagency Black Carp Work Group to identify highest-priority research, data and management needs, and to begin development of a strategic approach for detection, prevention, and control actions needed for this species. Initial recommendations and objectives for Black Carp were included in the Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States (Conover et. al. 2007) (National Plan) and serve to help inform step-down planning focused on the species, along with other contemporary Asian carp strategies and scientific publications. Development of the draft strategy by the Work Group is further informed by the ACRCC's annual Action Plan and the MRWG's MRP. While primarily focused on Bighead and Silver Carp management actions to date, the ACRCC's portfolio of projects offer opportunities to leverage existing efforts on sample and gear designs, fish monitoring (including remote sensing) , and response actions, and for inclusion of the new Black Carp strategy. New agency projects have been developed for inclusion in the 2017 Action Plan that are specifically focused on Black Carp priorities and support the basic goals and objectives of the National Plan and those framed by the Work Group as starting point to an interagency strategy.

General priorities include: (1) implementation of systematic monitoring focused on habitat use, range, dispersal, and early detection of this species; and on highest-risk locations, as informed by the best-available scientific data, (2) identification and development of response options available for agency deployment in the event of a new detection, (3) partner and stakeholder awareness and engagement on Black Carp, and (4) coordination across basins and jurisdictions on strategic actions and options to prevent the further expansion of Black Carp range, focusing on prevention opportunities at key strategic choke points. Current Black Carp management actions include the following:

- Genetics-based early detection tools, including environmental DNA (eDNA), are being refined for Black Carp monitoring
- A binational (U.S. and Canadian) ecological risk assessment for Black Carp is being developed
- Research to develop a species-specific toxic bait based on the unique feeding capabilities of Black Carp is in progress
- A comprehensive early detection and rapid assessment surveillance program for Asian carp (including Black Carp) is currently ongoing in the Illinois Waterway, Chicago Area Waterway System, and Great Lakes and key tributaries
- Southern Illinois University through Illinois DNR will continue an incentive program ($100 reward per fish) for Illinois waters to encourage commercial fishermen to report and donate all wild-caught Black Carp for research

The Work Group has identified the following objectives to support the primary goals of preventing: (1) the introduction and establishment of Black Carp into the Great Lakes and, (2) their establishment in the Upper Mississippi River Basin and Ohio River Basin:

- Determine the distribution, abundance, movements, and reproductive success of Black Carp in the Mississippi River
- Determine life history characteristics such as habitat use, foraging behavior, diet, growth, age structure, natal origin, recruitment and survival of young to include an understanding of spawning aggregates, drift dynamics, and larval swimming stamina
- Determine most effective surveillance, capture, and detection methods for Black Carp for each life stage and how, when, and where to apply each method
- Improve tools for identification to include improved species identification, updating standard process for ploidy determination and reporting for new observations of captures
- Identify control technologies that could prevent upstream dispersal, range expansion or establishment
- Develop and implement an active monitoring plan in the lower Illinois River
- Determine Black Carp interactions with locks and dams
- Development of tools that selectively eradicate Black Carp based on their feeding habits
- Develop a targeted eDNA monitoring plan for Black Carp to include monitoring of bait shops and targeted mussel beds of interest
- Identify all potential and current vectors for movement and new introductions of the species and identify actions to reduce these threats and risks and eliminate vectors

- Develop and implement an active and intense outreach campaign to educate other natural resource professionals, law enforcement, and the public on species identification and reason for concern
- Work with industry to reduce culture, use and potential release of the species into the wild
- Assess ecological impacts of Black Carp, particularly their effects on native mussels and benthic fishes.

All agency projects for Black Carp that are included in the 2017 Action Plan address one or more of these objectives. In 2017, the Work Group will continue to refine and finalize the strategic approach for Black Carp prevention and control. The strategy will incorporate the use of Integrated Pest Management, and will be updated and revised, as needed and informed by the most current science and capacity using the principles of adaptive management.

2.3.2 Addressing the Threat of Grass Carp

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

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

In 2012, six 1-year-old, diploid Grass Carp were captured in the Sandusky River, a major tributary to western Lake Erie. Researchers determined that these fish were spawned in the Sandusky River and that multiple, unrelated spawning fish produced these offspring. This finding was the first strong evidence, albeit circumstantial, of successful reproduction by 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 2015 and 2016, the scope of the Grass Carp problem in Lake Erie expanded greatly with the discovery of several diploid Grass Carp of reproducing age in Ontario waters of lakes Ontario and Erie.

To date, the findings of Grass Carp in Lake Erie suggest:

- Grass Carp exist in Lake Erie at unknown, but likely relatively low, abundance levels.
- To effectively implement broad or targeted response actions, coordinated effort by multiple agencies will be needed early in the invasion process.
- Existing information is not adequate to implement meaningful actions for control and eradication.
- New information from ongoing 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 Grass Carp in Lake Erie.

The ACRCC, in alignment with the goals of previous Action Plans to prevent the introduction, establishment, and spread of Asian carp into the Great Lakes, and with other fishery management agencies will address Grass Carp through efforts to:

- Prevent new introductions of Grass Carp in the Great Lakes.
- Identify and limit the dispersal of existing populations of Grass Carp in the Great Lakes and the Chicago Area Waterway System, including development of interagency/international response efforts.
- Encourage operational actions to prevent establishment in areas where Grass Carp are known to reproduce.
- Develop Grass Carp control technologies to assist in future management efforts.

Adaptive Management Framework for Grass Carp Control - In the Great Lakes, coordinated and cooperative fishery management is conducted by agencies signatory to *A Joint Strategic Plan for Management of Great Lakes Fisheries*, which is facilitated by The Great Lakes Fishery Commission. Many ACRCC agencies also are signatory to this plan. Plan members agreed in April 2016 to institute an executive-level invasive fishes committee to coordinate among Great Lakes fishery managers, the ACRCC, the Great Lakes Water Quality Agreement's Annex 6, and other entities. Terms of Reference are being developed for the committee, with key areas of responsibility expected to include coordination between plan members and other regional entities interested in eradication, management, and control of invasive fishes, including Grass Carp; communication and outreach within and outside the plan membership; and advice about prioritization of programs, projects, and funding related to fishes considered invasive to the Great Lakes. Finalized terms of reference for this committee are expected before the end of 2016. The plan's invasive fishes committee is expected to coordinate, communicate, and advise the ACRCC about Grass Carp management actions and important project and program needs in the Great Lakes.

In 2016, the Michigan Department of Natural Resources, **c**ollaborating with Ohio Department of Natural Resources, USGS, and USFWS, initiated development of an Adaptive Management Framework for Grass Carp control in Lake Erie. Multiple Structured Decision Analysis workshops will be hosted by the Michigan DNR. The workshops will be an inclusive process to establish regionally agreeable objectives for Grass Carp control in Lake Erie. The results of the workshops will then be used to develop a science-based Adaptive Management Framework for Grass Carp eradication in Lake Erie. In addition, a decision analysis will be completed with input from Lake Erie fisheries managers, scientific experts, and regional stakeholders. The decision analysis will consist of conducting workshops where participants identify objectives related to eradicating Grass Carp from Lake Erie and discuss the control options available and

uncertainties that might limit eradication success. The objectives will then be used to inform and construct a Grass Carp population model that can be used to evaluate the effectiveness of different eradication action plans, which will ultimately inform the Grass Carp Adaptive Management Framework for Lake Erie.

Detection and Control Technology Development — 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. This effort will include analyzing captured individuals to determine ploidy status, natal origin, maturity status, growth dynamics, and movement patterns that will be openly shared with all agencies. Michigan and Ohio will be working with 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 increased sampling efforts using traditional and other novel gears. In 2017, efforts will include:

- Increasing targeted sampling for Grass Carp using Lake Erie commercial fishermen (U.S Agencies).
- Conducting early life history sampling in western Lake Erie tributaries during the expected spawning season.
- Analyzing all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry.
- Estimating age, growth rates, and maturity status of all Grass Carp removed from the Great Lakes.

In 2017, the ODNR will further develop information from Grass Carp egg collections in the Sandusky River using 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 should provide even more both space and time-bound predictions of adult Grass Carp aggregations and assist in developing and implementing an intense, targeted traditional gear sampling plan at specified locations in the Sandusky River.

In FY 2017, the State of Ohio's goal is to validate information collected in 2016 and specifically take the following actions:

- 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.).
- In 2017, Ohio will develop and implement targeted traditional gear sampling plan using information from 2016 activities at specified locations in the Sandusky River.

In addition, USFWS, with assistance from Illinois DNR, USACE, USGS, and Southern Illinois University, will analyze 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.

An integrated pest management approach to addressing Grass Carp control, informed by adequate biological information as needed and researching a variety of complementary potential control mechanisms, will be essential to future efforts to manage Grass Carp. USGS will be leading research efforts on development of Grass Carp control technologies and strategies. Researchers from USGS collaborate with researchers from other federal (U.S. and Canadian), state, and provincial agencies as well as universities on several research projects.

USGS research is broadly focused to address species ecology and life history, and habitats. Understanding ecology and life history will inform which traits can be exploited in developing control strategies. Habitat assessments inform where Grass Carp might congregate and provide a means of assessing effects of Grass Carp herbivory. As a suite, these studies will inform control efforts under an integrated pest management strategy.

USGS has initiated several research projects under the broad topics of ecology, life history, and habitat, including:

- Sampling of known and potential spawning tributaries for Grass Carp eggs and larvae.
- Modeling of transport of eggs in the river in which they were captured to develop accurate and precise estimates of where spawning occurred and where eggs hatch.
- Laboratory research on methods for capturing larval Grass Carp to identify best methods for sampling for them in natural environments.
- Laboratory research to identify and assess strength of spawning cues will inform the specific conditions that favor attempts to spawn.
- Otolith microchemistry to provide a chemical record of the life of a fish.
- Telemetry of Grass Carp to assess spawning and overwintering related movements of fish in a heavily monitored system (Truman Reservoir) where Grass Carp have been established for some time.
- Assessments of locations of submerged aquatic vegetation, relative distributions, and species compositions. Aquatic vegetation is the sole forage of adult Grass Carp.

Grass Carp Risk Assessment — A binational ecological risk assessment for Grass Carp in the Great Lakes basin is nearing completion. Research and other data were used to inform a risk assessment team of Fisheries and Oceans Canada (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 was also submitted into the U.S. federal review process by USGS. When it is finalized (late 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 socio-economic risk assessment will be conducted for the Great Lakes regarding all aquatic invasive species, including Grass Carp (a timeframe is not yet available as the work is still being organized).

Education and Outreach — Education and outreach will be critical as part of the Grass Carp approach. Education and outreach about the damaging effects of Grass Carp will be needed to raise awareness and discourage illegal, deliberate introductions by private citizens, whether introduced for sport or vegetation control.

In addition, unfortunately, improper or illegal stocking practices, stocking of fertile fish in other states, and illegal sale of diploid fish as triploid fish across the United States will continue to be an issue. The ACRCC member agencies will work with fishery managers across the U.S. in support of development or enforcement of common regulations banning the sale or possession of diploid Grass Carp.

3.0 CANADIAN ASIAN CARP CONTROL EFFORTS

DFO, 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. In September 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 Carps) in the Canadian waters of the Great Lakes under its Asian Carp Program. Presented here is a summary of activities conducted in 2016 and plans for 2017.

Targeted Traditional Gear for Early Warning Surveillance – Since 2013, DFO has implemented an early detection surveillance program for the Canadian side of the Great Lakes and will continue these operations through the 2016 field season (approximately May through November). Selection of sites was based on those identified as at risk in Canadian tributaries in the "2011 Binational Ecological Risk Assessment for Asian Carps in the Great Lakes," followed by ground-truthing. A reassessment of the sites visited in 2014 resulted in the inclusion 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 1,047 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 Asian carp. In 2015, a total of 771 *Buffalo* sp. and 3,142 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 warning surveillance activities; see Response section.) The 2015 field work resulted in a capture total of 67,221 fishes representing 97 species.

For the 2016 field season, 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 the 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 the 2016/2017 fiscal year (ends March 2017) is the final year of the 5-year funded Asian Carp Program; funding options for future years are being considered.

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 May 2016, DFO tested the ploidy of a captured Grass Carp in the Province of Quebec.

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 using an electrofishing boat before a wetland was to be constructed 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 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 warning 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 indicates origin from aquaculture facilities.

In June 2016, an angler captured (and released) a Grass Carp in Lake Gibson, an isolated reservoir pond off of the Welland Canal, and reported the fish to the Invading Species Awareness Program hotline. DFO was notified, and response activities involving intensive trammel netting began immediately. These response activities resulted in the capture of eight Grass Carp in 1 day. Additional crews (including a crew from OMNRF) and gear types were deployed, and two more Grass Carp were captured by DFO the following day. Of these 10 Grass Carp, two were diploid males; however, only one appeared to be capable of reproducing. All of these fish had overdeveloped gonads that were not typical of their sex or

ploidy status; gonad histology testing will provide clarification. In August, a diploid male Grass Carp was captured by a commercial fisher in a trap net near Point Pelee, Lake Erie. Response activities involving intensive netting and electrofishing were invoked by DFO and OMNRF and no additional Grass Carp were captured. Further analysis to better determine origin and movement in the Canadian waters of the Great Lakes for all 2015 and 2016 Grass Carp specimens is under way.

Throughout 2016, DFO will continue to respond, in conjunction with its partners, to Asian carp captures in Canadian waters. Response triggers, actions, and protocols are being refined as DFO's experience with responses increases. ICS and response training for DFO included intensive in-class training and plans for conducting on-water training later have commenced. Internal response protocols and an equipment database are approaching completion. 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; funding options for future years are being considered.

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.

Fish Movement — 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 lakes Ontario and Erie, and lakes 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 through 2015, tracking of these fishes resulted in 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-bodies 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. 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 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 of different densities of Grass Carp 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 affected by Grass Carp establishment. Together, this research provided scientific information to inform the Grass Carp risk assessment (described below) that will be completed fall 2016.

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, GLFC, USGS, and USFWS. The draft risk assessment was presented at a Canadian Science Advisory Secretariat meeting for a face-to-face peer review by a variety of invited binational experts. The risk assessment is also in the U.S. federal review process within the USGS. When it is finalized (planned for fall 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 established 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, and 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 hosted an Innovative Solutions Competition at the University of Toronto at Scarborough that challenged post-secondary students to devise technological or other solutions for the prevention and control of Asian carp in the Great Lakes. The top prize went to students from the University of Toronto Scarborough for their low-impact, non-physical carbon dioxide barrier idea.

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 carps. 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 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 2016 for the Canadian waters of the Great Lakes and their tributaries. Efforts focused on monitoring and assessment on Lake Erie, Lake St. Clair, the Detroit River, the St. Clair River, southern Lake Huron, and Lake Ontario. eDNA is a key technique used for monitoring in these locations. Surveillance plans for 2017 are currently being developed by the Ministry.

OMNRF also conducts a variety of fisheries assessment programs throughout the Canadian waters of the Great Lakes and their tributaries. These programs are used to assess the status of sport, and commercial species as well as the prey fish that these fisheries rely on. Asian carp may be encountered through the course of these activities if they are present. In addition, OMNRF has a close relationship with commercial and sport fishers. These stakeholders are well informed of concerns regarding Asian carp and contact OMNRF and its partner agencies when they encounter suspect fish.

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. Validation of Black Carp eDNA markers has 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. OMNRF has also field tested the plan, in conjunction with DFO and other partners, in response to recent reports of Grass Carp in the Ontario portions of Lakes Ontario and Erie. In 2016, the province continued its efforts to improve the plan based on additional field experience, new science and improved coordination with U.S. partners.

Outreach Activities: The Ontario-wide Invading Species Awareness Program has been a partnership initiative of the OMNRF and Ontario Federation of Anglers and Hunters since 1992. The program focuses on the promotion of public awareness and prevention of the spread of invasive species. The program is also designed to track and monitor the occurrence and distribution of invasive species, including Asian carp. The program includes a toll-free hotline (1-800-563-7711) and website (*www.invading species.com*) hosted by OFAH, as well as a web-based reporting and tracking system called Early Detection and Distribution 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. OMNRF also partners with the Invasive Species Centre and the Ontario Invasive Plant Council to deliver various aquatic invasive species programs across the province, including outreach, communications, and development of best management practices.

Regulations: In 2005, Ontario made it illegal to possess live Asian carp. In 2015, Ontario enacted stand-alone invasive species legislation, the Invasive Species Act, which came into force on November 3, 2016. This Act regulated all four species of Asian carp under the Invasive Species Act. Possessing, transporting,

propagating, buying, selling, leasing, trading, and bringing Asian carp into Ontario is prohibited, unless the fish are dead and eviscerated. At the same time, Ontario also regulated four other species of fishes, three aquatic invertebrates, nine plants, and one family of fishes. The Act provides a suite of provincial tools that will allow Ontario to take action, while continuing to work with partners and complement the role of the Canadian federal government. The act will:

- Provide a strong legislative framework to better prevent, detect, rapidly respond to, and, where feasible, eradicate invasive species;
- Promote shared accountability for managing invasive species;
- Hold those responsible accountable for costs of control and eradication through strong penalties and cost recovery of expenses for managing invasive species; 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 QUEBEC

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

Surveillance and Monitoring:

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

A dedicated AIS early detection network was implemented in 2007. This network is composed of 40 volunteer commercial anglers who work in collaboration with the MFFP. This network operates as sentinels for AIS detection. Volunteers report any exotic, unknown, or suspicious fish caught. The

network covers over a 600-kilometer (km) stretch of the St. Lawrence River. The suspicious fishes caught are sent to the Ministry's experts for further identification when required. Fishermen have been informed and trained to identify Asian carp. Given the fact that fishermen are aware of the risks and threats these species represent, they would immediately communicate with the Ministry if a specimen where caught. The one and only Asian carp (Grass Carp) ever reported in the St. Lawrence River, about 70 km downstream of Montreal, on May 27, 2016, was reported by one of the volunteer of the AIS early detection network.

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

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

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

Quebec's Asian Carps Program

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

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

Specifically, the objectives of the Quebec Asian Carps Program — Phase I are:

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

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

The Québec Maritime Strategy may be found at:
https://strategiemaritime.gouv.qc.ca/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 Water Resources Reform and Development of 2014 (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 in carrying out activities designed to slow, and eventually eliminate, the threat posed by Asian carp; and development of an annual report to the Unites States Congress describing the coordinated strategies established and progress made toward the goals of controlling and eliminating Asian carp in the Upper Mississippi and Ohio River basins and 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 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 the 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

2017 Funding Matrix

FY 2017 GLRI Project Funding*

	#	Title	FY 2017 ($)
USACE	1	Great Lakes Mississippi River Interbasin Study (GLMRIS) - Brandon Road	0
	2	Lab Experimentation and Modeling to Quantify Response to CO2 in a Flowing Environment	$450,000
	3	Operation and Maintenance of Barriers	$0
	4	Barrier I Constuction	$0
	5	Telemetry - Barrier Efficacy Evaluation	$0
	7	Monitoring and Response Team Support	$150,000
	39	Ohio-Erie Canal Pathway Closure Assessment	$1,500,000
	44	Field Testing of Water Jets to Mitigate Barge Entrainment of Fish and Floating Species	$575,000
	45	Field Deployment of Barriers at Brandon Road Lock	$685,000
	46	Asian Carp Swim Speed Study	$0
	47	H & H Support for Eagle Marsh II	$25,000
	65	Electric Field-Based Aquatic Nuisance Species Dispersal Barrier: Development and Implementation of an Alternating Current Electric Dispersal Barrier	$477,500
	73	GLMRIS Program Management	$0
		Subtotal	**$3,862,500**
USFWS	6	Great Lakes Asian Carp Monitoring Program	$350,000
	7	Monitoring and Response Team Support	$820,000
	8	Barge Entrainment and Interaction Study	$400,000
	9	Hydro-Acoustic Assessment of Lock Mediated Fish Passage in the Upper Illinois River	$0
	11	Program Capacity for eDNA Sampling	$0
	12	Fisheries Capacity for eDNA Processing and Technology Refinement	$0
	14	Asian Carp Strategic Communications Plan and Website Operation and Maintenance	$200,000
	16	Registration of Microparticle Technologies	$75,000
	17	Registration of Carbon Dioxide Technologies	$75,000
	43	Program Support for Asian Carp Activities	$0
	48	Black Carp Genetic Analysis	$250,000
	49	Analysis of Grass Carp in the CAWS	$120,000
	50	Black Carp Assessment: CAWS and UMRB	$75,000
	51	Mass Removal and Monitoring of Juvenile Asian Carp	$120,000
	52	Barrier Defense Using Novel Gear	$100,000
	66	Predictive Model for Identifying Probability/Risk of Barges Entraining Asian Carps	$100,000
	67	Genomic Mapping of Bighead and Grass Carp to Aid in Genetic Surveillance and Potential Genetic Control Efforts	$60,000
		Subtotal	**$2,745,000**

FY 2017 GLRI Project Funding*

	#	Title	FY 2017 ($)
USGS	16	Registration of Microparticle Technologies	$100,000
	17	Registration of Carbon Dioxide Technologies	$150,000
	18	Development of Grass Carp Control Technologies	$325,000
	19	Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options	$300,000
	20	Characterization of Brandon Road Lock for Barrier Implementation	$350,000
	21	Use of Seismic Technology to Divert and Eradicate Asian Carp	$0
	22	Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp	$490,000
	23	Developing Targeted (Microparticle and Piscicide) Control Systems	$500,000
	25	Use of Acoustic Technology to Determine Behavior	$0
	26	Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish	$0
	27	Integrated Pest Management Program	$1,590,000
	45	Field Deployment of Barriers at Brandon Road Lock	$160,000
	53	Use of Complex Sound to Alter Behavior of Asian Carp	$217,000
	54	Development of Chemical Methods for Control of Aquatic Invasive Species during Lock Operations (Previously Hot Water, Chlorine and Ozone Use for Lock Treatment)	$100,000
	55	Communication and Demonstration of New Technologies for Control and Monitoring	$30,000
	56	Black Carp Control, Bait, and Attactant Use	$80,000
		Subtotal	**$4,392,000**
IL DNR	30	Enhanced Monitoring Above and Below Electric Barriers	$2,000,000
	31	Illinois River Stock Assessment/Management Alternatives	$300,000
	32	Contract Fishing for Asian Carp Detection and Removal	$1,400,000
	35	Use of Improved Gear and Novel Designs at Brandon Road	$150,000
	37	Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp	$300,000
	64	Monitoring Black Carp Population Front in Illinois Waterway and Middle Mississippi River	$0
		Subtotal	**$4,150,000**
ODNR	38	Killbuck Creek Pathway Closure Assessment	$500,000
	39	Ohio-Erie Canal Pathway Closure Assessment	$0
	59	Development of Grass Carp Response Capabilities in Ohio	$100,000
		Subtotal	**$600,000**
USCG	40	Manage Waterway Traffic in Support of Asian Carp Control Activities	$0
	41	Brandon Road Lock and Dam Risk Assessment	$200,000
	42	Electric Barrier Contruction and Operation Risk Assessment	$200,000
		Subtotal	**$400,000**
NOAA	61	Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes	$159,590
		Subtotal	**$159,590**
MIDNR	60	Grass Carp Eradication in Western Lake Erie	$150,000
		Subtotal	**$150,000**

FY 2017 GLRI Project Funding*

	#	Title	FY 2017 ($)
NPS	71	Develop and Implement Education Materials and Lesson Plans in Coordination with Teachers to Further the Asian Carp Response in the Midwest	$75,000
		Subtotal	**$75,000**
USEPA	43	Program Support for Asian Carp Activities	$290,910
	69	Facilitation Support for the Chicago Area Waterway System Advisory Comm	$75,000
	72	Economic Development and Marketing Efforts	$100,000
		Subtotal	**$465,910**
GLRI Total			**$17,000,000**

* The FY 2017 proposed funding was generally determined by assuming flat funding from the FY 2016 enacted budget

FY 2017 Agency Project Funding**

	#	Title	FY 2017 ($)
USACE	1	Great Lakes Mississippi River Interbasin Study (GLMRIS) - Brandon Road	$2,300,000
	2	Lab Experimentation and Modeling to Quantify Response to CO2 in a Flowing Environment	$0
	3	Operation and Maintenance of Barriers	$11,800,000
	4	Barrier I Constuction	$0
	5	Telemetry - Barrier Efficacy Evaluation	$200,000
	7	Monitoring and Response Team Support	$0
	39	Ohio-Erie Canal Pathway Closure Assessment	$0
	44	Field Testing of Water Jets to Mitigate Barge Entrainment of Fish and Floating Species	$0
	45	Field Deployment of Barriers at Brandon Road Lock	$0
	46	Asian Carp Swim Speed Study	$0
	47	H & H Support for Eagle Marsh II	$0
	65	Electric Field-Based Aquatic Nuisance Species Dispersal Barrier: Development and Implementation of an Alternating Current Electric Dispersal Barrier	$0
	73	GLMRIS Program Management	$300,000
		Subtotal	**$14,600,000**
USFWS	6	Great Lakes Asian Carp Monitoring Program	$1,150,000
	7	Monitoring and Response Team Support	$1,015,000
	8	Barge Entrainment and Interaction Study	$300,000
	9	Hydro-Acoustic Assessment of Lock Mediated Fish Passage in the Upper Illinois River	$0
	11	Program Capacity for eDNA Sampling	$1,100,000
	12	Fisheries Capacity for eDNA Processing and Technology Refinement	$1,300,000
	14	Asian Carp Strategic Communications Plan and Website Operation and Maintenance	$100,000
	16	Registration of Microparticle Technologies	$0
	17	Registration of Carbon Dioxide Technologies	$0
	43	Program Support for Asian Carp Activities	$75,000
	48	Black Carp Genetic Analysis	$100,000
	49	Analysis of Grass Carp in the CAWS	$30,000
	50	Black Carp Assessment: CAWS and UMRB	$0
	51	Mass Removal and Monitoring of Juvenile Asian Carp	$50,000
	52	Barrier Defense Using Novel Gear	$35,000
	66	Predictive Model for Identifying Probability/Risk of Barges Entraining Asian Carps	$0
	67	Genomic Mapping of Bighead and Grass Carp to Aid in Genetic Surveillance and Potential Genetic Control Efforts	$45,000
		Subtotal	**$5,300,000**

FY 2017 Agency Project Funding**

	#	Title	FY 2017 ($)
USGS	16	Registration of Microparticle Technologies	$150,000
	17	Registration of Carbon Dioxide Technologies	$50,000
	18	Development of Grass Carp Control Technologies	$425,000
	19	Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options	$500,000
	20	Characterization of Brandon Road Lock for Barrier Implementation	$0
	21	Use of Seismic Technology to Divert and Eradicate Asian Carp	$20,000
	22	Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp	$310,000
	23	Developing Targeted (Microparticle and Piscicide) Control Systems	$630,000
	25	Use of Acoustic Technology to Determine Behavior	$150,000
	26	Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish	$800,000
	27	Integrated Pest Management Program	$1,850,000
	45	Field Deployment of Barriers at Brandon Road Lock	$0
	53	Use of Complex Sound to Alter Behavior of Asian Carp	$183,000
	54	Development of Chemical Methods for Control of Aquatic Invasive Species during Lock Operations	$70,000
	55	Communication and Demonstration of New Technologies for Control and Monitoring	$20,000
	56	Black Carp Control, Bait, and Attactant Use	$70,000
		Subtotal	**$5,228,000**
USFWS-IL DNR	30	Enhanced Monitoring Above and Below Electric Barriers	$0
	31	Illinois River Stock Assessment/Management Alternatives	$0
	32	Contract Fishing for Asian Carp Detection and Removal	$0
	35	Use of Improved Gear and Novel Designs at Brandon Road	$0
	37	Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp	$0
	64	Black Carp Control	$0
		Subtotal	**$0**
ODNR	38	Killbuck Creek Pathway Closure Assessment	$0
	39	Ohio-Erie Canal Pathway Closure Assessment	$0
	59	Development of Grass Carp Response Capabilities in Ohio	$0
		Subtotal	**$0**
USCG	40	Manage Waterway Traffic in Support of Asian Carp Control Activities	$73,000
	41	Brandon Road Lock and Dam Risk Assessment	$2,000
	42	Electric Barrier Contruction and Operation Risk Assessment	$2,000
		Subtotal	**$77,000**
NOAA	61	Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes	$179,905
		Subtotal	**$179,905**
MIDNR	60	Grass Carp Eradication in Western Lake Erie	$0
		Subtotal	**$0**

FY 2017 Agency Project Funding**

	#	Title	FY 2017 ($)
NPS	71	Develop and Implement Education Materials and Lesson Plans in Coordination with Teachers to Further the Asian Carp Response in the Midwest	$0
		Subtotal	**$0**
USEPA	43	Program Support for Asian Carp Activities	$0
	69	Facilitation Support for the Chicago Area Waterway System Advisory Committee	$0
	72	Economic Development and Marketing Efforts	$0
		Subtotal	**$0**
Base Funding Total			**$25,384,905**

** The FY 2017 proposed funding was generally determined by assuming flat funding from the FY 2016 enacted budget.

FY 2017 Funding Summary

USACE GLRI Total	$3,862,500
USACE Agency Total	$14,600,000
USEPA GLRI Total	$465,910
USEPA Agency Total	$0
USCG GLRI Total	$400,000
USCG Agency Total	$77,000
USFWS GLRI Total	$2,745,000
USFWS Agency Total	$5,300,000
USGS GLRI Total	$4,392,000
USGS Agency Total	$5,228,000
USFWS - ILDNR GLRI Total	$4,150,000
USFWS - ILDNR Agency Total	$0
USFWS - ODNR GLRI Total	$600,000
USFWS - ODNR Agency Total	$0
USFWS - MIDNR GLRI Total	$150,000
USFWS - MIDNR Agency Total	$0
NOAA GLRI Total	$159,590
NOAA Agency Total	$179,905
NPS GLRI Total	$75,000
NPS Agency Total	$0
GLRI Total	**$17,000,000**
Agency Funding Total	**$25,384,905**

Appendix B

2017 Asian Carp Action Plan Action Items

Contents

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

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

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$2,300,000**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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 and Dam located in Joliet, Illinois. Further evaluation of ANS control measures at this control point constitutes a logical next step based on the range of alternatives identified in the GLMRIS Report and on 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 to be 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). Three species of concern have been identified in the GLMRIS Report, which 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 will include required environmental compliance analyses and support the justification of an agency decision.

Summary of Actions to Date: In January 2014, USACE completed and released the GLMRIS Report, which identified eight potential alternatives ranging from continuing current efforts to complete separation of the watersheds. The report also evaluated 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, Illinois. 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. A focused array of alternatives to be considered was developed, completing the Alternatives Milestone in June 2015. USACE also initiated development of the Tentatively Selected Plan. Additional data gathering and research performed on multiple ANS control measures conducted by other agencies, expert elicitation of the multiple control measures to determine effectiveness has also been completed.

Proposed Actions for FY 2017: Identify the Tentatively Selected Plan, submit 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 National Environmental Policy Act (NEPA) review.

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

- Submit Agency Decision Milestone document
- Development of physical model of flushing lock and more detailed engineering analysis of the Agency Decision Milestone Plan
- Complete feasibility level report
- Submit Civil Works Review Board document for review.
- Complete state and Agency review; complete and submit the Chief's Report.

Expected FY 2017 Milestones:

- Tentatively Selected Plan (TSP) Milestone January 2017

Outcomes/Outputs: Evaluate and recommend implementation of potential control technologies at Brandon Road Lock and Dam to reduce the risk of upstream interbasin transfer of ANS while minimizing impacts to waterway uses and users

Potential Hurdles: Maintain sufficient funding stream to continue the study without delay

2. Lab Experimentation and Modeling to Quantify Response to CO_2 in a Flowing Environment

Lead Agency: USACE – Engineer Research Development Center (ERDC)

Agency Collaboration: USACE – Chicago, USACE – Buffalo, University of Illinois Urbana – Champaign, U.S. Geological Survey (USGS), Illinois Department of Natural Resources (IL DNR)

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2017	**$0**	**$450,000**	**0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: This project includes research related to the efficacy, implementation, and impacts of the use of carbon dioxide gas (CO_2) as a non-physical barrier chemical to deter the movement of Asian carp associated with USACE infrastructure. Adding CO_2 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 CO_2 (hypercarbia).

Dissolved CO_2 (mg/L) in water influences fish movement in laboratory and field studies; however, no studies exist on how advective systems will change CO_2 effectiveness as a barrier technology. To address this gap, studies of fish response to CO_2 in flowing systems are being implemented. In addition, water quality models will be used to characterize how CO_2 is mixed in flowing systems and identify potential limitations of the approach so that effective mitigation can be designed. Additional studies will focus on implementation and barrier assessment. Fish behavior with multiple negative stimuli may be different from fish behavior to just one stimulus (such as the CO_2 barrier). Because the barrier may be operated across many months, if not the full year, the temperature of the water will vary. Water temperature impacts fish in many ways including swimming speed and respiration rate both of which will influence the susceptibility of fish to the CO_2 barrier.

Finally, there is a need to better understand how all fish traverse USACE infrastructure. While there are many techniques that can determine this, they are uniformly expensive and data intensive. Technologies with lower costs that are rapidly implementable are required. Recent advances in commercial off-the-shelf sonar provide an opportunity to field a low cost, accurate and easily implemented fish detection technology. These sonars can be repurposed to be an instrument capable of counting and identifying fish at any lock and dam. This information is vital in estimating barrier efficiency, because it would provide a baseline from which to compare barrier performance. The work is focused at Brandon Road Lock and Dam but other locations may be considered.

Preliminary results

Lower pH is a concern to 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 underway. Preliminary results for concrete suggest that that elevated CO_2 levels (70 mg/L 130 mg/L) have negligible impacts on concrete mixed according to original Brandon Road Lock and Dam specifications. Based on ongoing laboratory experiments with fish greater CO_2 concentrations (~250 mg/L) may be needed to deter fish. Higher test concentrations for concrete will be conducted.

When a CO_2-based fish deterrence barrier is operating, a zone of elevated CO_2 will be present in the approach channel of Brandon Road lock and Dam. Routine lock operations discharge water from the

approach channel into the Des Plains River. Thus, low pH associated with the operating barrier will be discharged into the Des Plains River. A water quality model was developed to quantify the potential to lower PH downstream of Brandon Road Lock and Dam. Initial results suggest that there is little potential to lower pH downstream of Brandon Road Lock and Dam.

Finally, a fine-scale CO_2 transport model was built for the Brandon Road approach channel. This mode aimed to develop knowledge related to dilution and mixing. From this mode researchers were able to estimate CO_2 loss from a standard filling and emptying cycle at Brandon Road. The model suggests that approximately 50 percent decrease in concentration of CO_2 as the lock is emptied over a 15- to 20-minute cycle. This provides the first engineering estimates of CO_2 required to maintain a barrier in Brandon Road Lock and Dam.

Summary of Actions to Date:

- Completed initial behavior testing of fish in advective environments; identify new information needs and path to integrate into field data and modeling simulations. This included integrated studies with UIUC.
- Provided information on downstream impacts of carbon dioxide on receiving environment focused on pH and CO_2 concentrations.
- Completed water quality CO_2 transport study at the local (Brandon Road approach channel) and reach (Brandon Road to Dresden Lock and Dam).
- Initiated concrete effects study using various concrete samples possibly including concrete from Brandon Road Lock and Dam.
- USACE conducted coordination efforts between ERDC, USGS, U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), and various other involved or interested parties.

Proposed Actions for FY 2017:

- Continue advective behavior studies for Brandon Road or other sites as directed to include pilot studies with deterrence effects from bubble barriers.
- Continue hydrodynamic studies (1D, 2D and 3D as appropriate).
- USACE-ERDC will conduct coordination efforts between ERDC, USGS, USEPA, USFWS, and various other involved or interested parties.
- Develop and implement a study examining temperature based behavioral effects on carp in relation to barrier activities.

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

- Implement behavioral studies integrated the most current hydrodynamic, water quality and barrier design information. Make projections of barrier operating outcomes for water quality and effectiveness.
- USACE will conduct coordination efforts between ERDC, USGS, USEPA, FWS, and various other involved or interested parties.
- Develop and analyze ongoing water quality models to support state and federal permitting requirements and barrier design and implementation.
- Finalize CO2 behavioral tests.
- Report on fish movement studies in advective environments.

Deliverables:

- FY 2017 - Report on response of Bighead Carp to CO_2 in flowing water.
- FY 2017 – Report on water quality and hydrodynamic model (final).
- FY 2017 – Report on final concrete effects study (final).

Expected Completion Date for Project: FY 2019

Expected FY 2017 Milestones:

- Brandon Road large-scale water quality and hydro modeling report –Completed September 2016
- Brandon Road fine-scale water quality and hydro modeling report – Completed September 2016
- Interim concrete effects report, year 1 – Completed September 2016
- Fish behavior report – March 2017
- Report on concrete effects study – draft for initial exposure assessments – Completed September 2016
- Report on response of Bighead Carp to CO2 in flowing water – March 2017
- Reports on water quality and hydrodynamic model – September 2017 (final)
- Report on final concrete effects study (final) – September 2017

Outcomes/Outputs:

- Tool to estimate near and far scale CO_2 concentrations under the influence of flowing water and project operations including various possible scenarios.
- Tool to estimate fish response to hydraulic and CO_2 concertation 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.
- Estimate of the impacts to USACE infrastructure from elevated CO_2 concentrations. This information will help determine if the barrier can be deployed in close proximity to USACE concrete structures.

Knowledge to scale and cost a CO_2-based fish deterrence system.

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	Asian Carp GLRI Funding	Other Funding
FY 2017	**$11,800,000**	**$0**	

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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

Barrier IIA was outfitted with an uninterrupted power supply (UPS) to ensure continuous delivery of power in the event of a utility power outage in FY2016. Additionally, efforts are underway to improve the cooling system of Barrier IIA.

Proposed Actions for FY 2017: Operation and maintenance of the barriers will continue, including regularly scheduled maintenance of the electric barriers.

Potential Out-year Actions (Subject to Future Appropriations): Operation and maintenance of the barriers will continue, including regularly scheduled maintenance of the electric barriers.

Expected Completion Date for Project: Unknown.

Expected FY 2017 Milestones:

Completion of annual maintenance and continuation of routine quarterly maintenance.

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 2017	**$0**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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. Main building construction was completed in 2016. Also, installation of the electrical equipment and mechanical components was scheduled to occur in 2016.

Proposed Actions for FY 2017: Main building construction is scheduled for completion in 2017. Also, installation of the electrical equipment and mechanical components are scheduled to occur in 2017.

Expected Completion Date for Project: TBD

Expected FY 2017 Milestones: TBD

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 Monitoring (Barrier Efficiency Evaluation)

Lead Agency: USACE Chicago District

Agency Collaboration: USFWS, USGS, SIUC, IDNR

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$200,000**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: USACE has led telemetry efforts in the IWW and Chicago Area Waterway System (CAWS) since 2010 with a primary objective of assessing the efficacy of the barriers as identified in the Asian Carp Regional Coordinating Committee (ACRCC) Monitoring and Response Plan. By surgically implanting transmitters into fish species (both Asian carp and surrogate species), USACE has empirical data to demonstrate the barriers are effective in preventing fish passage in the upstream direction. This funding request is to continue the work in assessing the efficacy of the CSSC dispersal barriers. Future work will combine the historical acoustic telemetry monitoring program with hydroacoustic systems at the barrier site. Additionally, continual refinement of the stationary receiver network is planned which will increase efficiency and coverage within the system. Further downstream, combining the existing receiver array established by USACE with the new receiver arrays established by SIUC and USFWS, will allow monitoring of 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 fine-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 32 strategic locations from the Upper IWW into the CAWS. A Vemco Positioning System (VPS) was also established around Barriers IIB and IIA that was capable of providing 2D fish movements in relation to the barrier fields. Transmitters have been surgically implanted into 535 fishes which were released throughout the system. Mobile tracking and receiver downloads have occurred monthly to ensure up-to-date data is provided to decision makers regarding the efficacy of the barrier system. Summary reports of work completed have been prepared annually and are included within the Monitoring and Response Plan annual summary report.

The following actions were completed in 2016:

- Winter receiver network was recovered and full receiver network was deployed in 3rd quarter FY 2016.
- Receiver downloads were completed every other month throughout FY 2016 with monthly summaries provided to the MRWG for distribution.
- Transmitter surgeries were successfully completed 3rd Quarter FY 2016 in surrogate species within the Lockport and Brandon Road Pools.
- Coordination occurred between USACE Chicago District, USFWS and SIUC in deployment of additional receivers to integrate the three telemetry networks.
- 2015 Interim Summary report completed.

Proposed Actions for FY 2017:

- Continued monitoring of tagged fishes within the study area.
- Supplemental transmitter surgery implants to maintain transmitter densities
- Integration of hydroacoustic monitoring at the dispersal barriers
- Continued range testing and habitat mapping throughout the focus area
- Real-time receiver installations above the Barriers and Brandon Road lock
- Integration of USACE telemetry with USGS online telemetry networking tool

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

- Continued monitoring of tagged fishes within the study area
- Supplemental transmitter surgery implants to maintain transmitter densities
- Refinement of hydroacoustic monitoring at the dispersal barriers
- Continued range testing and habitat mapping throughout the focus area

Deliverables:

- Real-time feedback of fish passage across CSSC dispersal barriers and the Brandon Road Lock and Dam
- Annual Interim Summary Report of 2016 data and results
- Monthly summaries to the MRWG
- Hydroacoustic monitoring demonstration complete at CSSC Dispersal Barriers

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

Expected FY 2017 Milestones:

- FY2017 Q1 - Winter breakdown of 2016 season and final data collection
- FY2017 Q1 – Supplemental surgery implants of transmitters
- FY2017 Q2 – Annual Interim Summary Report to the MRWG
- FY2017 Q3 – Spring set up of 2017 season and winter downloads
- FY2017 Q4 – Demonstration of hydroacoustic monitoring at barriers

Outcomes/Outputs:

- Real-time updates and alarms for tagged fish passage at the CSSC dispersal barriers and the Brandon Road Lock and Dam
- Increased monitoring of non-tagged fishes at the Electric Dispersal Barriers using hydroacoustics
- Annual Interim Summary Reports

Potential Hurdles:

- Weather-related delays to field work implementation
- Equipment long-lead delays of custom transmitters
- Potential technical difficulties in real-time receiver network

7. Monitoring and Response Team Support

Lead Agency: USACE – Rock Island District

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

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$150,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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

Summary of Actions to Date: The USACE provides technical assistance to lead agencies that support the Asian Carp Action Plan developed by the ACRCC. Specific actions include the following:

- Collaboration, technical and field support for lead agencies with ACRCC agencies on the implementation of the Action Plan and the Monitoring and Response Plan.
- 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.
- Biological, engineering, and navigation technical expertise.

Proposed Actions for FY 2017: USACE will continue the work highlighted above in relation to monitoring and response team support.

Deliverables:

- Collaboration, technical and field support for lead agencies with ACRCC agencies on the implementation of the Action Plan and the Monitoring and Response Plan.
- 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.
- Biological, engineering, and navigation technical expertise.

Expected Completion Date for Project: TBD.

Expected FY 2017 Milestones:

- Defined annually by the ACRCC in the Action Plan and the Monitoring and Response Plan.

Outcomes/Outputs:

- Coordination and implementation of activities identified in the 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: None

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	Asian Carp GLRI Funding	Other Funding
FY 2017	0	$1,500,000	0

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Closure of the Aquatic Invasive Species (AIS) pathway at the Ohio-Erie Canal (OEC), project construction

Summary of Actions to Date: The Great Lakes and Mississippi River watershed divide was assessed (2010-2013) under the USACE Great Lakes Mississippi River Interbasin Study (GLMRIS) to determine if there were viable surface water pathways for the transfer of AIS between basins. The GLMRIS Aquatic Pathway Assessment Report developed for the OEC connection determined the probability for the transfer of AIS from the Mississippi River Basin to the Great Lakes Basin as medium for Silver Carp, Bighead Carp, black carp, and northern snakehead, and low for skipjack herring.

- February 2013: ODNR met with the City of Akron to discuss the Aquatic Pathway Assessment Report for OEC. The ODNR and the USACE discussed the two primary areas of concern:
  - Direct transfer of water from the Mississippi River Basin to the Great Lakes Basin at feeder gates that transfer water from Long Lake to the OEC.
  - Redirect flooding along the OEC tow path that allows water to move from the Mississippi River Basin to the Great Lakes Basin.
- October 2013: ODNR facilitated framework funding for the USACE to conduct a preliminary assessment of closure options at OEC.
- March 2014 – August 2015: ODNR met with USACE on numerous occasions to discuss closure options and determine a path forward.
- September 2014: USACE completed a 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" report dated September 30, 2014. Included 50 percent design level designs.
- Sept 2014 – Aug 2015: Further design efforts in anticipation of additional funding.
- September 2016: The USACE completes 100 Percent Design Document Report for the OEC Aquatic Nuisance Species Control Project.
- 2016: USACE and ODNR implemented public and agency outreach efforts to inform the public of the plans for OEC and generally improve public awareness regarding AIS.
- 2016: USACE and ODNR continued development of Architecture and Engineering designs for replacement of Long Lake floodgates.
- June 2016: September 30, 2017: USACE will work on permitting and initial steps for implementation of closure options (e.g., environmental compliance, real estate, stakeholder coordination, cultural resources).

Proposed Actions for FY 2017: USACE issues construction award for implementation of OEC structural measures, which include construction oversight.

Potential Out-year Actions (Subject to Future Appropriations): Monitoring of recently completed construction and coordination with stakeholders. Completion of project construction.

Deliverables:

- Construction contract award.
- Monitoring & coordination (completion of construction if not yet complete).

Expected Completion Date for Project: 2018-2019

Expected FY 2017 Milestones: NA
Outcomes/Outputs: All structural measures are constructed and operating according to necessary specifications.

Potential Hurdles: Timeliness of funding with respect to anticipated construction award and completion dates.

44. Field Testing of Water Jets to Mitigate Barge Entrainment of Fish

Lead Agency: USACE

Agency Collaboration: USACE, USFWS, USGS

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$575,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Previous laboratory and field studies have shown that commercial barge tows operating within the CSSC can produce residual water currents and forces that can entrain and potentially transport fish across the electric barrier system. Laboratory studies completed in 2016 in a flume model indicate that water jets can be effective at removing entrained fish from the vicinity of northbound barge tows.

This project will develop and complete a field testing program to determine the feasibility and effectiveness of water jets for mitigation of entrainment. The tests will be conducted in the CSSC in the vicinity of the electric barriers to the extent possible. The intent is to temporarily install a water jet system in the water of the canal, place fish or a model for fish in areas near a barge tow where they are or will become entrained, and then monitor what happens as the barge tow passes over the water jets. The movements of the fish will be monitored by cameras. Water velocities and flow patterns will be recorded by flow meters. Some control runs with the water jets turned off will also be completed for comparison.

Summary of Actions to Date: In 2011, the U.S. Army Engineer District, Chicago (LRC), requested the USACE Engineer Research and Development Center (ERDC), Coastal and Hydraulics Laboratory (CHL), to determine if commercial navigation could cause or facilitate transport of Asian carp past the protective electric barriers at some time in the future. It was hypothesized that currents generated by moving vessels or the vessel structure itself could inadvertently entrain fish, where they would be carried along with the vessel across the electric dispersal barriers. Once passed, the fish would be free to swim further upstream and potentially on to Lake Michigan.

A 1:16.7 scale physical model with remote-controlled towboat and barges was used to evaluate the interactions of vessel, fluid motions, and nearly neutrally buoyant objects (model Asian carp) under a variety of vessel speeds and barge configurations typical of the CSSC in the vicinity of the electric barriers (Bryant et al. 2016). The primary tow configuration consisted of six barges traveling in a two-wide by three-long flotilla. Other configurations, including a one-wide by three-long configuration, were investigated as well. Four of the barges had a rake at one end and the other two were boxed at both ends. A number of barge configurations were investigated including rake-box, rake-rake, and box-box connections.

To conform to the natural flow in the CSSC the experiments were divided into northbound (upstream) and southbound (downstream) directions, which placed the tows in different hydrodynamic regimes. For southbound traffic, the return velocity was shown to be most relevant for model fish transport. Northbound traffic produced transport by four different modes. The modes that transported fish the greatest distances were entrainment in vortices that make up the wake flow, and entrainment in the vortices that exist within voids in the barge configurations.

Subsequent field tests completed by USFWS with support from USACE and USGS have shown that transport of fish by barge tow entrainment is possible in the CSSC at the barriers.

The previous physical model that was used in the earlier laboratory study was updated and tests were completed to investigate mitigation measures to remove or dislodge entrained Asian carp and to determine the efficacy of such measures.

The flushing alternatives were designed to remove fish before crossing the barrier and applied to northbound tows. The design included a manifold placed on the bottom of the canal with a series of upward facing jets that impinged on the bottom of the barge during passage. A number of trial tests with different manifold and jet configurations were conducted to determine which method removed the greatest number of fish. The results indicated that a jet oriented at 67.5 degrees from the horizontal with a 12 inch nozzle had a minimal effectiveness of 100 percent for a two by three barge configuration traveling at 2.5 mph. At higher vessel speeds (4 – 5 mph) the jets were unable to remove all fish. The main contributing factor to the lower minimum effectiveness was the increased vessel speed, which reduced the exposure time so the model fish were not subjected to the flushing action long enough to be removed from the barge junction.

Proposed Actions for FY 2017:

- Develop a scope of work (SOW) to test the use of water jets in the field. The SOW will include a detailed description of methodologies and expected products and outline in more detail the schedule and cost requirements for the project.
- Acquire, construct, and test the necessary apparatus, including jet nozzles, hoses, pumps, and piping.
- Install the water jet equipment in the canal and complete test runs with barge tows.
- Prepare a brief memorandum report summarizing the work completed and any immediately available results shortly after completion of the testing.
- Begin preparation of a final report summarizing in detail the test methods and results.

Proposed Actions Potential Out-year Actions (Subject to Future Appropriations): Complete the final report.

Deliverables: The FY 2017 deliverables will be the detailed SOW, completion of field testing, and the initial testing summary report.

Expected Completion Date for Project: The expected completion date is the second quarter of FY 2018.

Expected FY 2017 Milestones:

- First Quarter 2017 – Completion of SOW
- Second Quarter 2017 – Necessary equipment acquired and initial testing of water jet apparatus completed
- Fourth Quarter 2017 – Completion of test runs with barge tows. Completion of initial summary report

Outcomes/Outputs: The output will be the final report describing the effectiveness at disrupting entrainment of the various water jet operating scenarios tried and recommending if any are suitable for long-term implantation at the CSSC barriers site. Considerations for future longer-term deployment of water jets will be highlighted.

Potential Hurdles:

- Timeliness of funding with respect to equipment acquisition and construction and the field testing schedule
- Methodology for implementation of a water jet system in the canal, which has not yet been attempted
- Coordination with navigation

45. Field Deployment of Control Technologies at Brandon Road Lock

Lead Agency: USGS/USACE

Agency Collaboration: USFWS, IL DNR, USCG

Funding Table:

Funding	Agency Funding	USGS Asian Carp GLRI Funding	USACE Asian Carp GLRI Funding
FY 2017	**$0**	**$160,000**	**$685,000***

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:

Several potential control technologies are being considered to prevent Asian carp movement through Brandon Road Lock. The USGS has conducted numerous laboratory and field tests using complex sound to deter Asian Carp, however, if this technology is to be used at or around a lock and dam, proper testing and installation should be completed. The use of this technology at a lock within a navigation channel offers additional complexities over the typical field installation testing. This project would allow testing and monitoring of new control technologies in the approach channel of the Brandon Road Lock.

This testing will allow for the evaluation of deployment configurations, collection of operation and maintenance information for longer deployments, and assessment of impacts to native fish and any telemetered Asian Carp in the Dresden Island Pool over the deployment period. During the testing period, any impacts to navigation can be evaluated because the Brandon Road Lock is on a regulated navigation channel with on average 3,500 cuts (lockages) per year. The majority of the traffic is commercial cargo (tug boats and barges). The testing will also include an evaluation of issues associated with navigator and lock operator safety, such as possible interference with marine radios and other communication devices and other technology interferences that may impact navigation. Another objective of this project is to provide all potential parties with field experience in the deployment of these ANS control technologies and to inform engineering considerations of future deployments.

Summary of Actions to Date:

- Field scale testing of carbon dioxide and complex sound were completed under different templates at Morris, Illinois in 2015.
- Preliminary evaluation by the USGS and USACE of which control technologies were ready for large-scale field testing.
- Decision to pursue testing of complex sound for the first trial. Possibilities for future field testing include water jets to clear barge gaps and carbon dioxide.
- Initial ambient sound recordings were completed in September 2016 at Brandon Road lock.
- Project kick-off meeting in September 2016 at USACE Chicago office with USGS, USACE, FWS, USCG, USEPA, and IDNR invited to participate.

Proposed Actions for FY 2017:

- Complete all permitting and/or regulatory requirements for deployment of complex sound.

- Collect input data for a quantitative model of the study area incorporating ambient acoustics, boundary conditions (walls, channel, air-water interface), and potential interfering factors such as turbulence during lock releases.
- Install initial speakers in the study area and monitor sound field produced for approximately seven days to provide the modelers with information on how sound travels through the channel.
- Complete quantitative sound propagation model of the study area. Can use the information gathered during this assessment (refraction – sound moving in 360 degrees and bouncing off of objects- rates) to inform designs at other locks.
- Coordination and communication between USGS and USACE on engineering considerations—speaker location, power, monitoring equipment location, minimizing navigation impacts.
- Follow-up meeting to discuss implementation, coordinate responsibilities, and evaluate process.
- Continued monitoring of the carp population and assess native fish population that may be impacted by underwater sound (preliminary pre-study assessments).

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

- Develop designs/plans for deployment of complex sound and possibly other technology deterrents in the approach channel at the Brandon Road Lock and Dam.
- Construct a complex sound deterrent in the approach channel and miter gates at the Brandon Road Lock and Dam and begin the 30-day demonstration. This task includes power and control wiring from an available power source routed to new amplifier/transformer houses on both sides of the lock intended to protect the acoustic operating equipment. The initial assumption is that available power will need to be furnished from the Central Control Station, Riverwall Switchgear/MCC, or the downstream operating control stands. A multiple underwater speaker array will be installed across the downstream approach channel to create a full sound field barrier and possibly an array near the downstream lock gates. The underwater acoustic equipment will be anchored or ballasted on the rock channel bottom and protection of speaker cabling/wiring will be incorporated into the design to withstand prop wash and abrasion. Based upon the proposed downstream location for the underwater speaker array the installation assumes all wiring will require protection or embedment in the walls of the guidewalls. To accomplish the wiring protection, cofferdams, dewatering, saw cutting, concrete placement and wall armor repair are included in the design scope of work and cost estimate.
- Collect monitoring data as identified during designs/plans development.
- Further monitor and evaluate the fish population at and around Brandon Road Lock.
- Complete the complex sound trial, and depending on cost and logistical considerations, implement a second technology field trial such as water jets or carbon dioxide.
- Update the sound propagation model based on field measurements. This model could be used to design a larger array in the approach channel.
- The USACE will develop an after-action report of information needed for the incorporation of these technologies in future USACE control actions, if they are deemed applicable.
- The USGS will develop a report summarizing the results from these long-term deployments and monitoring data collection.
- Further monitor and evaluate the fish population at and around Brandon Road Lock.

Deliverables/Outcomes:

FY 2017

- Full scope of work developed for implementation and monitoring during field trial.
- Robust sound propagation model to inform design.
- Engineering design and specifications for the complex sound field installation.
- Draft reports from USGS and USACE of field trial results.

Expected Completion Date for Project: FY2020

Expected FY 2017 Milestones:

- Regulatory requirements fulfilled by February 2017.
- Initial installation of speakers complete in Brandon Road Lock and Dam study area by February 2017 for 7-day trial and data collection.
- Numerical model of acoustics of study area by July 2017.

Outcomes/Outputs:

- Long-term deployment information for technologies currently under development. USGS and USACE reports documenting the effectiveness, design considerations and other information. Considerations for future larger-scaled design and deployment will be highlighted.
- Provide USACE and other parties with field experience in the deployment of these ANS control technologies.

Potential Hurdles:

- Timeliness of funding with respect to field testing schedule
- NEPA and other regulatory/permitting evaluations
- Coordination with navigation and real estate
- Timeliness of contracting

46. Asian Carp Swim Speed Study

Lead Agency: USACE

Agency Collaboration: Chicago District USACE, Engineering Research and Development Center Environmental Lab USACE

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Information on the swimming performance of large (500-1000 mm TL) adult Bighead and Silver Carp are critical for assessing and developing hydraulic 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). Laboratory studies of Bighead Carp can control confounding environmental variables found in the field 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.). This experiment tests fish over a wide range of constant water velocities with several replicates for each water velocity. Each fish is acclimated to flowing water in the tunnel, subjected to a predetermined water velocity, and observed until it fatigues. Each fish is tested only once. Because most riverine fishes have maximum sustained swim speeds of 40 cm/s, prolonged and burst speeds in the 60-200 cm/s range are emphasized in testing. Fish are tested at 20 cm/s increments for a total of 8 test velocities.

Summary of Actions to Date: The USACE Engineering 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 (> 35 kg) and generating precisely controlled flows (measurable within 5 cm/s). The ease of mobility and use of on-site river water eliminates the need for acclimatization so that fish can be tested within minutes of their capture. The swim tunnel has been used to study White Sturgeon (in 2013), Paddlefish (in 2014), and most recently Bighead and Silver Carp (in 2015) (Hoover et al., 2016). The carp study was funded by the University of Minnesota and conducted during spring and summer 2015. The experimental design and set up of field collection protocols was completed in fiscal year 2016.

Proposed Actions for FY 2017:

- Autumn field data collection begins first quarter FY17.
- Winter field data collection begins second quarter FY17.
- Analysis of the data will be ongoing from the first field trials through the third quarter.
- Develop final report by fourth quarter FY17.

Deliverables/Outcomes:

- A refined understanding of the swimming capabilities of Bighead and Silver Carp will strongly support both the Electric Dispersal Barriers Project and the Brandon Road feasibility study of GLMRIS.
- Improved knowledge on sustained, prolonged, and burst swim speeds throughout the year will reduce uncertainty involved in assessing the performance of multiple barriers including but not limited to flow velocity, electric field, CO_2, and acoustic barriers.
- A final technical report will be published by the ERDC-EL, which will detail the study and its findings

Expected Completion Date for Project: Fourth Quarter FY17

Expected FY 2017 Milestones:

- Field data collection for autumn river conditions will be completed by first quarter FY17.
- Field data collection for winter river conditions will be completed by second quarter FY17.
- A final report will be completed by fourth quarter FY17.

Potential Hurdles:

- Harsh field conditions could limit availability of study specimens.

47. H&H Technical Support for Eagle Marsh Phase II Basin Separation

Lead Agency: USACE

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

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2017	**$0**	**$25,000**	**$15,000 (FY 16 Economy Act)**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Preliminary coordination and H&H support for future planning of Phase II of the berm reconstruction, which 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 to provide H&H and planning expertise.

Summary of Actions to Date: USACE provided periodic engineering support during construction Phase I berm construction, which was completed in November 2015.

Proposed Actions for FY 2017: It is expected that Phase II planning will be initiated by a partnering agency in FY17. USACE will continue technical H&H support for this effort.

Potential Out-year Actions (Subject to Future Appropriations): Continued H&H technical support to help understand required mitigation actions. Support to the development of mitigation actions and acquisition strategy.

Deliverables: Identify a lead agency and mitigation requirements for Phase II.

Expected Completion Date for Project: 2022

Expected FY 2017 Milestones:

- Understanding mitigation requirements FY17 – Q3
- Lead agency identified FY 17- Q4

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 required acquisition is unavailable
- Property owners resist acquisition

65. Electric Field-Based Aquatic Nuisance Species Dispersal Barrier: Development and Implementation of an Alternating Current Electric Dispersal Barrier to Block Passage of Small Sizes of Bighead Carp and Silver Carp

Lead Agency: USACE

Agency Collaboration: NA

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$477,500**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Description: Introduction.—The aim of this project is to design an Alternating Current Electric Dispersal Barrier (AC EDB) for the Brandon Road Lock and Dam. The project is broken into four broad tasks, each with a specific objective. Task One will develop scaled models and conduct Simulations of Intrusion with small sizes of live Bighead Carp to determine spatial and temporal characteristics for the waterborne electric field that needs to be produced by the AC EDB. Task Two will conceptualize the primary components of the AC EDB (power supply, monitoring and control systems, and electrode systems) necessary to produce the electric field tested in Task One. Task Three, a follow-on task for Task One, proposes additional laboratory testing under varying Seasonal/Environmental conditions. Task Four, a follow-on task for Task Two, proposes to design and construct the AC EDB components conceptualized in Task Two.

It is important to note that the AC EDB can be designed to be central in a multiple-technology deterrence system or as an accessory technology. The incorporation of alternative deterrence technologies can be included the design conceptualization. The AC EDB can be operated to function as a physiologic barrier, where fish of the targeted size and larger are rendered incapable of swimming through the electrified zone, or as a behavioral barrier. When being operated as a physiologic barrier, the output of the AC EDB can also be turned down from levels that target small fish to output levels safer for humans. The output of the AC EDB can be changed depending on the circumstance (for example, if a barge was present, switch on alternative technology to increase water velocity, or turn on complex sound). The AC EDB output could also be decreased to safer levels and then increased to higher levels after the barge has cleared the area. This type of flexibility can be designed into the system. If multiple deterrence technologies are being applied, a monitoring and control system will need to be developed to interface with each of them. It may be possible that the AC EDB monitoring and control system could be developed so alternative technologies (e.g., complex sound) can be integrated into the system.

Electric dispersal barriers (EDB) are being considered as a means of blocking upstream passage of Asian carp into Lake Michigan. Bighead Carp and Silver Carp are nuisance invaders of the Mississippi River System, with established reproducing populations in the system. The invasion front has recently moved upstream, increasing risk for invasion of the Great Lakes. The effectiveness of EBD on very small Bighead Carp and Silver Carp is of particular concern, with Brandon Road Lock and Dam selected as a strategic point for preventing upstream passage of these invasive fishes into the CAWS. Recent research related to EDB operating in the CSSC indicates the effectiveness for blocking passage of fish with pulsed DC (PDC) to be strongly influenced by fish size (Holliman 2011; Holliman 2014 A; Holliman 2014 B) with electric field parameters demonstrated effective on large fish shown to be less effective on small

fish. Recent research also indicates seasonal environmental conditions, specifically water temperature, to strongly influence effectiveness of EDB on the CSSC, with electric field parameters demonstrated effective on Bighead Carp at lower water temperatures shown to be less effective at summer season (warmer) temperatures.

Electric-field-based dispersal barriers can be an efficient method for preventing upstream movement of fish. Edward and Higgins (1972) and Bird and Cowx (1992) reported that maximum susceptibility to PDC may occur at different PDC frequencies among species and that fish of different sizes can exhibit their greatest susceptibility at different pulse frequencies. Typically, smaller fish require greater pulse frequencies and/or greater pulse amplitudes to induce passage-preventing behaviors. Use of higher PDC pulse frequencies and/or amplitudes may lead to increased concern for human safety, greater rates of anode destruction, and greater rates of corrosion of surrounding structures. Alternating current (AC) can be used for EBD and has the potential benefit of reducing concerns over corrosion and anode destruction. Moreover, AC can be manipulated to conserve electrical energy, to have characteristics of PDC but with constant reversals of electrode polarity, which would also prevent galvanotaxis (forced-swimming by fish) to the anode or in some cases the cathode. An AC EDB may have the distinct advantage, over PDC, in simplification of circuitry requiring less specialization in design and maintenance personnel.

Proposed Actions for FY 2017:

(1) Task One: **Specification of Electric Field Parameters for an Alternating Current Electric Dispersal Barrier: Evaluation of Alternating Current for Blocking Passage of Very Small Asian Carp (Funded)**

Objective: To determine sets of AC electric field parameters for EDB that achieve a reliability (probability) of 95 percent for inducing passage preventing behaviors in very small sizes of Bighead Carp at a 95 percent confidence level.

Background:

The first step in the process of conceptualization, design, development, purchase, and implementation of an EDB system is to specify the electrical stimulus that will be effective on the targeted fish sizes. USACE has developed research equipment, methods, modeling and simulation approaches, and scaled models for EBD, in support of the operation and optimization of EBD employed by the USACE on the CSSC, which can be employed for specification of effective electrical stimulus for EDB at the Brandon Road location and aid decision making processes, including broad (e.g., AC versus PDC) and narrow (design specifications).

- **Approach:** A scaled-model approach will be employed, where a Brett swim tunnel will be modified so the field strength at the water surface of an EDB will be simulated under controlled conditions. The field strength applied in the simulations will be determined by modeling EBD electric fields, assuming a water depth of 15 feet and bottom-mounted electrodes (e.g., Holliman et al. 2015). Simulations of intrusion into the EDB will be conducted with live Bighead Carp (or Silver Carp) of 1 to 2 inches total length. The scaled-model of the EDB will be characterized by AC electrical parameters under consideration (e.g., 60 Hz AC).
- Pilot testing will be conducted with candidate sets of electric field parameters and reliability demonstration testing will be conducted on promising sets of electric field parameters. Water temperature will be at ambient conditions (20 °C) and water conductivity will be selected after conferring with sponsors.

- Videography will be employed to record fish behavior during the electrical exposures, with automated and manual video review to determine onset of targeted behavioral endpoints and metrics of fish performance during electrical exposures (e.g., loss of posture, tetany, swim velocity, distance traveled by fish during exposure).
- Reliability demonstration testing will be conducted with an appropriate number of fish, with a 95/95 reliability standard for induction immobility/tetany specified (95 percent probability at a 95 percent confidence level). Depth of intrusion (i.e., distance into the EBD) at onset of immobility/tetany will be estimated and reported.
- **Deliverable:** A report will be prepared summarizing the results of the testing and potential application of results. Specifically, the descriptions of the electric field parameters evaluated, the estimated reliability for the sets of electric field parameters evaluated for induction of immobility/tetany, the estimated depths of intrusion (penetration) into the electric field, and fish size and species, will be provided.

Task One Time: Testing will occur in Year 1 at the Aquatic and Wetland Ecosystems Research and Development Center, Environmental Laboratory, ERDC, which is an approved facility under the Environmental Laboratory Institutional Animal Care and Use Committee, and accredited by the Association for Assessment and Accreditation of Laboratory Animal Care. Bighead and Silver carp are currently being maintained in the facility. However, additional fish may be necessary to complete all testing. A draft final report will be submitted 6 months after testing begins.

(2) Task Two: Conceptualization of an AC EDB system

Objective: This task will conceptualize AC EDB power supply, including monitoring and control systems, and electrode system for the Brandon Road Lock and Dam. Electric Dispersal Barriers (EDB) are composed of three primary systems, the physical structures, the power supply (including control and monitoring systems), and the electrode arrays.

- **Approach:** The USACE Chicago District will be queried for information and documents related to construction, operation, and maintenance of the power supplies, monitoring and control systems, and electrode systems of the EDB operating on the CSSC. If available, this information can be used for reference and evaluated for application in the AC EDB for the Brandon Road Lock and Dam. This information on EDB on the CSSC is not required for the conceptualization and design of the AC EDB to proceed, but may prove useful to compare and contrast existing ACOE PDC EDB with the conceptual AC EDB or for conceptualization of PDC EDB.
- A customized power system will be conceptualized for the AC EDB (or PDC EDB). Outcomes of experimentation and testing on targeted sizes and species of fish in Task One (this project title) can be used to inform specifications for the power supply and electrode system. These specifications, and, if possible, continued testing with the targeted species and sizes of fish (Task Three), will inform power supply conceptualization and requirements for output and preliminary cost estimates for design, construction, and installation, of the AC EDB power supply and electrode system. Input from the sponsors will be used to refine features and requirements for the EDB power supply, monitoring and control systems, and electrode systems. The potential for integration and interfacing electric field monitoring technologies, with fish monitoring-detection technologies, and other deterrence technologies is also a consideration.
- **Deliverables:** The conceptualization of the AC EDB will include a brief report, concept drawings/sketches, basic descriptions of the AC EDB capabilities, features, components, hardware, software, operation, and maintenance; input electrical energy requirements; basic descriptions of infrastructure requirements; preliminary cost estimates for design, construction, and testing of the AC EDB (or PDC EDB) power supply, monitoring and control system, and electrode system.

- Potential for integration with other deterrence technologies will be addressed, depending on information on other deterrence technologies being available. This task will identify high risk technological challenges to development of an AC EDB (or PDC EDB).

Task Two Time: Estimated time frame is 18 months. The first year will focus on basic descriptions of the AC EDB capabilities and components; the second year will complete the deliverables. Completion of the task is influenced by timing and availability of information related to the EDB operating characteristics if the sponsor prefers this information to be considered in the conceptualization of the AC EDB (or PDC EDB).

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

(3) Task Three: Laboratory testing will be continued with the scaled model developed in Task One to evaluate efficacy of an AC EDB on immobilizing small Asian carp and to compare sets of AC and PDC electric field parameters of interest under various seasonal/environmental conditions (water temperature, conductivity).

- **Deliverable:** Report containing recommendations for environmental operating rules and outcomes of comparative testing between the conceptual AC EDB and PDC EDB to aid decision making. This testing can further define features and requirements for AC EDB or a PDC EDB located at the Brandon Road Lock and Dam.

Task Three Time: Research scheduled for Year 2. Research preparation and equipment setup and testing will take 21 days. Data collection, evaluation and analysis will take 34 days and report generation will take an additional 14 days. A final draft report will be submitted 6 months after receipt of funding.

(4) Task Four: After specification of output (Tasks One and Three) and conceptualization of the EDB System (Task Two) and receiving sponsor input USACE will submit cost estimates, timelines, and benchmarks for design, construction, testing, and installation of the EDB power supply (AC or PDC), monitoring and control system, and electrode system.

Deliverables:

- Conceptual Design Review
- Critical Design Review (includes Mechanical Drawings, Detailed Engineering Drawings, Architectural Drawings, Software Specifications, Hardware Specifications, Breadboard Demonstrations, Material Cost Estimates)
- Final Design Report.

Expected FY 2017 Milestones:

- Development of the Computer Model for the AC EDB
- Completion of the 95/95 Testing under Summer Environmental Conditions (high risk for small fish)
- Development of environmental-based operating recommendations
- Conceptualization of the AC EDB System
- Sponsor Feedback on Conceptualized AC EDB System
- Development of Conceptual Design Review

- Development of Critical Design Review
- Completion of Final Design Review
- Sponsorship of Feedback on Final Review

Outcomes: Development of effective new aquatic invasive species deterrence technology and systems.

Potential Hurdles (challenges):

- Availability of small sizes of Bighead Carp.
- Development of new aquatic invasive species deterrence technology while keeping costs down.
- Efficacy of alternative technologies for deterrence of small sizes of aquatic invasive species.

73. GLMRIS Program Management

Lead Agency: USACE

Agency Collaboration: NA

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$300,000**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Description: The U.S. Army Corps of Engineers (USACE) has conducted the Great Lakes & Mississippi River Interbasin Study (GLMRIS) pursuant to the terms of the authority provided in Section 3061(d) of the Water Resources Development Act (WRDA) of 2007 (Public Law 110–114; 121 Stat. 1121), and in accordance with prevailing policies, guidance and regulations. In GLMRIS, USACE evaluated the range of options and technologies available to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River Basins through aquatic pathways.

GLMRIS has been conducted in two Focus Areas (FA1 & FA2). In FA1, study efforts are concentrated on evaluating prevention measures that could be employed near the Brandon Road Lock and Dam for the potential threat of ANS transfer via the Chicago Area Waterway System (CAWS). In FA2, a preliminary report completed in October 2010 identified 36 potential surface water connections outside of the CAWS that may form across the drainage divide that separates the Great Lakes and Mississippi River basins. A total of 18 of these locations were determined to pose unacceptable risk of potential transfer of ANS; the report provides detailed recommendations for completing the identification and characterization of ANS transfer risk across each of those locations. Risk was characterized at each of these locations and documented in pathway assessments. These assessments were and are being used by state resource agencies as a basis for further action as each deems necessary. Active FA2 projects include Eagle Marsh (Indiana), Ohio-Erie Canal (Ohio), and Little Killbuck Creek (Ohio).

Work performed under this project consists of programmatic oversight and management of all GLMRIS related efforts, and includes vertical team coordination, coordination among and support to project elements within the geographical boundaries of the GLMRIS program, budget development and defense, public outreach, and stakeholder engagement.

Summary of Actions to Date: Programmatic oversight and management of GLMRIS Focus Area 1 and 2 efforts.

Proposed Actions for FY 2017: Continued programmatic oversight and management of GLMRIS Focus Area 1 and 2 efforts

Potential Out-year Actions (Subject to Future Appropriations): Continued programmatic oversight and management of GLMRIS Focus Area 1 and 2 efforts

Deliverables: NA

Expected Completion Date for Project: NA

Expected FY 2017 Milestones: NA

Outcomes/Outputs: Efficient and effective execution of the GLMRIS program in cooperation with those responsible for the completion of individual project elements.

Potential Hurdles: NA

6. Great Lakes Asian Carp Monitoring Program

Lead Agency: USFWS

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

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$1,150,000**	**$350,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: The Service will continue to implement and refine, with input from our partners, a comprehensive and complementary early detection and rapid assessment surveillance program for Bighead, Silver, Grass, and Black carp in and near the Great Lakes. This program would complement the 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 basin-wide early detection protocol for Asian carp and other AIS. Sampling gear used and locations sampled are tailored each year to match conditions and agency needs, as well as to leverage new sampling technologies for species of interest. USFWS continues to coordinate with federal, state, and provincial partners to annually identify sampling locations (areas of concern), further develop and refine protocols, share information, and discuss ways to coordinate agency sampling efforts. In 2013, USFWS worked with our partners to conduct coordinated and complementary sampling efforts in the Great Lakes basin with both emerging and traditional gears. From May-November 2013, USFWS collected 2,240 eDNA water samples, electrofished, and set nets to assess presence or absence of Asian carp. In 2013, no Asian carp were captured; however, positive eDNA results were obtained from USFWS sampling in three locations. In 2014, USFWS expanded its overall sampling efforts and collected over 4,000 eDNA water samples, electrofished, trawled, sampled ichthyoplankcon, 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 three locations, which indicates the presence of genetic material. However, no live Asian carp were found in the area. In 2015, USFWS continued to expand its overall sampling efforts and collected over 4,500 eDNA water samples, electrofished, trawled, sampled ichthyoplankton, and set a variety of nets to survey for Asian carp. In 2015, no Asian carp were captured, and no positive eDNA results were obtained from Great Lakes tributary locations. In 2016, USFWS continued to expand its overall sampling efforts and collected over 4,600 eDNA water samples, electrofished, trawled, sampled ichthyoplankton, and set a variety of nets to survey for Asian carp. In 2016, no Asian carp were captured, and no positive eDNA results were obtained from Great Lakes tributary locations.

Proposed Actions for FY 2017: USFWS will work with partners to continue developing, adapting, and refining standard sampling protocols for the Great Lakes, and will continue implementing the protocol. USFWS staff/teams will be prepared, and may be mobilized, to respond to any Asian carp detected (using

either traditional gear or eDNA) in the Great Lakes. USFWS and partner agencies will fully implement a comprehensive Great Lakes basin wide early detection and monitoring program for Asian carp and other AIS. Efforts will continue on an annual basis to detect new invasions of Asian carp.

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

Deliverables:

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

Expected Completion Date for Project: Ongoing to maintain vigilance regarding potential new observations/occurrences of Asian carp in the Great Lakes or tributaries.

Expected FY 2017 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 gear 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	Asian Carp GLRI Funding
FY 2017	**$1,015,000**	**$820,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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, hydroacoustics, rotenone) and novel gears (DIDSON, Paupier net, Dozer trawl) 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 ACRCC 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. Service staff also conducted fish behavior studies (wild and caged) at the electric barriers. Service staff 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 ACRCC 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 4 weeks of seasonal intensive monitoring in the CAWS. No Asian carp were captured, but two grass carp were observed. 16 fixed and 32 fixed site electrofishing runs over the course of two events were completed in Dresden Island and Marseilles pools. Twenty-four Silver Carp and one grass carp were captured. As part of enhanced adult Asian carp monitoring efforts, staff set 14,300 yards of gill and trammel nets from Starved Rock Pool through the Lockport Pool and completed 35 electrofishing runs. Eleven grass carp, 15 Bighead Carp, and 416 Silver Carp were captured.

In 2016, Service and partner staff completed more than 200 electrofishing runs above the electric dispersal barriers during 2 weeks of seasonal intensive monitoring in the CAWS. No Bighead or Silver Carp were captured. Agency crews also completed over 100 electrofishing runs at fixed and random sites

in the Lockport, Brandon Road, Dresden Island, and Marseilles Pools in June 2016. No Bighead or Silver carp were observed in Lockport or Brandon Road Pools, but adult Silver Carp were collected in the Dresden Island Pool, Kankakee River, and Marseilles Pool. USFWS teams supported Asian carp monitoring and response activities for both juvenile and adult Asian carp throughout the region as necessary, and helped implement actions called for under the annually updated MRP.

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

Potential Out-year Actions (Subject to Future Appropriations): USFWS will support Asian carp monitoring and response activities throughout the region as necessary, and help implement actions called for under the annually updated MRP. USFWS will support Asian carp monitoring and response activities throughout the region as necessary, and help implement actions called for under the annually updated MRP.

Deliverables:

- Information regarding any new Asian carp observations/occurrences in the CAWS that will be provided to management agencies for potential action.
- Annual agency reports summarizing sampling efforts and findings.
- Presentations at conferences, to partner agencies, and to the public.

Participation in the annual updating of the MRP for the CAWS.

Expected Completion Date for Project: Ongoing to maintain vigilance regarding potential new observations/occurrences of Asian carp in the CAWS.

Expected FY 2017 Milestones:

- 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
- Completion of response efforts, as needed
- Completion of necessary barrier clearing, as needed.

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.

8. Barge Entrainment and Interaction Study

Lead Agency: USFWS

Agency Collaboration: USACE and USCG

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$300,000**	**$400,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: This project encompasses follow-up investigations to barge entrainment and fish interaction studies conducted in 2015 and 2016. Those studies showed that free swimming small fish could become entrained within barge junction gap spaces and subsequently transported upstream. Surrogate fish were transported upstream through the electric dispersal barrier, through upstream lockage operations, and over long distances (9.6 river miles). The proposed work for FY 2017 aims to address questions raised by the USFWS, USACE, other agencies, and the maritime industry regarding behavior of Asian carp in barge junction gap spaces and assess potential distances Asian carp may be transported within barge junction gaps. Further evaluations of management actions that could potentially reduce or eliminate fish entrainment will also be pursued. Additionally, a study designed to empirically estimate size selective entrainment probabilities for Asian carp will be undertaken.

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 junction gap 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 found that live fish were entrained across the barriers by passing barges, to varying degrees depending barge configuration (http://www.fws.gov/midwest/fisheries/carterville/didson-barge.html).

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. Further details of the 2015 study results can be accessed at https://www.fws.gov/midwest/fisheries/carterville/documents/2015-barge.pdf.

During 2016, studies continued investigations to: (1) evaluate behavior of wild fish near and in the junction gaps of barges as they traversed different sections of the CAWS; (2) determine the length of time and distance wild fish may be entrained in junction gap spaces of barges; (3) determine the size at which fish can vacate, of their own volition, the junction gap spaces of a rake to box barge; (4) evaluate entrainment probabilities under different barge configurations; and (5) determine the probability of

entrainment and transport of early life stages (eggs/larval) of Asian carp. Further details of the 2016 study results will be shared with the ACRCC member agencies, CEQ, DOJ, and the maritime industry.

Proposed Actions for FY 2017: The proposed work for FY 2017 aims to address questions raised by the USFWS, USACE, other agencies, and the maritime industry regarding behavior of Asian carp in barge junction gap spaces and potential distances Asian carp may be transported within barge junction gaps. Further evaluations of management actions that could potentially reduce or eliminate fish entrainment will also be pursued. Additionally, a study designed to empirically estimate size selective entrainment probabilities for Asian carp will be undertaken. A modified mark recapture study utilizing juvenile Asian carp of varying sizes will be performed in a downstream location with hyper-abundant Asian carp populations. Nets will be used to physically recapture marked study specimens and document entrainment transport distances. Additionally, multi-beam sonar systems and video cameras will be deployed around the barge tow. The images from the DIDSON or underwater cameras will be used to view and count fish in barge junctions over time and distance traveled. Additional data on temperature, flow, speed of the barges, and distances traveled by the barges will also be collected and compared to the sonar data collections.

Potential Out-year Actions (Subject to Future Appropriations): Additional actions proposed for future years will be directed by additional questions generated from ACRCC member agencies, CEQ, DOJ, and the maritime industry in response to findings from studies conducted during FY 2016 and FY 2017.

Deliverables:

- Agency reports outlining results of barge entrainment studies
- Presentations outlining results to ACRCC, CEQ, and Maritime industry, and peer-reviewed publications.
- Preliminary results will be presented as soon as possible after project year completion

Expected Completion Date for Project: 2019

Expected FY 2017 Milestones:

- Contract barge operations- May 2017
- Field trials- July -August 2017

Outcomes/Outputs:

- This project will provide an overarching understanding of the size specific risks for entrainment and upstream transport of Asian carp through barge entrainment pathways.

Potential Hurdles:

- Contracting delays
- Weather delays
- Political concerns regarding the stocking and potential upstream movement of Asian carp used during experimental trials.

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 2017*	**$0**	**$0**

* Work will continue in FY 2017 using remaining 2016 funds.

Project Explanation: Great concern exists 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.

It is proposed to extend and enhance our collective understanding of fish passage dynamics at the Brandon Road 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 Road Pools via the Brandon Road lock; (2) assess fish behavior within the Brandon Road lock before, during, and after lockage operations; (3) compare fish passage at Brandon Road 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 Road 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 Road and Lockport Lock and Dam 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, where abundances of Asian carp are found.

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

Expected FY 2017 Milestones:

- Data allowing the Brandon Road 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 Road 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

11. Program Capacity for eDNA Sampling

Lead Agency: USFWS

Agency Collaboration: Great Lakes States, USACE

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2017	**$1,100,000**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: USFWS Great Lakes Fish and Wildlife Conservation Offices can 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 would support USFWS Fish and Wildlife Conservation Office in conducting 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 basin-wide 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. This effort is directed towards Great Lakes and tributaries excluding the IWW or CAWS, and therefore does not overlap with USACE emergency protocols.

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 five Great Lakes. In 2014, positive eDNA results were obtained from USFWS sampling in three Great Lakes locations.

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.

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

Proposed Actions for FY 2017: 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 FY 2017 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 2017	**$1,300,000**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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 eDNA Quality Assurance Project Plan (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 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.

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.

In 2016, USFWS continued 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 continued 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.

Proposed Actions for FY 2017: 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 FY 2017 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.

14. ACRCC Strategic Communications Plan and Asian Carp Website Operation and Maintenance

Lead Agency: USFWS

Agency Collaboration: Work would support Asian carp communication efforts for all ACRCC member agencies.

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$100,000**	**$200,000**

* Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017. USFWS base funding is currently allocated for Asian Carp communications work related to USFWS projects in the Ohio River and Upper Mississippi River basins.

Project Explanation: Requested funding will be used by the U.S. Fish and Wildlife Service to increase the level of effort surrounding ACRCC communications work to create and implement a strategic communications plan that targets members of Congress and their constituents, the media, and environmental non-profits. Work would include management of AsianCarp.us website, scheduling and coordinating outreach events, creating ACRCC branded communication products, enhancing the ACRCC's social media strategy and ultimately increasing the reach of ACRCC messaging. Communications work will contribute to key audiences having a greater understanding and appreciation for the ACRCC's purpose, function, current actions and successes.

Summary of Actions to Date: USFWS has served a co-chair of the Communication Work Group since the inception of the ACRCC. Through our work with ACRCC member agencies USFWS has coordinated common messaging and media roll-outs, as well as fostered inter-agency collaboration through the management of AsianCarp.us, the ACRCC's primary outreach platform. Though the Service has previously received ACRCC funding for management of AsianCarp.us website, this FY 2017 request will be the first time additional funds are requested to help grow ACRCC communication efforts.

Proposed Actions for FY 2017:

- Creation of ACRCC strategic communications plan including enhanced social media strategy
- Stakeholder analysis for key audiences
- Development of key messages
- Coordination of editorial board visits and media availabilities to foster media engagement
- Scheduling and/or coordination of outreach opportunities throughout the year with key members of Congress and their constituents including, but not limited to, Hill briefings, listening sessions, roundtables and site visits
- Scheduling and/or coordination of ACRCC participation in targeted outreach opportunities throughout the year with environmental non-profits including, but not limited to, briefings, listening sessions, roundtables and site visits
- Creation of ACRCC branded communication products
- Management of AsianCarp.us website

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

- Providing updated ACRCC strategic communications plan
- Refining all messaging
- Coordinating editorial board visits and media availabilities to foster media engagement
- Scheduling and/or coordination of outreach opportunities throughout the year with key members of Congress and their constituents including, but not limited to, Hill briefings, listening sessions, roundtables and site visits
- Scheduling and/or coordination of ACRCC participation in targeted outreach opportunities throughout the year with environmental non-profits including, but not limited to briefings, listening sessions, roundtables and site visits
- Management of AsianCarp.us website.
- Creating ACRCC-branded communication products

Deliverables:

- Written strategic communications plan paired with a timeline for implementation
- Completed stakeholder analysis to inform message creation and delivery
- Creation of key messages that will resonate with selected key audiences (e.g. members of Congress, the media and environmental non-profits)
- The scheduling and coordination of two or more outreach ACRCC opportunities with members of Congress and/or their constituents, the media, and environmental non-profit organizations
- The creation of ACRCC branded communication products as needed/requested
- Coordination of posts and content placed on AsianCarp.us website

Expected Completion Date for Project: NA - Communications work is ongoing

Expected FY 2017 Milestones:

- April 2017 – Communications plan drafted, reviewed and approved by ACRCC by April 2017. Will include stakeholder analysis and key messages
- Late winter/early spring 2017 – Coordination of initial meetings with members of Congress and/or their constituents, or environmental non-profits
- Late spring/summer 2017 – Scheduling or coordination of one to two editorial board visits or media availabilities
- Summer to fall 2017 – Updated website content and the implementation of an enhanced social media strategy
- Late FY 2017 – Begin review and update of strategic communications plan for FY 2018
- ACRCC branded communication products will be created throughout the year as needed

Outcomes/Outputs:

- Communications work will contribute to key audiences having a greater understanding and appreciation for the ACRCC's purpose, function, current actions and successes.

Potential Hurdles: None

16. Registration of Microparticle Technologies to Selectively Deliver Control Agents to Asian Carp

Lead Agency: USFWS with USGS

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

Funding Table:

Funding	Agency Funding	USFWS Asian Carp GLRI Funding	USGS Asian Carp GLRI Funding
FY 2017	**$0**	**$75,000**	**$100,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: 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 Bighead 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 Bighead Carp. Currently, antimycin-incorporated microparticles are being evaluated for the potential to control populations of Bighead 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 U.S. Geological Survey's Upper Midwest Environmental Sciences Center (UMESC) will provide regulatory affairs support to the U.S. Fish and Wildlife Service (USFWS) in the development of biological and chemical pesticide controls of Bighead carp. Regulatory affairs support will include compilation of data and reports for submission to regulatory agencies (e.g.USEPA), identification of required data to attain chemical registration, coordination of experimental use permits and other regulatory support as needed to attain and maintain chemical registrations of tools to control Bighead Carp. The UMESC will also develop specific data required to attain registration of microparticles to control Bighead 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 ESA Section 7 consultations to ensure that all actions taken regarding testing and implementation of Bighead 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 Service will serve as eventual registrant of Bighead Carp control technologies developed under this template, and will work with USGS to ensure that any applications, including experimental or test applications, of control technologies developed under this template are compliant with NEPA.

Summary of Actions to Date: In FY14, UMESC participated in registration and control technology projects by initiating formulation review with the USFWS to determine Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles. USFWS initiated development of Standard Operating Procedures (SOPs) to provide guidance for field use of microparticle-based Bighead Carp control agents by approved agents, and collaborated with USGS to identify and obtain target sensitive native fish and mussel species for laboratory testing to support the registration process.

In FY15, UMESC completed a consultation with USEPA for a formulation review to determine registration data requirements of antimycin-incorporated microparticles and assessed registration requirements for alternative control agents of Bighead Carp. USFWS continued development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of microparticle controls.

In FY16, UMESC completed review with USFWS to determine Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles in limited open-water application sites and initiated submission of studies to complete USEPA registration of antimycin-incorporated microparticles to USEPA. Development of a protocol to conduct environmental fate studies was initiated.

Proposed Actions for FY 2017:

- 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

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

- Review environmental fate studies of antimycin-incorporated microparticles
- Assess registration requirements of biologically-derived controls of Bighead 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 Silver and Bighead Carp
- Assist management agencies that plan to deploy antimycin-incorporated microparticles in limited open-water application sites
- 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
- Coordinate submission of studies to address Section 7 ESA-consultation data requirements of biologically-derived controls incorporated microparticles
- USFWS will coordinate meetings with state and federal agency partners to identify future opportunities for implementation of microparticles in support of Asian carp prevention strategies (for implementation following approval and registration).
- Provide regulatory affairs support for control products registered by USFWS and other public agencies

Deliverables:

FY 2017:

- Complete protocol for environmental fate studies with antimycin-incorporated microparticles
- Initiate environmental fate studies with antimycin-incorporated microparticles
- Submit permit for deployment of antimycin-incorporated microparticle
- Review data requirements for registration of antimycin-incorporated microparticles
- Training program and protocols for implementation of microparticles use in the field
- Protocol for environmental fate studies with alternative active ingredient microparticles
- Section 3 registration process to allow use of antimycin-incorporated microparticles nationwide
- Continue registration process for alternative active ingredient microparticles
- Complete non-target feeding studies with antimycin-incorporated microparticles

Expected Completion Date for Project:

- Contingent upon UMESC projected completion dates for development of microparticle delivery technologies

Expected FY 2017 Milestones:

- Determination ofUSEPA registration and Section 7 ESA-consultation data requirements for antimycin-incorporated microparticle registration (June 2017)

Outcomes/Outputs:

- Development of a targeted delivery system for selective control of Silver and Bighead Carp

Potential Hurdles:

- Limited availability of antimycin
- Potential impacts of antimycin on non-target species due to non-selectivity
- Regulatory permitting

17. Registration of Carbon Dioxide Technologies

Lead Agency: USFWS and USGS

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

Funding Table:

Funding	USFWS Agency Funding	USFWS Asian Carp GLRI Funding	USGS Asian Carp GLRI Funding
FY 2017	**$0**	**$75,000**	**$150,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: This project supports the use of carbon dioxide (CO_2) to control Asian carp. CO_2 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, CO_2 must be evaluated for its environmental impacts on species of concern to help meet the requirements of the ESA (Section 7 consultation). CO_2 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 are to (1) provide regulatory affairs support for the use of CO_2 as a deterrent to control Asian carp and (2) develop registration-specific data to support the registration of CO_2 as a lethal pesticide control. This project supports a larger project that is evaluating CO_2 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 CO_2. The chemical and biological control SOPs serve as core components of the documentation required to use CO_2 as either a deterrent or a lethal control agent , and will include protocols on safe transport, handling, storage, and dispersal of CO_2 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 U.S. Geological Survey's Upper Midwest Environmental Sciences Center (UMESC) provides regulatory affairs support to the U.S. Fish and Wildlife Service in the development of biological and chemical pesticide controls of Asian carp. Regulatory affairs support includes 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 is also developing specific data required to attain registration of CO_2 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 Service will serve as eventual registrant of Asian carp control technologies developed under this template, and will work with USGS to ensure that any applications, including experimental or test applications, of control technologies developed under this template are compliant with NEPA.

Summary of Actions to Date: In FY14, UMESC completed waiver requests for specific sections of CFR 40 parts 150 to 159 that most likely do not apply to anticipated use of CO_2 as a control agent for Asian carp.

In FY15, consultations with USEPA resulted in determinations that Section 18 Emergency Exemption registration was the best approach for CO_2 registration and the necessary data requirements were identified. Data requirements for USFWS Section 7-ESA consultation for use of CO_2 as a deterrent for Asian carp were also identified. A meeting was coordinated between USFWS, USACE, IL DNR, ILUSEPA, USEPA, and USGS to initiate discussion on site selection for application of CO_2 as a deterrent to Asian carp movement. 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.

In FY16, data was compiled to support a Section 18 Emergency Exemption application for the use of CO_2 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 CO_2 deterrent or the use of CO_2 as a control agent in limited open-water application sites. Guidance was provided for studies on effects of CO_2 on non-target organisms to ensure compliance with Section 7-ESA consultation. USFWS participated in CO_2 Advisory Group comprised of federal and state agencies to develop plan for transitioning from CO_2 research to management applications.

Proposed Actions for FY 2017:

- USFWS will continue development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of CO_2 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, in partnership with USGS, will develop comprehensive planning assessments for deployment of CO_2 at a lock and/or approach channel to deter movement of Asian carp
- 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-ESA 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 CO_2 as a control agent, and identify related requirements.
- Respond to USEPA or state regulatory agencies regarding the use of CO_2 as a deterrent or to register CO_2 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 CO_2 as a deterrent or the use of a CO_2 as a control agent in limited open-water application sites to control Asian carp
- Assist management agencies that plan to deploy CO_2 as a deterrent or the use of a CO_2 as a control agent in limited open-water application sites to control Asian carp

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

- Continue comprehensive planning assessments for deploying CO_2 at a lock and/or approach channel to deter Asian carp movements
- Continue to evaluate the effects of CO_2 enriched water on non-target species
- Continue USEPA registration of CO_2 as a control agent in limited open-water application sites
- Complete studies to address USFWS Section 7 ESA consultation data requirements of a CO_2 barrier or the use of CO_2 as a control agent in limited open-water application sites
- Respond to USEPA or state regulatory agencies review of data submitted to register CO_2 as a barrier or 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 CO_2 as a barrier or control agent in limited open-water application sites
- Assist management agencies that plan to deploy CO_2 as a barrier or control agent in limited open-water application sites to control Asian carp

Deliverables:

- Submission of USEPA registration application for emergency exemption use of CO_2 (Section 18 Permit)
- Draft Standard Operating Protocols
- Section 7-ESA consultation for proposed deployment site(s)
- CO_2 registered for emergency exemption use under Section 18
- Standard Operating Protocols complete final revision/review
- Comprehensive planning assessment for CO_2 at lock/approach channel
- Section 7-ESA consultation for proposed deployment site(s)

- CO_2 safety and training programs and protocols for agency staff for implementation of control technologies in the field
- Section 7-ESA consultation for additional proposed deployment site(s)
- Registration of CO_2 as a barrier or control agent in limited open-water applications

Expected Completion Date for Project:

Contingent upon UMESC projected completion dates for development of CO_2 as a control for Asian carp

Expected FY 2017 Milestones:

- Determination of USEPA registration and Section 7-ESA Consultation data requirements for use of CO_2 as a deterrent or the use of CO2 as a control agent in limited open-water application sites to control Asian carp (2017)

Outcomes/Outputs:

- CO_2 efficacy will be determined as a management tool for Asian carp
  - Barrier/deterrent
  - Lethal control
  - Enhancement of removal effort

Potential Hurdles:

- Potential effects of CO_2 on non-target species due to non-selectivity
- Potential effects of carbonic acid on in-water navigation/control structures
- Capacity of the infusion system to evenly disperse CO_2-infused water within an uncontrolled flow environment to maintain target concentrations
- Regulatory permitting

48. Black Carp Genetic Analysis

Lead Agency: USFWS

Agency Collaboration: Missouri Department of Conservation (MDC), other partners who may catch Young-of-Year (YOY) Black carp, USGS

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$100,000**	**$250,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: The Service will use traditional genetic sequencing to confirm visual identification of any captured small fish, and conduct lab work to optimize and test multi-locus genetic markers from the literature in order to evaluate the relatedness of YOY black carp captured during regular monitoring events in the Mississippi River (Objectives 1 and 4). Age 0 black carp maybe difficult to distinguish from other small fish in the Mississippi River, and confirmation of visually identified fish solidifies observations of this species in the Mississippi River. Genetic ID can be used to test morphometric tools developed by collaborators in the field and improve field identification of small Black Carp (Objective 4). The multi-locus genetic markers can inform managers with information on how many adults contributed to the YOY fish captured in the wild which will help address Objective 1. Tissue from these same fish will also be used to generate whole genome sequences for this species which can be used to further develop monitoring and control tools (Objectives 1, 3, 6, and 9). To address understanding of diet (Objective 2), the Service will attempt to capture adult fish with gut contents available for analysis and use a variety of genetic analyses to document presence of native mussel DNA in the diet. These methods may also work on fish, commonly captured by commercial fishers, whose guts are purged due to being held in nets.

Field validation of highly sensitive black carp markers has proven to be more challenging than it was for silver and Bighead Carp. Part of this may be due to the behavior and biology of these benthic fish and their current location in the Mississippi River that has large volumes of water that effectively dilute the signal. The YOY captured in fall of 2016 are in much smaller agricultural drainage systems, and may be ideal field sites for using eDNA. There are dozens of field sites that need to be searched, and some may be difficult to sample with traditional fisheries gear, so paired sampling events would be helpful to both field validate the markers as well as lead to a much more rapid screening process to cover many more sites in a shorter time frame (Objectives 3, 6, and 9).

Summary of Actions to Date: The fish captured in 2015 (2 YOY) and 2016 (~34 YOY) were preserved in ethanol specifically for genetic analyses.

Proposed Actions for FY 2017:

- Use traditional sequencing techniques to confirm species ID done visually in the field.
- Test, optimize and collect data on multi-locus microsatellite markers from the literature to determine relatedness or parentage of the YOY fish.

- Use Next Generation Sequencing techniques to generate whole genome sequences for Black carp in US waters.
- Capture adult fish with gut contents still present and preserve gut contents for genetic analysis.
- Use the newly validated eDNA markers along with traditional fisheries sampling methods in the small drainage systems similar to habitat where several dozen YOY fish were captured in 2016. This may help field validate the markers and provide a rapid screening tool to search several sites quickly.
- Continue to provide sequence confirmation of visual ID and conduct relatedness or parentage analyses on YOY fish captured as part of regular monitoring efforts coordinated under various carp management plans.
- Use or provide genome data to develop new tools for the monitoring or control of black carp. Analyze preserved gut contents with genetic analyses.

Deliverables: Confirmation of ID of YOY black carp in Mississippi River waters, gain some understanding of how many adult fish contributed to the YOY captured during regular monitoring efforts, and whole genome sequence data.

Expected FY 2017 Milestones:

- Optimization of multi-locus markers by February 2017, generation of data by April 2017, analysis of data and results available by June 2017. Data collection and analysis done in out years within 2 months of sample receipt. (note, these same markers can also be used to look at the relatedness of YOY silver and Bighead Carp captured during regular monitoring activities)
- Field validation of the newly lab validated black carp eDNA markers.
- Confirmed sequence ID of YOY by January 2017, and each January in out years.

Outcomes/Outputs:

- Information that will enhance understanding of black carp biology and life history in the Mississippi River and any other systems where fish are collected.
- Raw data that can be used to develop new monitoring or control tools.

Potential Hurdles:

- Microsatellite markers from literature may not work well with these specimens.
- Annual monitoring efforts may not capture any YOY fish in out years.
- Gut content analyses can be challenging in the lab, and interference from fish DNA or digestive enzymes could block PCR-based methods.

49. Analysis of Grass Carp in the CAWS and the Upper Illinois Waterway (IWW)

Lead Agency: USFWS

Agency Collaboration: USACE, Illinois DNR, USGS, SIU

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$30,000**	**$120,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: This project encompasses analyzing Grass Carp in the Upper IWW and CAWS to better understand their population dynamics and determine if this population may be a source to Great Lakes populations. Grass Carp specimens will be collected through direct and indirect sampling events to determine relative abundance, high concentration areas, ploidy, age/growth, gonadal histology, and a gonadosomatic index. Specimens captured in the upper pools of the IWW (Dresden Island, Brandon Road and Lockport) will be implanted with acoustic telemetry transmitters and monitored to determine habitat selection and large and small scale movement.

Summary of Actions to Date: USFWS personnel acquired historical data of Grass Carp captured in the Upper IWW and CAWS from the Illinois DNR. With this information, kernel density maps were created by the USFWS Midwest Fisheries Center for Dresden Island and Brandon Road pools to determine potential high distribution areas that could be targeted during direct sampling efforts. Grass Carp collected were processed for life history traits, and eyeballs or blood samples were sent to the USFWS Fish Health Center to analyze ploidy. Otoliths, vertebrae and gonads were sent to USGS Columbia Environmental Research Center to determine age, microchemisty, gonadal histology and a gonadosomatic index.

After August 2016, Grass Carp captured within Dresden Island, Brandon Road and Lockport Pools were implanted with acoustic transmitters to monitor movement patterns and habitat selection. Blood samples were taken during the tagging process to determine ploidy. Fish movement was tracked using the current telemetry array managed by USACE. Four additional stationary receivers were placed in backwater areas within Dresden Island and Brandon Road Pools to supplement the current telemetry array. Active tracking was used to better understand habitat selection and small scale movement patterns. Detections of non-USFWS fish from stationary downloads and active tracking were disseminated to their proper agency.

Proposed Actions for FY 2017: Sampling for Grass Carp in the Upper IWW will continue based on the kernel density maps that encompass 2016 capture data. The USFWS has an additional 50 acoustic transmitters that will be implanted in captured Grass Carp. Grass Carp that are not able to be implanted or captured during sampling events will be processed for life history traits similar to those taken in 2016. Stationary receivers will be downloaded bimonthly and processed for large scale movement. Active tracking events will take place monthly to supplement the stationary array and determine fine scale movement and habitat preference. Detections of non-USFWS fish will be disseminated to their proper agencies.

Proposed Actions Potential Out-year Actions (Subject to Future Appropriations): Funding and project continuation will be based on information collected and questions generated during FY16 and FY17.

Deliverables:

- Agency reports outlining results of Grass Carp life history traits, distribution and movement within the Upper IWW and CAWS.
- Reports and presentations to the MRWG and a peer reviewed publication.

Expected Completion Date for Project: February 2018

Expected FY 2017 Milestones:

- All data will be provided to the ILDNR and other partners after the 2017 field season
- This information can then be used by managers to determine potential management options.

Outcomes/Outputs:

- Data on Grass Carp life history traits, distribution and movement within the Upper IWW and CAWS.
- Data and information that assists 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: Southern Illinois University-Carbondale (SIU)

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$75,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Black carp (*Mylopharyngodon piceus*) is a large, molluscivorous species introduced to the U.S. primarily for biological control of aquaculture pond snails and is listed as an injurious species under the Lacey Act. Data from an ongoing collaborative study (SIU, USGS, and USFWS, MO Dept. of Conservation) indicate that Black carp have become established in parts of the Mississippi River basin. Current study includes an evaluation of gears for sampling Black carp to develop an active sampling/monitoring program for this species, with the goal of providing 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. 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 and guiding initial development of containment and control strategies.

Knowledge of the ecological impacts of Black carp is also needed to inform risk assessments, including those focused on the Great Lakes. While Black carp clearly represent a potential threat to native mussels, their actual ecological impacts (including potential interactions with and effects on native benthic fishes) within their invaded range are unknown. A goal of current research is to gather additional Black carp diet data and bioenergetics modeling to estimate Black carp prey consumption rates, with particular focus on their potential and realized impacts on native mussels. However, whether establishment of Black carp may also be affecting native benthic fishes is unknown. The goal of the proposed project is to assess use diet composition and stable isotope analysis to assess trophic overlap between Black carp and native benthic fishes. Results of the proposed study will provide insight into effects of Black carp on native riverine fish species and potential interactions with benthic fishes in the Great Lakes watershed.

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 SIU) 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 SIU. 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.

An incentive program ($100 reward per fish) has been 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 (IDNR) contract with SIU. This project also supports Black carp otolith chemistry analyses at SIU, and continued partnerships between SIU and the USFWS and USGS to conduct ploidy testing, gonad histology, and age estimation. The following actions were taken in 2016:

- Evaluate gears for sampling Black carp and develop an active sampling program for Black carp to assess habitat use and develop occupancy models (focusing on the Mississippi River and tributaries) – ongoing project.
- Tissues and structures from each fish will be taken for ongoing collaborative study (SIU, USGS, USFWS, MO Dept. of Conservation) to refine estimates of population characteristics (ploidy, natal environments, fecundity, age at maturity, growth, genetics) – will continue through FY 2018.

Proposed Actions for FY 2017:

- Expand scope of active sampling program 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 to assess current geographic range of Black carp – ongoing project.
- Use diet composition data and a bioenergetics model to estimate Black carp consumption rates on prey items, with particular focus on native mussels (consumption rate calculations may be spatially explicit if diet composition or growth rates differ geographically) – ongoing project.
- Conduct diet composition and stable isotope analysis of Black carp and native benthic fishes to assess trophic overlap between Black carp and native species, focusing on large rivers where Black carp are most abundant – proposed project.

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

Conduct diet composition and stable isotope analysis of Black carp and native benthic fishes to assess trophic overlap between Black carp and native species, focusing on smaller rivers (comparable size to Great Lakes tributaries) – proposed project.

Deliverables: Annual project accomplishment reports and at least one presentation per year at conferences relevant to aquatic invasive species in the Great Lakes/Mississippi River basins. A peer-reviewed manuscript reporting project results is planned for 2018.

Expected Completion Date for Project: 12/31/2018

Expected FY 2017 Milestones:

- Complete analysis of diet, stable isotope data from 2017 sampling

Outcomes/Outputs:

- Evaluation of Black carp diet and trophic overlap with native benthic fishes as an indicator of potential competitive interactions.
- Initial assessment of potential impacts of Black carp on native benthic fishes to inform Black carp risk assessments.

Potential Hurdles:

Other than the usual challenges associated with fish sampling in 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	Asian Carp GLRI Funding
FY 2017	**$50,000**	**$120,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: There is a large, ongoing, targeted effort to remove adult Asian carp by partner-contracted commercial fisherman utilizing 3-4" gill nets. To maximize the reduction of Asian Carp populations at the leading edge, all size classes must be targeted for removal. Current gears do not address the juvenile life stages that exist and may continue to pose a threat to the Great Lakes if not effectively removed. There is a need for the Service to further develop techniques targeting juvenile Asian carp species.

Summary of Actions to Date: In 2016, USFWS coordinated with partners to evaluate traditional boat electrofishing and three innovative trawling methods (dozer trawl, paupier net, and surface trawl) for detection and monitoring of Asian carp in the Illinois River. Silver carp were captured in all gears (Figure 1). The paupier captured significantly more juvenile Silver Carp than other gears evaluated. (Figure 2).

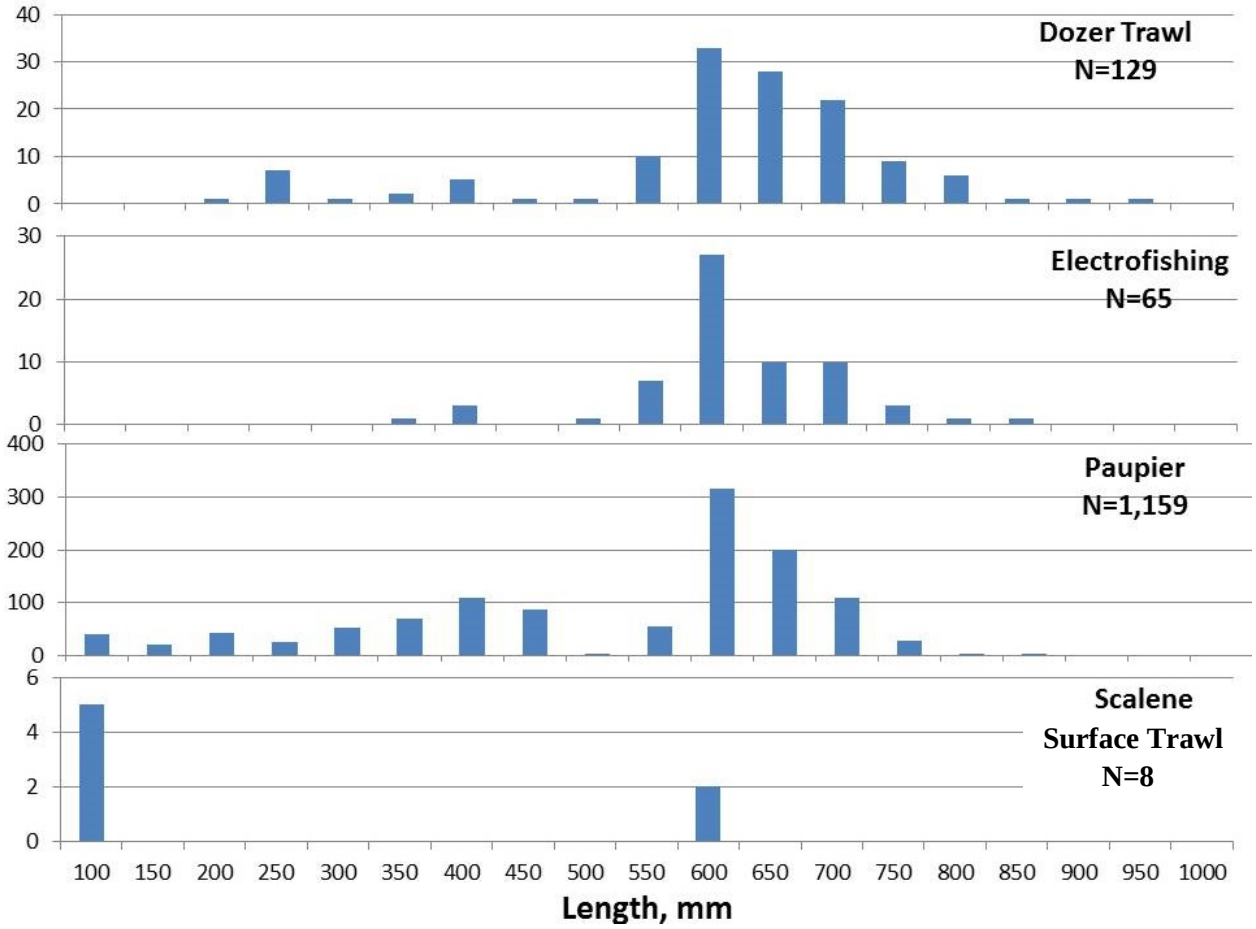


Figure 1. Length frequency histogram of Silver Carp captured in Illinois River, 2016.

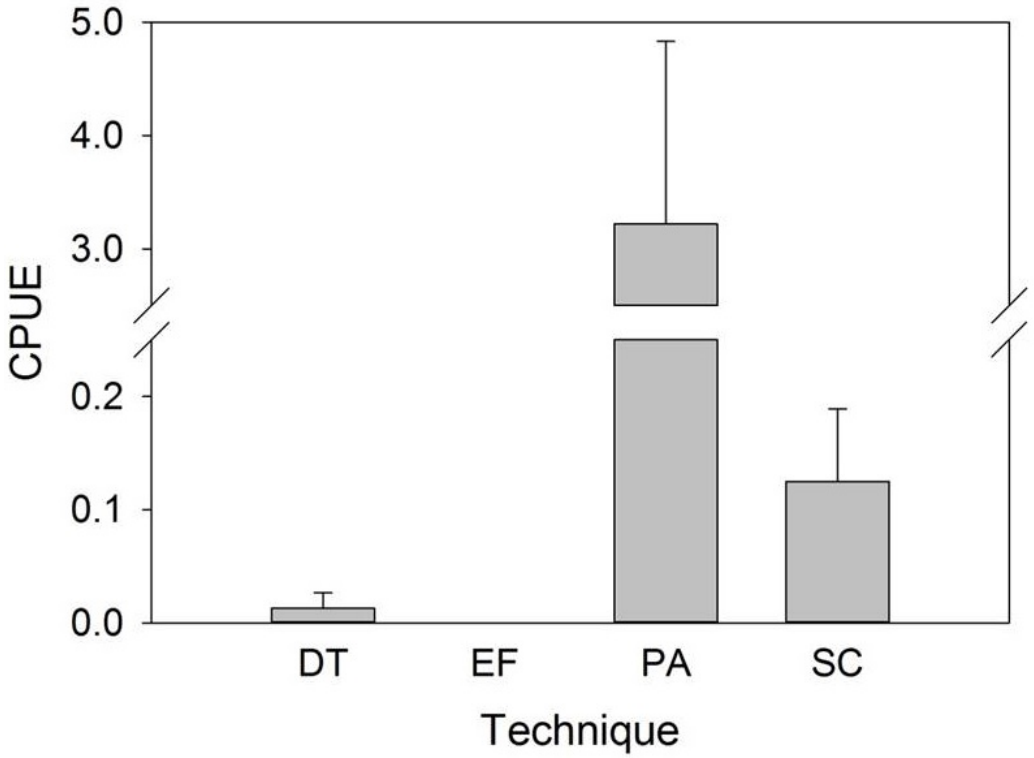


Figure 2. Catch of Silver Carp <200mm per five minutes of sampling with electrified dozer trawl (DT), traditional boat electrofishing (EF), electrified paupier (PA), and surface trawl (SC) in Illinois River 2016.

In addition to evaluating innovative trawling techniques, purse seine deployment and retrieval techniques were developed in 2016. A purse seine scaled for use in a riverine environment was deployed and retrieved in backwater, low-flow main channel, and tributary habitats. Early results demonstrate proof-of-concept for this removal technique.

- USFWS worked 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.
- USFWS began development for gears to be used by a standard river vessel and crew to target concentrations of juvenile carp as part of ongoing monitoring and removal efforts for Asian carp.
- Gear evaluation data shows the effectiveness of novel trawling techniques compared to traditional electrofishing and that these new gears successfully sample smaller size classes of Asian carp.

Proposed Actions for FY 2017:

- Complete data analysis.
- Refine and adapt purse seine nets for deployment in the CAWS.
- Detect and remove concentrations of juvenile Asian carp.
- Evaluate experimental techniques in collaboration with partners to determine the most appropriate sampling method for detection and removal of juvenile Asian carp species.
- Develop removal and monitoring protocols for effective innovative trawling methods.

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

- Refine and adapt purse seine and other innovative sampling techniques removing juvenile Asian carp in the CAWS.
- Create standard protocols for construction and use of novel techniques targeting juvenile Asian carp in the CAWS and other Great Lake habitats.
- Detect and remove concentrations of juvenile Asian carp.
- Incorporate novel techniques into protocols assessing risk of juvenile Asian carp to the Great Lakes, rapid response, and other management and control efforts.

Deliverables:

- Annual reports submitted to Asian Carp Regional Coordinating Committee Monitoring and Response Workgroup (ACRCC MRWG).
- Presentations to conferences, agencies, and public.
- A long-term data set to better understand the population dynamics of juvenile Asian carp species in the CAWS river system.

Expected Completion Date for Project: Ongoing as needed.

Expected FY 2017 Milestones:

- October-December – Fall intensive sampling of Asian carp, evaluation of previous data.
- January – March – Evaluation of data set, preparation of annual reports, presentations and conferences, evaluate current sampling gear techniques and apply modification where needed.
- April – June – Spring intensive sampling of Asian carp, evaluate and modify experimental sampling.
- July – September – Summer intensive sampling of Asian carp, evaluate and modify experimental sampling.
- July – September - Summer intensive sampling of Asian carp, evaluate and modify experimental sampling, continue a long-term juvenile Asian carp sampling protocol.

Outcomes/Outputs:

- An enhanced suite of gears for conducting early detection, rapid assessment, rapid response, and removal efforts for Asian carp in the CAWS and other river systems.
- Information that will build upon existing knowledge of distribution and habitat requirements for juvenile Bighead, Silver, Grass, and Black carp.
- Effective protocols for detection, monitoring, and removal of juvenile Asian carp species.

Potential Hurdles:

- Coordination among agencies and contractors.
- Agreement regarding sampling gears and sampling design among partners.
- Environmental 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	Asian Carp GLRI Funding
FY 2017	**$35,000**	**$100,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Since 2015, the Service has been contributing to monthly mass removal of Asian carp in the Starved Rock and Marseilles Pools of the Upper Illinois River. This project, referred to as Barrier Defense, was established to reduce the number of Asian carp downstream of the electric dispersal barriers. Contracted commercial fishermen routinely deploy gill nets in backwater habitats in areas of no flow targeting concentrations of Asian carp for removal. Gill nets are generally 3-4" mesh and are biased toward capturing large Asian carp. The electrified paupier enhances commercial netting efforts by removing a wide size range of Asian carp in a variety of habitats.

Summary of Actions to Date: In 2016, the electrified paupier participated in monthly barrier defense efforts in coordination with Illinois DNR and contracted commercial fishermen beginning in May and extending through the fall. The paupier was effective at large scale removal in various habitats of the Starved Rock and Marseilles pools. Data analysis is ongoing, however, through August 2016 over 2,600 Silver Carp measuring 250 to 755mm were removed from varying habitats (Figure 1).

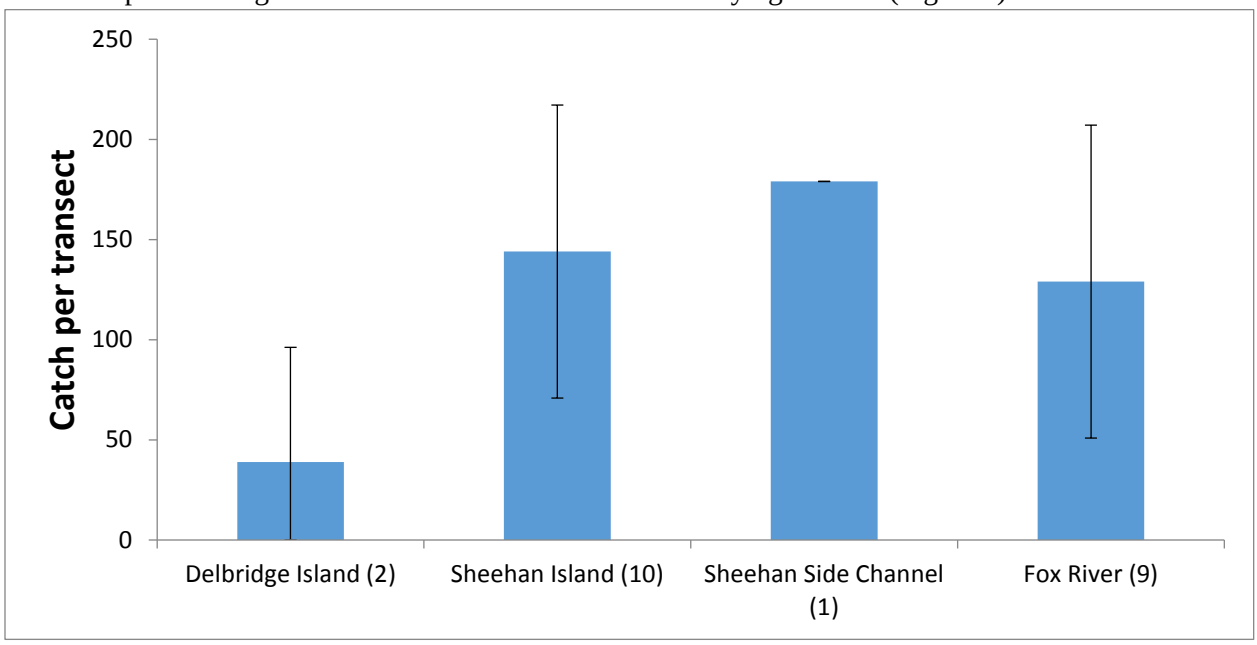


Figure 2. Silver Carp catch per transect in four differing removal locations during barrier defense efforts in the Starved Rock Pool, Illinois River, May through August 2016.

Proposed FY 2017Actions:

- Coordinate with Illinois DNR and contracted commercial fishermen to target concentrations of Asian carp for removal in the Illinois River.
- Improve electrified paupier efficiency by including additional crews and equipment and through mechanical modifications to boats and/or supplemental equipment.
- Evaluate efficacy of electrified paupier by comparing catch to commercial netting.
- Collaborate with Illinois DNR and other partners to develop data collection protocols for barrier defense efforts to assess population dynamics of Asian carp in the Illinois River system and assess barrier defense efforts.

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

- Coordinate with Illinois DNR and contracted commercial fishermen to target concentrations of Asian carp for removal in the Illinois River.
- Improve electrified paupier efficiency by including additional crews and equipment and through mechanical modifications to boats and/or supplemental equipment.
- Collaborate with Illinois DNR and other partners to develop data collection protocols for barrier defense efforts to assess population dynamics of Asian carp in the Illinois River system and assess barrier defense efforts.
- Create standard protocols for use of electrified paupier in the CAWS.
- Utilize past data to inform and develop a strategic plan for Asian carp removal efforts in the Illinois River
- Collaborate with Illinois DNR and other partners to assess barrier defense efforts as a large scale Asian carp management and control effort.

Deliverables:

- Annual report submitted to Asian Carp Regional Coordinating Committee Monitoring and Response Workgroup (ACRCC MRWG).
- Presentations to conferences, agencies, and public.
- A long-term data set to better understand the effectiveness of barrier defense in the Illinois River system.

Expected Completion Date for Project: Ongoing as long as needed.

Expected FY 2017 Milestones:

- October-December – Fall intensive sampling of Asian carp, Evaluation of previous data
- January – March – Winter intensive sampling when allowable, evaluation of data set, preparation of annual reports, presentations and conferences, evaluate current sampling gear techniques and apply modification where needed.
- April – June – Spring intensive sampling of Asian carp, evaluate and modify experimental sampling.
- July – September – Summer intensive sampling of Asian carp, evaluate and modify experimental sampling.

Outcomes/Outputs:

- Reduced Asian carp propagule pressure to the electric barrier.
- Reduced risk of Asian carp challenging the electric barrier.
- Information that will contribute to existing knowledge of distribution, demographics, and habitat requirements for Bighead, Silver, and Grass carp.
- Protocol for removal of Asian carp in the Illinois River using an electrified paupier.

Potential Hurdles:

- Coordination among agencies and contractors.
- Sampling gear and/or site logistics.
- Agreement regarding sampling gears and sampling design among partners.
- Environmental conditions.
- Staff availability.
- Public resistance to continued monitoring and response efforts.

66. Predictive Model for Identifying Probability/Risk of Barges Entraining Asian Carp

Lead Agency: USFWS

Agency Collaboration: USGS

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$100,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: In an effort to calculate the potential probability of commercial barges inadvertently entraining Asian carp juveniles, larvae, or eggs, the Service and USGS wish to develop a predictive model and decision support tool. This model will make it possible for managers to predict the likelihood of barges encountering and affecting movement of small Asian carp. This model could likewise lead to advising managers on possible control efforts. The Service will conduct field sampling and specimen identification of juvenile, larval, and egg life stages in a scientifically tenable fashion to support the data needs of the modeling process conducted by USGS researchers. Sampling and identification of these early life stages is labor intensive, but is critical to the modeling process.

Summary of Actions to Date: In 2013, USACE completed a laboratory based 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 the electrical field around barges traversing the barriers showed distortion of the electrical field and weakening of the electrical field in some cases, particularly in the void space of a rake-to-box barge configuration. Field studies conducted by the 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 can be entrained across the electric barriers by passing barges, to varying degrees depending on the barge configuration.

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 system as well as several lockages and over long distances of almost 10 miles. Electrical measurements taken over the Barrier 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 9.6 miles. Field sampling to identify larval and egg life stages and juvenile fish was conducted in 2016.

Proposed Actions for FY 2017:

- Continue larval/egg sampling as directed for input into USGS model framework.

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

- Sampling may continue into early 2018, as directed by USGS per model needs.

Deliverables:

- USGS will produce a predictive model for identifying probability/risk of barges entraining Asian carp

Expected Completion Date for Project: Spring 2019

Expected FY 2017 Milestones:

- All data will be provided to the USGS upon completion of 2017 field studies.
- The USGS will then use this information to develop a model and decision support tool capable of predicting the likelihood of barges encountering and affecting movement of small Asian carp.
- This information can then be used by managers to search for potential control options.

Outcomes/Outputs:

- Model generation

Potential Hurdles:

- Unpredictability of spawning event timing

67. Genomic Mapping of Bighead and Grass Carp to Aid in Genetic Surveillance and Potential Genetic Control Efforts

Lead Agency: USFWS

Agency Collaboration: USGS

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$45,000**	**$60,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Description: Sequencing the entire genome of an Asian carp species is advantageous, because it would provide detailed information on the mapped species that is useful in multiple applications, from designing future eDNA markers for detection programs, to development of potential molecular or genetic control mechanisms. The WGL has a Next Generation sequencing instrument that can make this process relatively quick and affordable to generate the raw data needed to map the genome. Processing the data is labor and time intensive, but the computational needs are available for WGL staff at USGS UMESC. Work would be conducted by USFWS, in collaboration with USGS, to map the whole genome of Bighead and Grass Carp.

Proposed Actions for FY 2017: Obtain tissue samples and collect raw sequence data for genome assembly. The Silver carp genome assembled from 2016 AC framework template funded efforts would be used as the model to speed up the data processing step.

Deliverables: Fully sequenced Bighead and Grass Carp genomes.

Expected Completion Date for Project: Fall 2017

Expected FY 2017 Milestones:

- Obtain tissue samples.
- Collect raw sequence data for genome assembly.
- Complete lab analysis.

Outcomes/Outputs: Sequenced Bighead and Grass Carp genomes to provide base information to researchers and managers to inform future monitoring and potential control actions.

Potential Hurdles:

- Possible uncertainty in DNA sequencing outcomes.

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	USGS Asian Carp GLRI Funding	USFWS Asian Carp GLRI Funding
FY 2017	**$0**	**$100,000**	**$75,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:

The goals of this project are to (1) provide regulatory affairs support for registration of microparticles for use as a control agent, and (2) develop registration-specific data to support registration of microparticle controls for Asian carp. This project supports a larger effort that is evaluating development of microparticles to selectively deliver chemical or potentially biological control agents to Asian carp. Currently, antimycin-incorporated microparticles are being evaluated for their 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 development of comprehensive Standard Operating Procedures (SOPs) and institutional guidance for use by approved state or federal agencies in 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 will 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 the 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 U.S. Geological Survey's Upper Midwest Environmental Sciences Center (UMESC) will provide regulatory affairs support to the U.S. Fish and Wildlife Service in developing biological and chemical pesticide controls for Asian carp. Regulatory affairs support will include compilation of data and reports for submittal 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, and 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 will 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 comply 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 will 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 act as liaison 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 comply with NEPA.

Summary of Actions to Date:

- UMESC initiated formulation review with the USFWS to identify Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles.
- USFWS initiated development of SOPs to provide guidance for field use of microparticle-based Asian carp control agents by approved agents and collaborated with USGS to identify and obtain target sensitive native fish and mussel species for laboratory testing to support the registration process.
- 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
- Began initial discussions with USEPA on studies required to register antimycin incorporated microparticles. USEPA has indicated that there may be a suite of studies required because of the increased use of antimycin for nuisance fish control.
- Began development of a protocol to conduct environmental fate studies.
- Prepared waiver requests for some of the registration requirements that are not likely to apply.

Proposed Actions for FY2017:

- Complete protocol for environmental fate studies of antimycin-incorporated microparticles
- Initiate environmental fate studies with of antimycin-incorporated microparticles to support registration
- 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
- Complete review with USFWS to determine Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles in limited open-water application sites
- Complete registration review with USEPA to determine registration data requirements of antimycin-incorporated microparticles in limited open-water application sites

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

- Develop protocol and initiate non-target feeding study with mussels to help support antimycin registration
- 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
- Respond to USFWS review of data submitted to address Section 7 ESA-consultation of antimycin-incorporated microparticles
- 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
- Complete protocol for environmental fate studies of alternative active ingredient microparticles
- Provide regulatory affairs support for control products registered by USFWS and other public agencies
- Provide regulatory affairs support for control products registered by USFWS and other public agencies
- Complete environmental fate studies of antimycin-incorporated microparticles
- Assist management agencies that plan to deploy antimycin-incorporated microparticles in limited open-water application sites to control Bighead Carp
- Assess registration requirements of alternative active ingredients for control of Bighead Carp
- Respond to USEPA or state regulatory agencies review of data submitted to register microparticles containing alternative active ingredients in limited open-water application sites
- Initiate environmental fate studies with of alternative active ingredient microparticles to support registration
- Develop protocol and initiate non-target feeding study with mussels to help support registration of alternative active ingredient microparticles
- Coordinate submission of studies to address Section 7 ESA-consultation data requirements of biologically-derived controls incorporated microparticles

Deliverables:

- Completed protocol for environmental fate studies with antimycin-incorporated microparticles
- Initiate environmental fate studies with antimycin-incorporated microparticles
- Permit for deployment of antimycin-incorporated microparticle
- Data requirements for registration of antimycin-incorporated microparticles

Expected Completion Date for Project: Ongoing

Expected FY 2017 Milestones:

- Determination of USEPA registration and Section 7 ESA-consultation data requirements for antimycin-incorporated microparticle registration by June 30, 2017
- Acquisition of Experimental Use Permits to allow experimental use of antimycin-incorporated microparticles in limited open-water application sites to control Bighead Carp by September 30, 2017

Outcomes/Outputs:

- Section 3 (national) registration of antimycin-incorporated microparticles to control Asian carp.

Potential Hurdles:

- Limited availability of antimycin.
- Ability to identify alternative active ingredients to incorporate into microparticles.
- Registration could be cost prohibitive, depending on the number of studies USEPA requires as a result of the increased use of antimycin for nuisance fish control.
- Registration could be cost prohibitive for alternative active ingredient microparticles, depending on the number of studies USEPA requires, especially if not much data exist to support registration or the product is not currently registered.

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	USGS Asian Carp GLRI Funding	USFWS Asian Carp GLRI Funding
FY 2017	**$50,000**	**$150,000**	**$75,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:

This project will support the use of carbon dioxide (CO_2) to control Asian carp. CO_2 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, CO_2 must be evaluated for its environmental impacts on species of concern to help meet the requirements of the ESA (Section 7 consultation). CO_2 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 CO_2 as a deterrent to control Asian carp, and (2) develop registration-specific data to support registration of CO_2 as a lethal pesticide control. This project supports a larger effort that is evaluating CO_2 to control Asian carp. This project includes development of comprehensive Standard Operating Procedures (SOPs) and institutional guidance for use by approved state and federal agencies in implementing the chemical or biological control agents in prevention actions. The SOPs will be developed based on the model of existing Standard Operating Procedures for the Use of Rotenone in Fish Management SOP manual currently in use nationally and tailored to CO_2. The chemical and biological control SOPs will serve as core components of the documentation required to use CO_2 as either a deterrent or a lethal control agent and will include protocols on safe transport, handling, storage, and dispersal of CO_2 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 U.S. Geological Survey's Upper Midwest Environmental Sciences Center (UMESC) will provide regulatory affairs support to the U.S. Fish and Wildlife Service in development of biological and chemical pesticide controls of Asian carp. Regulatory affairs support will include compilation of data and reports for submittal 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 CO_2 to control Asian carp, including studies that describe product chemistry, physical/chemical properties, and USEPA Group A acute toxicity (acute oral, dermal, and inhalation toxicity, eye and dermal irritation, and 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 comply 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 will 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 user manuals and labeling requirements for control technologies developed under this template and act as liaison 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 comply with NEPA.

Summary of Actions to Date:

- UMESC completed waiver requests for specific sections of Code of Federal Regulations (CFR) 40 Parts 150 to 159 that most likely do not apply to this anticipated use pattern of CO_2.
- Completed a consultation with USEPA to determine the best approach for the registration of CO_2 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 identify the necessary data requirements to obtain a Section 18 Emergency Exemption for CO_2 as a deterrent for Asian carp.
- Coordinated a meeting between USFWS, USACE, IL DNR, USCG, Illinois EPA, USEPA, and USGS to initiate discussion on site selection for application of CO_2 as a deterrent to Asian carp movement.
- Completed a review with USFWS to determine Section 7 ESA-consultation data requirements of a CO_2 deterrent zone or the use of CO_2 as a control agent in limited open-water application sites.
- Compiled data to support a Section 18 Emergency Exemption application for the use of CO_2 as a deterrent to prevent the movement of Asian carp.
- Coordinated submittal of studies to address USFWS Section 7 ESA-consultation data requirements of a CO_2 deterrent or the use of CO_2 as a control agent in limited open-water application sites.
- 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.
- Provided guidance for studies on effects of CO_2 on non-target organisms to ensure compliance with Section 7 ESA-consultation requirements.
    - Publications that may support ESA Section 7
        - Waller and others. Effects of carbon dioxide on juveniles of the freshwater mussel *Lampsilis siliquoidea* (Unionidae)
        - Hannan and others. Physiological effects of short- and long-term exposure to elevated carbon dioxide on a freshwater mussel, *Fusconaia flava*

  - Hannan and others. The response of two species of unionid mussels to extended exposure to elevated carbon dioxide
  - Jeffery and others. Responses to elevated CO2 exposure in a freshwater mussel, *Fusconaia flava*
- Provided regulatory affairs support for control products registered by the USFWS and other public agencies.
- USFWS continued development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of CO_2 for control of Asian carp.
- Responded to USEPA regarding the use of CO_2 as a deterrent or to register CO_2 as a control agent in limited open-water application sites.
- Worked with CO_2 Advisory Group to develop site-specific information for the Section 18 Quarantine Exemption.

Proposed Actions for FY 2017:

- Submit Section 18 Quarantine Exemption application to allow use of CO_2 as a control tool in the waters of Illinois.
- Work with appropriate state and federal agencies to obtain permits to allow use of CO_2 as a deterrent barrier near a lock in FY 2018.
- Assist management agencies that plan to deploy CO_2 as a deterrent or the use of a CO_2 as a control agent in limited open-water application sites to control 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 sites, 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 CO_2 as a deterrent or to register CO_2 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 CO_2 as a deterrent or the use of a CO_2 as a control agent in limited open-water application sites to control Asian carp.
- Assist management agencies that plan to deploy CO_2 as a deterrent or the use of a CO_2 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.

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

- Respond to USEPA or state regulatory agencies regarding the use of CO_2 as a deterrent or to register CO_2 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 CO_2 as a deterrent or the use of a CO_2 as a control agent in limited open-water application sites to control Asian carp.
- Assist management agencies that plan to deploy CO_2 as a deterrent or the use of a CO_2 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 submittal of studies to address Section 7 ESA-consultation data requirements for CO_2 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.
- Submit renewal application for Section 18.
- Respond to USEPA or state regulatory agencies regarding the use of CO_2 as a deterrent or to register CO_2 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 CO_2 as a deterrent or the use of a CO_2 as a control agent in limited open-water application sites to control Asian carp.

Deliverables:

- Completed Section 18 Quarantine Exemption for CO_2.
- Completed SOP for CO_2 use as carp deterrent.
- Completed training for use of CO_2 as carp deterrent.

Expected Completion Date for Project:

- Registration will be on-going. Section 18 permits are valid for 3 years, so renewals will need to be submitted in year 2 to allow continued use.

Expected FY 2017 Milestones:

- Approved Section 18 Quarantine Exemption to allow use of CO_2 as a deterrent or as a control agent in limited open-water application sites to control Asian carp by March 31, 2017.
- Complete USFWS Section 7 consultation by March 31, 2017, to allow use of CO_2 as a control tool.
- Complete SOP for using CO_2 as a deterrent by March 31, 2017
- Provide training in safety and use of CO_2 as deterrent by June 30, 2017.

Outcomes/Outputs:

- Completed Section 18 Quarantine Exemption for using CO_2 as a deterrent.

Potential Hurdles:

- Capacity of the CO_2 infusion system to evenly disperse CO_2-infused water within an uncontrolled flow environment to maintain an effective deterrent barrier
- Potential effects of CO_2 on water quality
- Potential effects of CO_2 on non-target species due to non-selectivity

18. Development of Grass Carp Control Technologies

Lead Agency: USGS - GLSC, CERC, UMESC, IL/IAWSC

Agency Collaboration: USFWS, Department of Fisheries and Oceans Canada, Michigan Department of Natural Resources, New York State Department of Environmental Conservation, Ohio Department of Natural Resources, Ontario Ministry of Natural Resources and Forestry, University of Toledo, Bowling Green State University, University of Illinois

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$425,000**	**$325,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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. U.S. Geological Survey (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. This evidence was the first, 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. 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 eight suspected Grass Carp eggs in the Sandusky River on five different sampling dates during three separate high-flow events. Five eggs, at least one from each high-flow event, were confirmed as Grass Carp using quantitative Polymerase Chain Reaction (PCR) for a Grass Carp-specific marker and by genetic sequencing. These discoveries confirmed 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.

The scale and scope of the Grass Carp invasion of Lake Erie increased drastically in 2016. In March, a commercial fisherman delivered a 351—millimeter (mm) total length Grass Carp to Ohio Department of Natural Resources (DNR), which transferred it to USGS. It was determined to be diploid, strongly implicating it as a recruit from one of the 2015 spawning events. (Otolith microchemistry, which will confirm or refute Sandusky River origin, will be completed in October 2016.) Several larger diploid fish from western Lake Erie have been either delivered to USGS or tagged by Michigan DNR as part of a study of Grass Carp movements. In July 2016, a bow fisherman caught at least five Grass Carp in Dunkirk Harbor, New York, all of which were determined to be diploid, and most were females. As of the writing of this template, samples were still under analysis to estimate age and to assess otolith microchemistry. At the very least, these fish represent an expansion of the known range of Grass Carp in Lake Erie, and it may signal the existence of an eastern basin spawning location.

Direct evidence of spawning in the Sandusky River in 2015 provided the opportunity to model spawning events and potentially identify rearing areas for Grass Carp in the Sandusky River. USGS-funded

University of Toledo researchers estimated spawning and hatch locations using the existing FluEgg model, which models particle flux, a steady-state HECRAS model, which provides simulated hydraulic conditions in rivers, and data on egg stage and capture location from 2015 spawning events. Given likely spawning locations, eggs were projected to hatch in the river for all spawning events. Researchers determined for several past events, including at least two that resulted in recruitment, that hatching may have occurred beyond the mouth of the Sandusky River using an upgraded, unsteady-state HECRAS model and FluEgg to estimate the risk of past spawning events resulting in recruitment. This result is contrary to existing knowledge that hatching must occur in flowing water and demonstrates further modeling is needed to better understand egg drift and when spawning events are likely to result in recruitment.

The flow characteristics in the Lower Sandusky River are greatly affected by the incoming flow and water surface fluctuations in the Muddy Creek Bay, and more importantly, their interactions. The estuary-type characteristics of the Sandusky River increase the possibilities of Grass Carp hatching before they reach Muddy Creek Bay. The results from the hydraulic model and, ultimately from the FluEgg model, is imperative to calibrate and validate the model. A stream gage installed in 2016 will provide data through 2017 to measure changes in water level as a function of time at different locations on the lower Sandusky River. A dye study during the next high-flow event in 2017 or 2018 will provide data for calibration and validation.

Improvements to the HEC-RAS RAS and FluEgg models will support five different tasks: (1) hindcasting spawning locations from egg sample locations, (2) prediction of hatching ranges corresponding to collected eggs, (3) assessment of historical recruitment of Grass Carp, (4) preparedness for emergency response activities related to observed Grass Carp reproduction in the Sandusky River, and (5) information on egg transport to support and refine egg sampling plans.

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 differ from Bighead Carp and Silver Carp, their spawning and early life history requirements are quite similar. Grass Carp often spawn with Silver Carp, their eggs and larvae drift similarly, and their young are often captured together in the same type of habitat. Wherever Grass Carp can successfully spawn and recruit, it is likely that Bighead Carp and Silver Carp also would be successful. Thus, what is learned studying Grass Carp will be transferable to Bighead Carp and Silver Carp and be useful for managers in planning rapid response and control methods for those fishes should they invade the Great Lakes. Outcomes will also be applicable elsewhere in the United States where there is concern about the expansion of Asian carp. 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, merging biology and hydrology to better understand spawning, recruitment, seasonal and spawning-related movements, triggers for spawning, and behaviors that might be used in control efforts. Results of this research program form the base of knowledge for managers to formulate potential control and management strategies and tactics under the Integrated Pest Management (IPM) framework. These studies are proposed to continue through 2018. In response to other research activities conducted by partners and results of 2014-2016 USGS research, additional studies are proposed 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 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 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 under way 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 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 in 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.

In addition to determining spawning and rearing areas of Grass Carp 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 factors 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.

Although the Sandusky River is currently the only known spawning tributary, other potential tributaries cannot yet be ruled out. Complete knowledge of all spawning tributaries is necessary if control measures are to be attempted and successful. High-probability tributaries (based on current knowledge) can be sampled directly or by leveraging partnerships. When direct sampling is not possible, otolith microchemistry can be used to infer where fish have been, provided water chemistry is known. Existing water chemistry data sets on Great Lakes tributaries have been mined to identify gaps spatially (which tributaries have not been sampled at all) and in terms of flow levels when water samples were taken. New water chemistry data will be collected in unsampled streams and at unsampled flow levels in all streams (low, medium, and high flow) to build a library that can be used to assess where Grass Carp may have been given their otolith microchemistry.

Properly interpreting otolith microchemistry given water chemistry of bodies of water where fish reside requires understanding rates of uptake of elements into otoliths. In 2016, USGS worked in collaboration with Bowling Green State University on a pilot project to determine uptake of Strontium (Sr) in Grass

Carp otoliths. (Strontium to calcium ratios are a diagnostic metric.) Small, triploid Grass Carp were held in cages in several ponds with varying levels of Sr and killed after 2 months. Water chemistry samples were collected at regular intervals to characterize Sr in water. Otoliths will be analyzed and curves relating Sr in otoliths to Sr in water will be developed. If the pilot study was successful, a full study will be conducted in ponds and potentially in a controlled laboratory setting.

Thermal thresholds for maturity of Grass Carp have been reported in Chinese and Russian literature, but a critical reading of those thresholds reveals the methods used and descriptions of attainment of thresholds lack sufficient detail to properly understand and interpret those thresholds. Ongoing research at the USGS CERC laboratory, where adults are raised to maturity in ponds and then spawned to produce fry for experimentation, can be augmented to assess thermal thresholds in a controlled environment. Knowing thresholds will further refine understanding of when spawning can be expected in natural waters.

Fully understanding and predicting recruitment events, which will be critical information for control efforts, require sampling of fry to link to specific spawning events. Capture of fry requires not only modeling to project when and where fry might be, but sampling methods capable of capturing them. Light traps are successful at capturing larval Grass Carp, but it is not known whether particular wavelengths or intensities are more successful. Experiments to test these factors will be incorporated into existing studies.

The directly observed 2015, suspected 2013, and demonstrated 2011 spawning events, increasing numbers of diploid Grass Carp captured throughout the Great Lakes, and observations of subtle shifts in vegetation communities in western Lake Erie concern USGS researchers 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 geographic information system (GIS) mapping, coupled with on-the-ground samples in key locations in the lower Sandusky River and upper Sandusky Bay will permit assessment of what, if any, effect Grass Carp may have already had on aquatic vegetation communities and establish baseline conditions for assessing future effects. The two different remote sensing methods at different scales can be validate with on-the-ground sampling to validate and refine the remote sensing methods.

Summary of Actions to Date:

- Used Bongo nets to sample for eggs June through August and light traps to sample for larvae of Grass Carp from July through September in the Sandusky River and headwaters of Sandusky Bay.
- Used remote sensing imagery (scale 10^4 to 10^6 meters) to detect and map where submerged aquatic vegetation (SAV) does and does not occur using object-based image analysis and generated maps for western Lake Erie, and then used hydroacoustics (10^2 to 10^3 meters) to validate remotely-sensed SAV, and then collected vegetation (10^0-10^1 meters) to validate hydroacoustics and remotely sensed SAV.
- Received Grass Carp collected by state and federal collaborators and continued to collect otoliths and age estimation structures to assess ages of fish, whether they were naturally reproduced, and to assess spawning locations.
- Aged Grass Carp collected by state and federal collaborators and collected GIS and gonad histology to determine age of maturation in the Great Lakes basin.
- Continued to perform otolith core measurements of oxygen isotopes of Grass Carp collected from the Great Lakes basin to establish extent of escapement of illegally-stocked diploid fish as a

contribution to the Great Lakes Grass Carp population versus natural reproduction within the basin.

- Mined existing data sets on water chemistry of Great Lakes tributaries to identify gaps for future sampling.
- Installed a real-time VEMCO acoustic receiver in the Sandusky River near projected spawning locations to detect the presence of acoustically tagged Grass Carp.
- Purchased acoustic tags and archival tags for Truman Reservoir Grass Carp telemetry study with diploid and triploid Grass Carp, obtained large diploid Grass Carp, and located large triploid Grass Carp, which will be purchased for tagging and stocking. Archival tags to be used in the study are expected to arrive in late fiscal 2016 for implantation along with acoustic tags in October 2017. The archival tag manufacturer provided similar archival tags for testing deployment, and implantation procedures for these unique tags were tested. Those carp are currently in ponds and were harvested and test data downloaded in September 2016 to evaluate the adequacy of the implantation procedure before tags are implanted in fish to be stocked in Truman Reservoir.
- Additional stationary receivers and thermal data loggers were deployed by the Missouri Department of Conservation in Truman Reservoir.
- Used data on egg stage, location of capture, and water temperature from 2015 spawning events in Truman Reservoir to project location of spawning.
- Analysis of samples collected in Truman Reservoir for another project in FY 2015 found many Grass Carp eggs and eDNA, and constituted evidence of Grass Carp spawning in flashy reservoir tributaries that much smaller at low flows than any previously identified Asian carp spawning river.
- Grass Carp were spawned to provide the fingerling Grass Carp for the precocious maturation study.
- Used the FluEgg model to estimate spawning and hatching locations of Grass Carp eggs in the Sandusky River.
- Completed a pilot study of uptake rates of Sr in Grass Carp otoliths.
- Wrote reports/publications and presented at regional, national, and international professional meetings.

Proposed Actions for FY 2017:

- Continue to sample the Sandusky River and other Lake Erie tributaries for evidence of spawning of Grass Carp and project spawning locations for known spawning events. Expand sampling to include sampling deeper, later in the descending limb of major flow events and during lower-magnitude events to ascertain the full range of conditions when Grass Carp spawn.
- Complete hindcasting of 2011, 2013, and other potential spawning events from 2003-2010 (to be determined) to assess recruitment potential from these events.
- Continue to collect water temperature, rainfall, and hydraulic data for use in modeling probability of spawning.
- 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.

- Sample water chemistry of dozens of Great Lakes tributaries to establish library of water chemistry for estimating potential spawning tributaries.
- Complete and analyze data from pilot studies on otolith Sr uptake and potentially begin larger-scale study (contingent on degree of success of pilot project).
- Continue work on first-generation probabilistic models of risk of spawning using hydrologic and meteorologic variables.
- Complete gonad histology of Grass Carp collected from Great Lakes in 2015 and 2016 for determination of age at maturation and time of year of maturation. Note that number and timing of samples may be inadequate for final determination.
- Tag and track Grass Carp throughout the year in Truman Reservoir; most summer tracking to be performed by Missouri Department of Conservation. Winter tracking to be performed by CERC. Winter locations will be assessed with sidescan sonar to evaluate presence of schools of fish. After the spawning season, CERC will try to recapture some of the Grass Carp for retrieval of the archival tags. When fish are captured, the tags will be re-deployed after data are retrieved in the same or different fish.
- Purchase additional equipment if needed (such as transmitter tags, and stationary receivers) and add throughout the reservoir and tributaries.
- Retrieve, process, and compile water temperature data, hydrograph and reservoir water levels, and data from recaptured Grass Carp.
- Begin precocious maturation of small Grass Carp in in spring 2017 and begin pilot experiments manipulating velocity, turbidity, and water temperature to determine if these variables can be manipulated and which of these variables, or combination of variables, are direct cues for Grass Carp spawning.
- Continue sampling vegetation in western Lake Erie and initiate sampling in Dunkirk Harbor and Buffalo Harbor in collaboration with New York State Department of Environmental Conservation (NYSDEC).
- Complete first-generation maps of aquatic vegetation for western Lake Erie, and 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.
- Complete data analysis of aquatic vegetation collections 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, and validate remote sensing and hydroacoustics for assessment of presence of aquatic vegetation.
- Complete maps of aquatic vegetation for eastern half of Lake Erie (U.S. side).
- Develop a model for areas of western Lake Erie with inadequate imagery for mapping vegetation.
- Identify high-priority areas for vegetation inventory and monitoring using both remote sensing and available on-the-ground validation sampling compiled in a decision support tool by using results of aquatic vegetation detected through object-based image analysis from 2016 (western Lake Erie) and the vegetation model,.
- Test the maturation status of Grass Carp in ponds, validate/test published "degree-days" necessary in a given year required for maturation of gonads.
- Test at least three different wavelengths of light in light traps to assess differences in ability to capture larval Grass Carp in ponds at CERC.

- Develop water temperature regression model in hourly basis at different sites along the lower Sandusky River to account for diurnal thermal variations and to improve the realistic simulation of egg development and transport.
- Install a stream gage to measure velocity in the Sandusky River near the mouth (fall 2016). These data will provide observations of velocity magnitude and direction that will be used to assess the performance of the hydraulic model.
- Evaluate hydraulic model performance using flow data retrieved from installed gage near the mouth.
- Model Sandusky hydrodynamics incorporating natural seiche produced by Muddy Creek Bay at the mouth of Sandusky River. Modeling would be achieved by performing a 2D simulation of the system, including Muddy Creek Bay. Results from hydraulic modelling are key input to the FluEgg model. In addition, the 2D simulation of the flow would allow researchers to visualize potential preferential paths of Larvae into Muddy Creek Bay, beneficial to larvae sampling efforts.
- Enhance egg/larvae sampling efforts collaboratively using FluEgg results to better capture the mass of eggs (increase number of eggs captured).
- Assess sensitivity of FluEgg results resulting from input uncertainty to improve the understanding of FluEgg model.
- Collect continuous water depth data at different locations along the lower Sandusky River during the spawning season in FY 2017 to help refine input data for FluEgg simulations at different locations.
- Begin to develop a Story Map to visually explain the results of the historical Grass Carp recruitment in the Sandusky River.
- 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.
- Write reports/publications and present at professional meetings.

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

- Continue to sample the Sandusky River and other Lake Erie tributaries for evidence of spawning of Grass Carp and project spawning locations for known spawning events.
- Finalize protocols for sampling eggs/larvae and monitoring river flow and temperature.
- 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.
- Complete age and growth analysis and publish in primary literature.
- Complete experiments on uptake rates of Sr in otoliths and publish in primary literature.
- Complete collection of water chemistry data from Lake Erie tributaries and publish data library.
- Conduct full study of attraction of larval Grass Carp to various wavelengths of light and develop protocol for effective sampling based on results.
- Tag and track Grass Carp throughout the year in Truman Reservoir; most summer tracking to be performed by Missouri Department of Conservation. Winter tracking to be performed by CERC. Winter locations will be assessed with side scan sonar to evaluate presence of schools of fish. After the spawning season, in the late summer, CERC will try to recapture some of the Grass Carp to retrieve the archival tags. When fish are captured, the tags will be re-deployed after data are retrieved in the same or different fish.

- Continue to track Grass Carp in Truman Reservoir over the winter of FY 2018; beginning in December or January, after fish are in winter locations, assess size of any schools present with side scan sonar r split beam sonar, depending on habitats selected and appropriateness of gear type. After school size (if any) is determined, attempt to recapture these fish and collocated fish with trammel nets and if possible with trawling gear. Download data from any archival tags recaptured. Enumerate the different species of fish captured along with the recaptured fish to determine whether Grass Carp are overwintering in single-species or multi-species aggregations, if any.
- From spring 2017 and, if necessary 2018 spring data, determine if triploid Grass Carp are performing spawning movements similar to those of diploid Grass Carp.
- Complete gonad histology of Grass Carp collected from Great Lakes for determination of age at maturation and time of year of maturation.
- Re-sample vegetation in areas sampled in 2016 to assess changes in areal coverage, density, species distribution and relative abundance of SAV.
- Model vegetation for areas of Eastern Lake Erie with inadequate imagery for mapping
- Complete decision support and visualization tools for Grass Carp data.
- Complete maps of aquatic vegetation for all of Lake Erie (U.S. Side).
- Collect hydraulic data and modify the hydraulic model, as necessary, to account for the removal of the Ballville Dam.
- Continue operation of streamflow gage during the spawning season to provide continuous hydraulic data to support assessment of Grass Carp reproduction in the Sandusky River
- Begin simulation of water temperature within the HEC-RAS model.
- Use flow data collected in FY 2017 at different downstream locations to enhance FluEgg input flow data.
- Collaborate with Ohio DNR to evaluate performance of the FluEgg model using results from a dye study of the Sandusky River below Ballville Dam (ODNR funded project).
- Evaluate potential implications on Grass Carp reproduction due to the removal of the Dam using the FluEgg model and River input data from hydraulic model.
- Continue the development of Sandusky River story maps with main findings from this project and potentially share with managers.
- Use FluEgg simulations to predict longitudinal distribution of eggs and larvae at different developmental stages as a recommendation tool to determine high-priority zones for habitat assessment, monitoring activities, and application of control alternatives.
- Write reports/publications and present at professional meetings.

Outcomes/Outputs:

- Obtained direct evidence of spawning of Grass Carp in the Sandusky River.
- Obtained 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.
- Potential control strategies in the Sandusky River in collaboration with state and federal partners.
- Effects, if any, of Grass Carp herbivory in Lake Erie.
- Thermal cues for maturation of Grass Carp.
- Methods for sampling early life history stages of Asian carp.
- Calibrated, validates, and increasingly accurate models of egg drift to predict spawning and recruitment events.

Expected FY 2017 Milestones and Deliverables:

- Annual results of sampling for eggs and larvae in Great Lakes tributaries
- Annual results of species distributions, relative abundances, and areal coverage of submerged aquatic vegetation in western Lake Erie
- Results of pilot experiment and full experiments on uptake rates of Sr and other cations into otoliths of Grass Carp.
- Research papers on age and growth of Grass Carp in the Great Lakes.
- Research papers on heritage, potential spawning locations, and movements of diploid Grass Carp in the Great Lakes.
- Report on spawning potential of Grass Carp on the Cuyahoga River and Muskingum River.
- Data from stream gage installed and maintained in the lower Sandusky River near the mouth will be published through Ohio WSC.
- Continuous water depth-data at different locations along the lower Sandusky River will be published through Ohio Water Science Center.

Potential Hurdles:

- Much of the research conducted under this template involves wild biological organisms in a natural environment. Random variation, long-term weather patterns, and stochastic events beyond the control of a researcher can prevent work and thus achievement of milestones and deliverables.
- Knowledge of Grass Carp in the Great Lakes changes almost weekly, as new fish are found in new locations or as research is published. Occasionally, this new information requires a radical change in focus to remain relevant with respect to the ultimate goal of initiating control measures.
- Field crew personnel necessary to complete project may be limited.
- Loss of field equipment (receivers, temperature loggers, light traps, and 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.

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	Asian Carp GLRI Funding
FY 2017	**$500,000**	**$300,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:

This project investigates the influence of habitat stimuli, such as river hydraulics and water-quality, on the population range, movement, and spawning and recruitment success of Asian carp. A deeper understanding of how Asian carp interact with the hydraulics and water quality of a river will inform efforts to control Asian carp through management of habitat factors.

The first objective of this project is to isolate the natural and managed controlling factors that contribute to the movement of Asian carp within the pools of the Illinois River and how one or more of these factors could be used to prevent future movement or to reduce Asian carp populations. The IL DNR, the USFWS, and the USACE have documented the distribution of Bighead and Silver Ccarp in the pools of the Illinois River and have identified favorable habitats. Since 2006, the upstream expansion of the adult carp population in the Illinois River has stalled in the Dresden Island Pool. However, juveniles were found approximately 12 miles farther upstream in 2015 than in previous years. Sharp contrasts in flow conditions, water quality, and food supply between these pools and the CAWS may be acting as controlling factors to the upstream movement.

The relationship between habitat stimuli and behavioral response in the paired main channel/backwater system of the Illinois River is investigated through comparison of fish movements with continuous measurements of discharge, velocity, and a suite of water-quality parameters (water temperature, pH, dissolved oxygen, specific conductance, chlorophyll-a, blue-green algae, nitrate, and turbidity). Along with the continuous monitoring, discrete samples have been collected at seven locations along the river to analyze for more than 700 constituents not previously assessed, such as pesticides, metals, volatile organic compounds, hormones, pharmaceuticals, and other wastewater indicator chemicals. Initial analysis of these water-quality samples indicates that the concentrations of pharmaceuticals, volatile organic compounds, and hormones are higher in the Dresden Island Pool than in the Marseilles Pool, whereas pesticide concentrations are higher in the Marseilles Pool than upstream in the Dresden Island Pool. Additionally, existing data, including long-term water-quality sampling by the Metropolitan Water Reclamation District (MWRD) of Greater Chicago, will be reviewed.
In addition to determining why adult Asian carp have not moved farther upstream, the velocity and flow data will be evaluated to identify optimum locations (channel constrictions, pinch points, and backwater areas) for testing and implementing hydrologic control methods. Hydrologic control applications seek to

enhance the effectiveness of harvesting and Integrated Pest Management (IPM) controls in decreasing populations of Asian carp. Hydrologic control applications can include isolation of backwater areas, which are critical to juvenile Asian carp, through river level manipulation using river control structures such as the eight lock and dam structures on the Illinois Waterway. Hydrologic control methods, when combined with mechanical, chemical, and biological controls, have the potential for a 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.

The second objective of this study is to build on an existing model of Asian carp egg and larval transport (FluEgg) to provide better predictions of carp population growth in a river. The Illinois Waterway is identified as a high priority for spawning response activities and a hydraulic model to generate input for FluEgg improves the capability to identify spawning locations and quickly predict where eggs and larvae will be located after a spawning event. Enhanced predictive capabilities will contribute to larger-scale control efforts and the application of new control technologies. Previous laboratory experiments have identified the hydrodynamic conditions that can lead to increased egg and larval mortality. Additional laboratory work will demonstrate how eggs and larvae interact with river substrate. FluEgg simulations of egg and larval transport predict the reach length required for successful egg hatching under specified flow and water temperature conditions. For successful recruitment, eggs must hatch in close proximity to suitable larval habitat; therefore, accurate predictions of carp population growth are contingent on linking FluEgg results with habitat data. Moreover, further research is needed to examine factors that influence Asian carp spawning and recruitment success and to incorporate those factors into the FluEgg framework. The next evolution in tools and control approaches developed for the partner agencies will include incorporation of the FluEgg model into a large decision support tool framework that incorporates habitat availability.

Summary of Actions to Date:

- Hydraulic and Water-Quality data collection and analysis
  - Published 2015 water quality data for Illinois River main channel and backwater sites.
  - Continued velocity mapping of selected river reaches in support of Integrated Pest Management (IPM) and spawning documentation activities (in coordination with IDNR and other agencies) and published ScienceBase data releases.
  - Collected final set of water-quality samples for detailed chemical analysis (including laboratory schedules for pharmaceuticals and hormones) for evaluation of potential effects on Asian carp population.
  - Began analysis of the water-quality sample results and drafted the sampling methods report.
- Spawning and Recruitment
  - Continued to incorporate successful recruitment criteria (juvenile habitat) with existing egg transport characterization methodologies to determine which rivers may pose a greater probability for establishment of sustainable populations in the Great Lakes basin.
  - Used flow and velocity data collected during June 2015 spawning conditions on the Illinois River to simulate egg and larval drift with FluEgg from observed spawning locations and identify potential nursery habitat available at the gas bladder inflation stage.

  - Adapted the U.S. Army Corps of Engineers (USACE) hydraulic models of each pool on the Illinois Waterway into a continuous model from Brandon Road Lock and Dam to the confluence with the Mississippi River to generate input data for FluEgg analysis in FY 2017.
  - Acquired and maintained Asian carp broodstock for laboratory experiments.
  - Assessed larval swimming behavior of Grass Carp and Bighead Carp to provide data for FluEgg larval drift simulations.
  - Consulted with coordinated team of USGS, IL DNR, Illinois Natural History Survey, and other partners on suitable nursery habitat and backwater sites in the upper Illinois River
  - Collected bathymetry data of Rock Run Rookery to increase understanding of that backwater habitat.
  - Finalized risk analysis of Asian carp spawning in the CAWS to share with USACE.
- Fish Telemetry (Moving to IPM in 2017)
  - Maintained real-time fish telemetry equipment on upper Illinois River and Wabash River and published the data collected to the web. Wabash River equipment was removed when the Eagle Marsh project was completed.
  - Continued development of the telemetry data webtool/database. Held partner engagement calls with SIU, USACE, the U.S. Fish and Wildlife Service (USFWS), and state fisheries managers to get input and buy-in from the agencies contributing data to the database.

Proposed Actions for FY 2017:

- 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 IDNR and other agencies) and publish data collected in FY 2016.
  - Publish water-quality analyses from FY 2015 and FY 2016 sampling effort.
  - Draft a Scientific Investigations Report (SIR) or journal article relating the Asian carp movement data and water-quality data
  - Determine if additional water-quality sampling on the Illinois Waterway is needed.
- Spawning and Recruitment
  - Use egg data from Purdue sampling on the Wabash River to verify FluEgg model.
  - Conduct laboratory experiments in a flume with sand substrate to determine the drift behavior of eggs and larvae and their interaction with bottom material in flowing water.
  - Complete a U.S. Geological Survey (USGS) software release of FluEgg executable and source code, including a user's manual.
  - Increase resolution of the temperature functionality in the FluEgg egg and larval drift model.
  - Simulate the hydraulic conditions in the Illinois River during the spawning season of 2015 to hindcast spawning locations.
  - Create an operational hydraulic model of Illinois Waterway to generate input for the FluEgg model as part of the Decision Support Tool for IPM.

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

- Hydraulic and Water-Quality data collection and analysis
  - Publish 2017 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 IDNR and other agencies) and publish data collected in FY 2017.
  - Publish an SIR or journal article relating the Asian carp movement data and water-quality data
- Spawning and Recruitment
  - Perform data analysis of first phase of flume experiments; draft of a journal article with main findings.
  - Second phase of laboratory experiments in a flume with pea gravel substrate to determine the drift behavior of eggs and larvae and if the substrate decreases mortality compared with the sand substrate experiments.
  - Implement mortality simulation capability in FluEgg egg and larval drift model.
  - Refine operational hydraulic model of Illinois Waterway to generate input for the FluEgg model as part of the Decision Support Tool for IPM.
  - Simulate a range of hydraulic and temperature conditions to determine which combinations lead to recruitment success.

Deliverables:

- Analysis of relation between water-quality and Asian carp position in the Illinois Waterway
- USGS Software release and users' manual for FluEgg egg and larval drift model
- Illinois River HEC-RAS unsteady model for FluEgg analysis

Expected Completion Date for Project: ongoing

Expected FY 2017 Milestones:

- Draft journal article on modeling of egg drift in Illinois River by September 2017.
- USGS report on Illinois River water-quality sampling methods by January 2017.
- Draft journal article on Illinois River water-quality analysis by April 2017.
- USGS Software release of FluEgg by September 2017.

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.
- Improvement in ability to predict settlement and dispersal of Asian Carp eggs and larvae obtained from flume experiments with drifting Asian carp eggs and larvae.
- Incorporate successful recruitment criteria (juvenile habitat) with existing egg transport characterization methodologies.
- 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.

Potential Hurdles:

- The project has a large field data collection component that 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.
- Flume experiments will be performed using live Asian carp eggs; potential hurdles include spawning/recruitment failure, difficulties in transporting eggs from CERC to Illinois, egg visibility/ability to capture photographically, permitting for experimenting with live eggs and larvae.

20. Characterization of Brandon Road Lock for Barrier Implementation

Lead Agency: USGS

Agency Collaboration: USACE, USFWS, MWRD, Illinois DNR

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$350,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:

To help prevent the movement of Asian carp from the Mississippi River basin to the Great Lakes basin, additional barriers on the Chicago Area Waterways have been proposed at the Brandon Road Lock and Dam as a component of the GLMRIS Report developed by the USACE in three of the eight 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 carbon dioxide 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, and 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 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 maximize efficacy as an aquatic invasive species barrier while minimizing 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, U.S. Fish and Wildlife Service (USFWS), and Illinois Department of Natural Resources (IL DNR), require the U.S. Geological Survey (USGS) to be flexible to the needs identified.

Summary of Actions to Date:

- Collected additional velocity distribution data in lock chamber and channel downstream to define flow velocity distributions under representative of lock operations.
- Continued operation of two velocity and two water-quality gages to provide continuous data to identify typical and extreme hydrologic conditions relative to synoptic mapping events.
- Documented the range of mixing environments near the lock and downstream created by the expected range of hydrologic/hydraulic variation by applying a dye tracer under normal flow and flushing conditions and tracking it through the lock to document mixing zones and rates within the lock and downstream of the lock.
- Analyzed and compiled synoptic velocity field mapping and dye tracer study results and shared those results with the USACE through conference calls, WebEx presentations, and data releases.

- Completed water-quality data collection and analysis, including information to assist the USACE in assessing the potential effects of CO_2 on structures.
- Developed the scope of a reaeration study for the river below Brandon Road Lock needed to simulate retention in water and loss of CO_2 from water downstream from a barrier.
- Collected water velocity data along the wall of the Electric Dispersal Barrier System to quantify barge-induced upstream return flows due to barge passage (collaboration with USFWS and USACE).
- Collected additional water velocity data in the gap space, along the sides, at the bow, and at the stern of a 2x3 barge raft under typical operational speeds and maneuvers to expand understanding of the potential for small fish and egg/larvae entrainment and upstream transport by moving barges and potential mitigation procedures (collaboration with USFWS).
- Began writing reports documenting data for the USACE and contractors to use to implement selected barriers.

Proposed Actions for FY 2017:

- Support USACE GLMRIS decision making by participating in meetings and calls, providing regular updates on data collection and results and specific briefings as requested.
- Continue operation of two velocity and two water-quality gages to provide continuous data for hydraulic and water-quality model calibration and validation.
- Complete reaeration study of river reach below Brandon Road Lock and draft a report of the results.
- Publish data from 2016 barge entrainment studies.
- Publish journal article on barge-induced return flows at the Electric Dispersal Barrier and potential for aiding upstream fish passage
- Publish USGS Scientific Investigations Report (SIR) on velocity and dye study data and analysis.
- Publish USGS SIR on water-quality data and analysis, with an emphasis on the carbon dioxide in the system.
- Draft journal article describing collection and analysis of continuous carbon dioxide data.
- Continue collaboration with USFWS on barge entrainment studies, including drafting a paper on the findings from 2016 barge entrainment studies and field data collection, if requested.
- Collect detailed channel and wall geometry with a multi-beam echo sounder survey to support the USACE's analysis of construction alternatives.

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

- Support USACE GLMRIS decision making by participating in meetings and calls and specific briefings as requested.
- Continue operation of two velocity and two water-quality gages to provide continuous data, if needed.
- Publish journal article on collection and analysis of continuous carbon dioxide data.
- Publication with results of 2016 barge entrainment studies.
- Publication with analysis of hydrodynamics around barges in confined and unconfined channels.
- Additional hydraulic and water-quality data collection as partners identify.

Deliverables:

- USGS data releases on barge hydrodynamics
- USGS SIR on velocity and dye study results
- USGS SIR on water-quality data analysis
- Collaborative journal article with USFWS on barge-induced upstream return flows at the electric dispersal barrier and potential for aiding in fish passage

Expected Completion Date for Project: 2019 (Unless follow monitoring is requested)

Expected FY 2017 Milestones:

- Publication to the web of real-time velocity and water-quality data (ongoing)
- Publish data releases from 2016 barge entrainment studies by December 2016
- Publish USGS SIR on velocity and dye study data and analysis by July 2017
- Publish USGS SIR on water-quality data and analysis, with an emphasis on the carbon dioxide in the system by August 2017
- Publish barge-induced return flows journal article with USFWS by August 2017

Outcomes/Outputs:

- Calibration and validation data for the models developed by the USACE staff 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.
- Information about the channel that can be used to improve cost estimates for construction activities.
- Data that can be used to address the potential for small fish to be moved through the electric dispersal barrier by barges, either in the gap space or by return flows.

Potential Hurdles:

- Coordination with USACE is essential to getting the most value from this data collection.
- Field work components are subject to weather conditions and lock maintenance. Overall project completion and field activities depend on timing of funding.
- Publication schedule is affected by length of time various reviewers need, which is beyond the control of project personnel.

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	Asian Carp GLRI Funding
FY 2017	**$310,000**	**$490,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017

Project Description: Currently, prevention of Asian carp movement from the Mississippi watershed into the Great Lakes rests on a single electric barrier located in the CAWS. Supplemental and redundant deterrent strategies to the electric barrier would improve the efficacy of deterring Asian carp movement into the Great Lakes. As such, chemical barriers that deter fish passage and allow continued river navigation are being developed. Additionally, managers need chemical controls to reduce Asian carp populations and decrease the number of fish attempting to move upstream to further support barrier efficacy.

Some work has been done to define biological limits and potential benchmarks for candidate chemicals that may serve as a non-physical barrier and lethal control of Asian carp. One candidate barrier chemical that has received a great deal of attention is carbon dioxide gas (CO_2). Adding CO_2 to water has two main effects: (1) a reduction in pH caused by the formation of carbonic acid (a weak acid), and (2) elevation of dissolved CO_2 (hypercarbia). While the exact mechanism that induces avoidance and toxicity in fish exposed to CO_2-enriched water has not yet been defined, it is believed that CO_2 functions by disrupting normal respiration and acid-based regulation. It is important to note that additions of CO_2 do not function as a 'bubble curtain' (not a physical obstruction), CO_2 does not deter movement by causing hypoxia, and the inevitable change in pH associated with elevated CO_2 is not sufficient to cause fish to move. Rather, it is believed that fish have CO_2 receptors in their gills and are able to sense CO_2 in the water, and it is the presence of a physiologically unacceptable concentration that causes fish seek fresh water. Additionally, CO_2 does not appear to be species-specific, with most fishes affected in a similar fashion; a CO_2 barrier would therefore likely prevent the movements of non-target fishes as well. In addition, CO_2 appears to affect smaller fishes as well as larger ones. Collectively, CO_2 would benefit Asian carp management by denying access to critical habitat, blocking upstream movement, reducing overwinter survival, and pushing fish into locations to promote harvest and removal.

Summary of Actions to Date: To date, multiple laboratory and pond studies have been completed with Asian carp and non-target species. Discussions with the USEPA regarding regulatory framework for research applications of CO_2 in open water applications, including barrier operations, have been initiated and drafts of Section 18 permits are being developed. The physiological response of native mussels to CO_2 study has been completed under the guidance of Section 7 consultation by the USFWS. Numerous manuscripts have been developed and have been published in scientific journals.

The following work was completed in 2016:

- Completed evaluations of CO_2 injected under-ice to enhance overwinter mortality of invasive cyprinids (Silver Carp, Bighead Carp, Grass Carp, and common carp).
- Completed evaluations to determine CO_2 concentrations that induce avoidance and immobilization behaviors with Silver Carp and Bighead Carp.
- Completed evaluations to determine the effect of temperature on Silver Carp and Bighead Carp movement in response to elevated CO_2.
- Completed evaluations of CO_2 injection methods in laboratory flumes to determined gas-transfer efficiency (collaboration with University of Wisconsin – Platteville engineering students).
- Completed acute toxicity evaluations on the effects of CO_2 on non-target juvenile mussels.
- Completed chronic toxicity evaluations on the effects of CO_2 on non-target juvenile mussels (including federally endangered species).
- Participated in CO_2 Advisory Group made up of federal and state agencies to develop plan for transitioning from research to management applications.
- Published a peer-reviewed manuscript describing the avoidance responses of Silver Carp and Bighead Carp to a CO_2 barrier in outdoor ponds (Cupp and others 2016, Canadian Journal of Fisheries and Aquatic Sciences).
- Published a peer-reviewed manuscript describing the swimming responses of invasive carp and native fishes to CO_2 (Donaldson and others 2016, Transactions of the American Fisheries Society).
- Published a peer-reviewed manuscript describing the effects of CO_2 on juvenile mussels (Waller and others 2016, Environmental Toxicology and Chemistry).

Proposed Actions for FY 2017:

- Develop comprehensive planning assessments for deploying CO_2 at a lock or approach channel to deter Asian carp movement.
- Conduct applied field studies to demonstrate potential management applications:
  - Apply CO_2 to block Asian carp access to backwater areas of the Illinois River
  - Apply CO_2 to enhance Asian carp removal efforts
  - Apply CO_2 as lethal control of Asian carp under-ice in backwaters of large river
    - Obtain required permits in FY 2017
    - Conduct trials in winter of calendar year (CY) 2017
- Continue to evaluate the behavioral responses of Asian carp to CO_2 enriched water.
  - Determine the movement of Asian carp in response to gradients of elevated CO_2 in flowing water
- Continue to evaluate the effects of CO_2 enriched water on non-target species.
  - Determine the behavioral responses of mussels to elevated CO_2
- Publish a report and associated data describing the use of CO_2 injected under-ice to enhance overwinter mortality of Asian carp.
- Publish a report and associated data describing the effects of temperature on the behavioral responses of Asian carp to elevated CO_2.
- Publish a report and associated data describing the effects of elevated CO_2 on common and endangered mussels (non-target impacts).
- Complete studies as needed to complete USEPA registration CO_2 as a control agent in limited open-water application sites.
- Expand studies with potential non-target species (such as banded killifish and caddisfly) to address USFWS Section 7 ESA-consultation data requirements of CO_2 as a control agent for emerging locations.

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

- Conduct field studies at lock or approach channel to deter the movement of Asian carp.
- Conduct field studies applying CO_2 as lethal control to enhance winterkill of Asian carp.
- Conduct field studies to support Asian carp removal efforts.
- Assist management agencies that plan to deploy CO_2 as a control agent in open-water applications.
  - To block/deter Asian carp movement at key locations
  - To enhance Asian carp fishing/removal efforts
  - To administer as lethal control to Asian carp
- Continue to develop studies as needed to complete USEPA registration of a CO_2 barrier or the use of a CO_2 as a control agent in limited open-water application sites.
- Complete studies to address USFWS Section 7 ESA-consultation data requirements of a CO_2 barrier or the use of a CO_2 as a control agent in limited open-water application sites.
- Respond to USEPA or state regulatory agencies review of data submitted to register CO_2 as a barrier or as a control agent in limited open-water application sites.
- Respond to FWS review of data submitted to address Section 7 ESA consultation of the use of CO_2 as a barrier or as a control agent in limited open-water application sites.

Expected Completion Date for Project:

- Transition to management agencies can occur at any time and future research is tailored to supporting management decisions and implementation.

Expected FY 2017 Milestones:

- Demonstrate field application of CO_2 to deter fish movement.
- Demonstrate field application of CO_2 to enhance fishing removal efforts.
- Comprehensive planning assessment for CO_2 at lock/approach channel.

Outcomes:

- Define the effectiveness of CO_2 as an Asian carp management tool
  - Barrier/deterrent
  - Lethal control
  - Enhance removal efforts
- Provide recommendations to management agencies on the operating conditions for applications listed above

Potential Hurdles:

- Capacity of the CO_2 infusion system to evenly disperse CO_2-infused water within an uncontrolled flow environment to maintain target concentrations.
- Potential effects of carbonic acid on in-water navigation/control structures.
- Potential effects of CO_2 on non-target species caused by non-selectivity.

23. Developing Targeted (Microparticle and Piscicide) Control Systems

Lead Agency: USGS

Agency Collaboration: USFWS, Southwest Research Institute, Missouri Department of Conservation, Viterbo University, and Illinois Department of Natural Resources

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$630,000**	**$500,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017

Project Explanation:
No current technology can specifically target Asian carp for control within aquatic ecosystems. Available toxicants used in aquatic invasive species control programs are non-selective and are applied throughout the entire water column, resulting in equal exposures of native and invasive species alike. Developing targeted delivery systems with high specificity toward a targeted organism, like an Asian carp, would increase the ability of management agencies to control or limit a species like Asian carp while minimizing potential impacts on native species. Targeted selectivity can be achieved by understanding the habits and physiological characteristics of the target organism and incorporating into a delivery system technologies that will exploit unique feeding 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.

Incorporating technologies developed for the pharmaceutical and agricultural industries has the potential to change the way that invasive species like Asian carp are managed. The use of spray-atomization to encapsulate a control agent is now feasible. Significant progress has been made in the past several years to identify a formulation of a spray-atomized particle that does not leach the control agent, is readily consumed by the fish, and is easily scalable for commercial production. Both controlled laboratory and pond trials have been completed that demonstrate the efficacy of this new delivery tool. In both laboratory and pond studies, Silver Carp and Bighead Carp died following particle exposure, while Largemouth Bass, a native, appeared unaffected. For this technology to be useful for resource managers, a comprehensive field study must be conducted that demonstrates the specificity of the particle and assesses its potential ecological impacts.

There is a current lack of registered piscicides for use by aquatic resources managers to control aquatic invasive fish. This significantly limits the number of potential control agents available for timely use in particle by resource managers. Two registered piscicides are commonly used for controlling sea lamprey and are much less toxic to the boney fishes such as Asian carp. The registered piscicides — rotenone and antimycin — have the toxicity needed for inclusion in a particle. However, rotenone is broken down into non-toxic forms within the gastrointestinal tract, leaving antimycin as the only viable control agent. Therefore, developing a suite of new control agents would provide a management option within an integrated pest management program designed to control populations of Asian carp and is essential to successful management of these nuisance species.

Progress has been made in the identification of new chemical control agents. A large chemical database has been established and crude models that predict toxicity from chemical properties have been developed. More than 30 potential new piscicides have been identified from this database. Six chemicals have passed through the initial cytotoxicity trials and are now being evaluated using conventional *in vivo* toxicity tests. Once a chemical has been validated for piscicidal properties, that chemical will then initiate into the registration process.

Biological controls can also be easily incorporated and, with their addition, the control may have increased specificity. A couple of pathogens (Largemouth Bass Virus and *Lactococcus lactis* spp. *lactis*) have been found to affect Silver Carp and Bighead Carp cells more than Bluegill cells or isolated from fish kills were isolated from dead Silver Carp following a Silver Carp only fish kill in Mississippi. Currently, neither of these pathogens has been evaluated as potential controls for Silver Carp or Bighead Carp, even though both have anecdotally been observed to have potential selectivity.

One promising new technology for species-specific control is the use of genetic tools. Two technologies that have garnered considerable interest in the use of clustered regularly interspaced short palindromic repeats (CRISPR) as a gene drive system and RNA interference (RNAi) to knock-down key processes for the survival of the animal. One advantage of CRISPR is that an inheritable trait can be generated that is detrimental to the animal and that is rapidly spread via natural reproduction through a population using only a few animals. This trait can then be used to eradicate all animals of that population. However, once released, this trait can easily be passed from one population to another and ultimately become an "invasive" trait. Before CRISPR is developed as a tool for controlling invasive species, USGS scientists must determine the risk of this 'invasive" trait to native populations. The other technology, RNAi, simply targets only those individuals that are exposed. A properly designed RNAi will knock down a key regulatory process within the animal and can be extremely specific. RNAi has been designed to target transcriptional control at the sub-species level in fruit flies and therefore has significant potential as a control of Asian carp. However, first, a description of the transcriptome of the targeted species of Asian carp is needed so that a target gene can be identified. Once a target sequence has been identified, RNAi can be designed and purchased from a commercial provider and tested for efficacy.

Summary of Actions to Date:

- A prototype to manufacture microparticles has been designed.
- A formulation of a microparticle was identified that (1) holds the control agent (antimycin A); (2) is of the appropriate size (50 to 100 microns [µm]); and (3) is readily consumed by both Silver Carp and Bighead Carp.
- Silver Carp and Bighead Carp were found to have higher levels of the protease trypsin and higher levels of phosphatases then that in Gizzard Shad or Bigmouth Buffalo. These enzymes could be used as a potential release mechanism for the control agent.
- Silver Carp were found to actively feed earlier in the year when native fishes are not feeding. This may be a time of the year for application of a microparticle to increase its specificity for Silver Carp and Bighead Carp.
- Both Silver Carp and Bighead Carp could be killed with microparticles, while showing minimal mortality in Largemouth Bass and Bluegill in controlled laboratory studies.
- Both Silver Carp and Bighead Carp could be killed with microparticles without killing any Largemouth Bass in pond studies.
- Cytotoxicity protocols for new piscicides have been identified.
- A chemical database for novel piscicides was developed and published.

- Structure Relationship Models (SARs) have been developed to identify new chemicals that may be highly toxic to fish and chemicals that may have selective toxicity toward cyprinids.
- Six chemicals have been identified that may be more toxic to cyprinids.
- Largemouth Bass Virus (LMBV) is more virulent to both Silver Carp and Bighead Carp cells than to Bluegill cells.
- Microparticles were re-formulated to contain a talc to improve dispersal and lessen clumping.
- A trial to measure the amount of microparticle consumed by a fish in a feeding was determined using yttrium as a marker. The trial found that consumption of microparticles within 1 hour was highly variable between tanks of fish. In some tanks, all fish consumed the microparticle, while another tank with the same number of fish fed at the same rate of microparticle consumed no microparticles. The amount of microparticle consumed by individual fish was also highly variable (up to 3 grams per kilogram [g/kg] body weight). In all tanks, less than 50 percent of the microparticle was consumed by the fish.
- Two trials were conducted in the ponds where Largmouth Bass, Silver Carp, and Bighead Carp were exposed to antimycin-latent microparticle. The amount of antimycin added to the pond was equivalent to treating the pond at a rate of 10 parts per million (ppm), a typical antimycin treatment level. Within 24 hours, 50 percent of the Asian carp were dead, while no Largemouth Bass died during these trials.
- Studies to validate the SARs model and identify a new piscicide have been initiated. Initial results have indicated that one potential chemical was found to be toxic to Silver Carp and Rainbow Trout, but much less toxic to Bluegill. These studies will be concluded during FY 2017.
- A metabolomic study was conducted and has been submitted to Chemosphere for publication. This type of study helps to identify the mode-of-action (MOA) of toxic chemicals and improve SARs models to predict toxicity.
- A manuscript describing the digestive enzymes in Silver Carp and Bighead Carp has been submitted for publication in Fish Physiology and Biochemistry.
- Methods have been developed to use metagenomics to assess blue-green algae consumption by Silver Carp and Bighead Carp.

Proposed Actions for FY 2017:

- A large-scale field assessment of particles will be conducted that will include a population assessment of invertebrates and vertebrates pre- and post-exposure to identify which species are likely to be affected by the use of particle during a management action.
- A field deployment will be initiated of antimycin-latent microparticles to accomplish a management action.
- Studies will continue to screen through potential new control chemicals using cytotoxicity trials and then conduct *in vivo* assays with only those chemicals that demonstrate selectivity.
- Metabolomic studies will continue to identify the MOA for various classes of chemicals to refine models to identify new piscicides.
- Diurnal feeding behavior of Asian carp will be determined to enhance uptake of particles in field trials.
- Studies to determine the impacts of microparticles on native mussels will be initiated.
- Studies will be initiated to identify genetic-based controls, specifically RNAi at critical development stages for Grass Carp.
- The spread of CRISPR will be modeled to assess the potential expansion, extirpation of the species in the Mississippi River Basin, and potential spread of the trait into the fish's native range.
- Studies will be conducted to address U.S. Fish and Wildlife Service (USFWS) Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles and obtain experimental use permit for deployment of antimycin-latent microparticle.

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

- Toxicity trials will be completed with the microparticles for those species that were identified as being affected during FY 2017 large-scale field assessment.
- A large-scale-field trial will be completed with toxic particles to demonstrate use in management. This effort will be a type of workshop and will initiate the transfer of this technology to natural resource managers.
- Screening will continue through potential new control chemicals using cytotoxicity trials and then through *in vivo* assays with only those chemicals that demonstrate selectivity.
- Metabolomic studies will be conducted to identify the MOA for various classes of chemicals to refine the models to identify new piscicides.
- Studies will be initiated to evaluate the use RNAi as a control for Grass Carp.
- Studies will be initiated to identify genetic-based controls, specifically RNAi at critical development stages for another species of the Asian carp.
- Studies will be initiated for registration of at least one new piscicide.
- Studies will be initiated to support registration of microparticles.
- Registration requirements of biologically-derived controls of Asian carp will be assessed.
- Studies will be initiated to identify necromones or pheromone modifications that could be used to disrupt Asian carp spawning behavior.

Deliverables:

- Patent for the microparticle will be submitted.
- A publication will be submitted on the results for the development and testing of the microparticle. This manuscript will include development of the formulations, laboratory efficacy trials, and pond trials.
- A manuscript will be submitted on the results of the *in vivo* toxicity trials for identification of a cyprinid-specific control.
- A publication will be submitted that identifies the types of blue-green algae consumed by Asian carp.

Expected Completion Date for Project: Ongoing

Expected FY 2017 Milestones:

- A large-scale field assessment of particles will be completed by June 30, 2017.
- The study evaluating diurnal feeding behavior of Asian carp will be completed by September 30, 2017.
- Transcriptome of Grass Carp will be completed by September 30, 2017.
- A model describing the spread of CRISPR to assess the potential expansion, extirpation of the species in the Mississippi River Basin, and potential spread of the trait into the fish's native range will be completed by July 31, 2017.
- *In vitro* cytotoxicity assays to assess chemical toxicity for Asian carp and native fishes will be completed by March 30, 2017.
- A draft of the transcriptome of Grass Carp will be completed by September 30, 2017.
- A formulation for a Grass Carp bait will be developed by June 31, 2017.

Outcomes/Outputs:

- Approximately 12 candidate fish toxicants will be 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:

- Obtaining access to candidate fish toxicants from private chemical libraries.
- Establishing contracts to produce the quantity of antimycin-A.

25. Use of Acoustic Technology to Determine Behavior

Lead Agency: USGS Columbia Environmental Research Center

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$150,000**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017

Project Explanation:

Asian carp are generally skittish when approached by boat, and Silver Carp 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. Asian carp are famously believed to have highly developed net avoidance behavior, which inhibits control methods based on harvest. Comparing catch rates between different net types to assess the 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 by lack of knowledge of the types of behaviors that allow Asian carp to avoid nets. This study plans to assess the behavior of Asian carp in relation to different gear types and to propose gear modifications that might enhance harvest efficiency.

DIDSON is a high-frequency sonar camera that produces images at a rate high enough to observe fish swimming patterns and guilds of fish species based on crude body shape and behavior. DIDSON sonar has been used to conduct fish counts passing specific areas in a river; investigate spawning behavior, and study trawl net avoidance. With this tool, fish can be accurately observed with minor interference. The ability of the DIDSON to discretely observe in situ Asian carp behavior at night or in turbid water will broaden the understanding their behavior. 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 behavior, in association with traditional gear, will be classified and quantified. Water quality will be measured at each site, especially including water temperature, velocity, and turbidity, parameters that 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 hypotheses regarding gear modifications that amend or negate such behaviors. In addition, the ability of DIDSON to assess the size of fish whether they are captured will be used to develop data on the selectivity of mesh size and type for specific sizes of fish, so that gear can more easily be selected according to the size of fish targeted, and also to the benefit of interpretation of existing fishery data using gill and trammel net.

Summary of Actions to Date: Field work was completed in October 2016. A presentation on preliminary data was given at the American Fisheries Society meeting.

Proposed Actions:

Proposed Actions for FY 2017:

- Analysis of completed video will be finished by May 2017.

- Complete field work with hoop nets.
- Begin measurement of behavior of fish at trap net mouths or simulated trap net mouths, with the goal of establishing the optimum size of opening for target size of fish. These data are needed for design of trap nets, as well as the design of "Stow nets" and for the opening size of the "escape gap" of cells that are cleared during the Unified Method. Driving, by means of typical boat driving and also through generation of sound from speakers, will be evaluated as a means of driving fish through these gaps.
- Statistical analysis of the very large amount of data already compiled will be completed in FY 2017, and manuscript production will be initiated, with the first submittal anticipated in fall 2017. Expected products within publications include a table of selectivity of size of mesh to size of fish, comparison of responses of the fish to the different net types used, a compendium of the distance from the different net types where the fish seem to respond to the net, and potential methods of deployment that could be used to take advantage of the several avoidance behaviors identified. In addition, estimates of detection probability per encounter of fish of appropriate size for that net will be provided, which should be useful in understanding the potential for netting rare fish to detect the rare fish.

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

- Field work is not anticipated at this time, but may be proposed based on results and success of previous efforts.
- Analysis of video from 2017 hoop net deployments will be completed and a manuscript drafted and submitted, including an estimate of the proportion of fish entering the hoop as they approach it from downstream. Determine if fish moving upstream are attracted to or avoid the hoop net current shadow and if fish approaching very close to the mouth of the net then avoid the net, for two different sizes of hoop net.
- Analysis of trap net/unified method cell opening size gap video completed.

Expected FY 2017 Milestones:

- **Fall FY 2017:** Finish project related field work. Continue video analysis.
- **Spring/Summer FY 2017:** Finish video analysis. Start statistical analysis. Begin metadata creation. Initiate production of manuscript, including table of selectivity of size of mesh to size of fish, comparison of responses of the fish to the different net types used, a compendium of the distance from the different net types where the fish seem to respond to the net, and potential methods of deployment that could be used to take advantage of the several avoidance behaviors identified.

Outcomes/Outputs:

- Outcomes from this project will be a description of behaviors of Asian carp encountering the various 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.
- Specifically, a table of selectivity of size of mesh to size of fish, comparison of responses of the fish to the various net types used, a compendium of the distance from the different net types where the fish seem to respond to the net, and potential methods of deployment that could be used to take advantage of the several avoidance behaviors identified. In addition, estimates of detection probability per encounter of fish of appropriate size for that net will be provided, which should be useful in understanding the potential of netting of rare fish to detect the rare fish.

- In addition, information will be provided that is necessary for optimization of the Unified Method regarding the size of opening required to allow nearly all fish to escape a cell or enter a trap net. Smaller openings are preferred because they are less likely to allow escapement from trap or re-entry of a cleared cell before it can be closed, but too small of a gap is likely to repel fish and keep them from moving in the desired direction.

Potential Hurdles:

- Weather and flooding can always lead to unsafe netting conditions and delay field work. Damage to nets will need time to repair if not replaced. Equipment problems such as DIDSON camera malfunctions and boat repairs can also 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	Asian Carp GLRI Funding
FY 2017	**$800,000**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017

Project Explanation:
Early detection is a vital part of managing any invasive species, including the invasive Asian carp. The Asian carp consist of four species that are native to Asia and include Black Carp, Grass Carp, Silver Carp, and Bighead Carp. Efforts to date have focused on Silver Carp and Bighead Carp, collectively known as the Asian carp. All four species are currently expanding their ranges throughout the Central United States and three species — Black Carp, Silver Carp and Bighead Carp — threaten to invade the Laurentian Great Lakes. A few Grass Carp have been captured in the Great Lakes, and reproduction has been verified in the Lake Erie Basin, but populations are thought to be relatively low. Identification of their invasion front and size of the population of these species is vital to their management and control. Traditional fisheries methods for capturing and monitoring a population are highly inefficient at capturing fish when at a low abundance. Not only are these methods inefficient, these four species are known to avoid the conventional gears used to capture most fish species. Therefore, new tools are needed for resource managers to more effectively detect and control these species and minimize the risk of them spreading.

One method that has garnered significant interest is in the use of eDNA. This method detects the presence of nucleic acids shed from an organism in water without the need for capturing the actual organism. Environmental DNA methods have proven effective for detection of Silver Carp and Bighead Carp DNA in waterways, but significant concerns about the technology and on the interpretation of a positive detection continue to exist. Improvements to eDNA technology will offer managers a “molecular toolbox” for detection and characterization of an aquatic species. Thus far, studies have indicated that potential applications of eDNA may include detection of spawning events, fish movement, and habitat utilization. Refinements to eDNA methodology have improved detection sensitivity, minimized false negatives from PCR inhibition, increased cost-effectiveness, and decreased time between sampling and results. Molecular technologies that need improvement include methods developed for Silver Carp and Bighead Carp to Grass Carp and Black Carp, estimation of fish biomass or indication of relative abundance, and methods that can help to determine the presence of a live fish.

Molecular methods used in medicine (loop-mediated isothermal amplification [LAMP], high-throughput sequencing [HTS], digital PCR [dPCR], and quantitative PCR [qPCR]) are at the forefront of technologies being developed for environmental monitoring. A portable LAMP assay has been developed for detection of Silver Carp and Bighead Carp in baitfish tanks. This assay is now being used by several

state and federal natural resource agencies to monitor the presence of Silver Carp and Bighead Carp in the baitfish trade. Also, methods to use an eDNA approach to analyze DNA shed from organisms within ichthyoplankton tows have been identified. These methods will significantly decrease the time between collection and identification, and development of methods to combine ichthyoplankton tow eDNA analysis with HTS are currently under way.

Much more work is needed to improve the interpretation of eDNA detections. One particular project will aim to identify differential degradation patterns of DNA and breakage hot spots so that new markers can be designed that will indicate how recently the DNA was deposited. The use of unique gut microbial markers will also be validated that could be used to compliment eDNA, and alternative markers investigated such as specific Bighead Carp metabolites (pheromone and hormones). Using existing data, models will be developed that will identify the probability of a detection coming from a live fish or some other vector or fomite. These models will be used to help recognize data gaps and inform future studies.

Summary of Actions to Date:

- Identified significant spike in eDNA correlated with spawning event in the Wabash River and applied "stair-step" markers to eDNA samples, detecting Bighead Carp sequences of greater than 800 base pairs that indicate freshly shed eDNA from live fish.
- In the Missouri River, identified a similar spike in Bighead Carp eDNA correlated with a spring rise in water level and the presence of eggs, indicating a spawning event.
- In four Truman Reservoir tributaries, identified similar spike in Grass Carp eDNA coincident with egg capture, indicating spawning events.
- No eDNA from Bighead or Silver Carp captured in Truman Reservoir tributaries, even at hydrograph events that caused spawning in Grass Carp, an indication that Asian carp are likely absent or present in low numbers and not spawning.
- Described a linear relationship over 4 orders of magnitude between Bighead Carp 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 Bighead Carp sperm under controlled laboratory conditions, showing a good fit to exponential decay with a half-life of about 8 hours.
- One manuscript is published, one in review, and three are in preparation from CERC.
- Validated new qPCR markers through a multi-lab round robin double-blind study for Bighead Carp mitochondrial DNA to allow incorporation into the USFWS eDNA monitoring program.
- Initiated validation of Bighead Carp -specific microbial communities to detect Bighead Carp.
- 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.
- Developed and validated the portable DNA/RNA detection kit.
- Completed transect-sampling of sites along the Upper Mississippi River Pools 8 and 26, where the expected invasion front is currently located.
- 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 Bighead Carp population density study in small pond mesocosms to connect laboratory and field results for eDNA shedding rates.
- Estimated relative Bighead Carp density in Missouri River tributaries with side-scan sonar and traditional capture methods, and conducted simultaneous sampling for eDNA quantification to characterize habitat usage and fish movement.
- Conducted comparisons of water sampling methods during field and pond studies to optimize water sampling methods for eDNA detection and quantification.
- Initiated studies to look at the way DNA breakdown and the potential use of RNA to design markers to indicate how recent the DNA had been shed and alleviate concerns about the source of the DNA.
- Identified a method using HTS protocols to analyze composite water samples, plankton tows, and ichthyoplankton tows for detection of Asian carp.
- Developed an initial occupancy model using data from the Wabash River. This model has been published in Molecular Ecology Resources.
- Completed studies validating the use of digital PCR (dPCR) as an alternate to qPCR for quantifying eDNA concentrations have been completed.
- Completed the *in vivo* portion of the mesocosm study of eDNA shedding rates from larval Silver Carp.
- Completed analysis of eDNA quantity in 2014/15 samples from upper Mississippi sites with a gradient of known relative population densities of Asian carp and collected samples for 2016.
- Conducted a field trial of the use of eDNA analysis to monitor the effect of a management action, in conjunction with a test of the unified fishing method
- Continued to sequence mitochondrial DNA of fishes native to Upper Mississippi River whose mitochondrial DNA sequences are underrepresented in GenBank.
- Initiated a quantitative analysis of the contribution of eDNA from carcasses of Silver Carp in outdoor mesocosms.
- Initiated laboratory studies on the degradation of eDNA from sperm in river water, comparing Missouri River water with standard well water.
- Completed analysis of relative Bighead Carp 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.
- Complete analysis of comparisons of water sampling methods from field and pond studies to optimize water sampling methods for eDNA detection and quantification.
- Initiated a study that evaluates the distribution of BC and land-use practices by using eDNA.
- Conducted a workshop to train law enforcement on the use of the portable DNA detection device.
- Submitted a manuscript that describes the use of LAMP and the portable detection tool for peer review.

Proposed Actions for FY 2017:

- 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

- Continue to develop HTS protocols to analyze composite water samples, plankton tows, and ichthyoplankton tows for species composition/richness determination, Bighead Carp biomass, and spawning events and locations.
- Validate microbial source markers for potential inclusion into surveillance program in an effort to track live fish.
- Develop models to estimate the biomass of silver and Bighead Carp from eDNA flux rate in flowing water under field conditions.
- Develop a LAMP assay for both Black Carp and Grass Carp.
- Integrate eDNA sampling and HTS with long-term monitoring.
- Develop a sampling protocol for both Black Carp and Grass Carp eDNA.
- Validate qPCR markers for Grass Carp.
- Initiate eDNA shedding rate studies of Grass Carp.
- Develop and validate a second qPCR marker for Black Carp. Currently, these is only one validated marker for Black Carp.
- Initiate eDNA shedding rate studies of Black Carp held under secure laboratory conditions at CERC.
- Complete land use patterns and eDNA sampling.
- Create aprobabilistic model for eDNA to inform of live fish.
- Initiate genome and transcriptome sequencing of both Black and Grass Carp.
- 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 Silver and bighead carpCarp.
- Continue to assess land-use practices with fish movement and eDNA sampling.
- Continue studies that evaluate the utility of eDNA for assessing the effects of management actions.
- Evaluate data from the use of the portable detection device by law enforcement.

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

- Complete development of eRNA or nuclear markers and evaluate usefulness in captive tank or field samples known to contain presence recently introduced live fish..
- Transfer technology for the use of HTS protocols to USFWS or other management agencies in analyzing individual or composite water samples, plankton tows, or ichthyoplankton tows to correlate with species composition/abundance.
- Complete the development of qPCR assays from Silver Carp and Bighead Carp DNA that span multiple restriction site regions of interest in an effort to develop markers useful for tracking live fish.
- Begin to transition the use of species-specific microbial communities as a compliment to eDNA to monitoring programs.
- Use eDNA to monitor for spawning events by Grass Carp in the Sandusky River or other Great Lakes tributaries.
- Repeat sampling of upper Mississippi sites with a gradient of known relative population densities of Bighead Carp, in collaboration with the Long-Term Resource Monitoring Program or in areas with commercial catch data, to characterize any changes in populations over time.

- Use eDNA analysis to monitor the effectiveness of the unified fishing method for removing Bighead and Silver Carp from Creve Coeur Lake, Missouri.
- Complete analysis of land-use practices and carp population density and eDNA quantity.
- Quantify the effect of feeding rate and food type on eDNA shedding rates of Black Carp.
- Design and validate quantitative PCR assays for rapidly degraded sites on the mitochondrial DNA genome.
- Complete data analysis comparing eDNA quantification with estimates of relative density in Missouri River tributaries and wetlands from side-scan sonar and traditional capture methods, to characterize habitat usage and fish movement.
- Initiate feeding studies to determine a measurable proxy for feeding rates that can be used as an eDNA correction factor for improving biomass estimates.
- Investigate the use of pheromones or metabolic products for early detection of live fish.

Deliverables:

- Publication of Upper Mississippi River eDNA results and comparison of qPCR vs dPCR
- Publication of Missouri River Silver Carp spawning study
- Publication of Truman reservoir Grass Carp spawning study
- Publication of Silver Carp eDNA degradation study
- Publication 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
- Mississippi River cyprinid mitochondrial genome sequences added to GenBank
- Publication of handheld detector validation study
- Training for expanded use of handheld detector by FWS and additional Great Lakes states
- Handheld assay available for grass and Black Carp
- A method to use HTS to efficiently screen ichthyoplankton tows for the presence of Asian carp without destroying eggs/larvae

Expected Completion Date for Project:

- UMESC will complete the comparison of Bighead Carp and Silver Carp eDNA on pools of the Upper Mississippi River between qPCR and dPCR by 2017.

Expected FY 2017 Milestones:

- Establishment of HTS protocols to assist in answering management questions above and beyond the presence of eDNA that hinge on fish movement, spawning events, and fish abundance by September 30, 2017.
- Expansion of the species detected with use of the handheld detection device by September 30, 2017.

Outcomes/Outputs:

- Multiple validated methods to detect a variety of molecular signals.
- Tools to accurately identify the route of entry of 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.
- Limited to collecting samples only when there is not ice cover.

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 Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$1,850,000**	**$1,590,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:
Integrated pest management (IPM) will be needed to keep Asian carp from invading the Great Lakes. Prerequisites to effective IPM include (1) understanding the life history, status and risk of the pest; (2) prioritizing resources to be protected; (3) setting tactical objectives and performance measures; (4) selecting and implementing the best available monitoring, surveillance, control and containment actions (tactics); (5) evaluating the efficacy of implemented tactics using performance measures to inform future actions; and (6) developing and implementing new monitoring, surveillance, control, and containment tactics as needed. This template serves to describe the work conducted by the U.S. Geological Survey (USGS) in collaboration with other research organizations and management agencies from the funding provided by the Great Lakes Research Institute (GLRI) and USGS (appropriated) that supports the development of adaptive IPM, including the following primary objectives: (1) implementation and evaluation of new tactics for monitoring, surveillance, control, and containment; (2) development and evaluation of databases, decision support tools, and performance measures; (3) understanding the movements, behaviors, and reproduction of populations; and (4) development of a process to execute adaptive IPM using structured decision making (establishing objectives, alternative actions, performance measures, monitoring and assessment, and feedback to inform future actions).

Two primary tactics currently being deployed to keep Asian carp from invading the Great Lakes from the established populations in the Illinois River include the electrical barriers in the CAWS and contract fishing in the upper Illinois River (between Starved Rock Dam and the electrical barriers). The area between Starved Rock and the electrical barriers is recognized as having reduced abundance and limited recruitment 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 recruitment from local 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 local recruitment from reproduction, as evidenced by continuous monitoring. Minimizing the number of Asian carp in this buffer reduces the likelihood that Asian carp will challenge the electrical barrier and the potential for propagules of Asian carp to reach the Great Lakes.

New deterrents, monitoring, surveillance and decision support tools to increase the efficacy of these two existing tactics (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 deterrent technologies such as sound or CO_2 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 allows for protection across a greater range of conditions and life

stages and allows for backup in the case of failure of a single technology. Because limited numbers of Asian carp have been detected upstream of Brandon Road Lock and Dam, studies at this lock are being conducted to help fill the need for longer-term redundant deterrents. Additionally, deployment of CO_2 or sound at locks and dams between Brandon Road and Starved Rock Lock and Dam (in the "buffer zone") might reduce Asian carp abundances in that stretch of river in the short term. Deterrent technologies (such as CO_2 and sound), and algal attractants might 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 buffer zone with advanced telemetry methods (for example., passive receivers transmitting data in real-time, enhanced acoustic arrays, and satellite-capable transmitters), newly developed techniques for the detection of larval and juvenile life stages of Asian carp might further enhance the efficacy of the existing tactics and inform new ones. The development of databases, decision support tools, and targeted analyses from existing data will also help maximize data and information usefulness for IPM for Asian carp. Understanding the movements, habitats, and behaviors of Asian carp in emerging and established populations will allow for better application of all of these tools.

In this implementation phase, the USGS and its partners, including Illinois Department of Natural Resources (IL DNR), SIU, WIU, the U.S. Fish and Wildlife Service (USFWS), the U.S. Army Corps of Engineers (USACE), and others will deploy sound, CO_2, feeding attractants and advanced surveillance techniques, and develop behavioral information, databases, and associated decision support tools, to maximize the efficacy of contract fishing and minimize immigration of Asian carp into the upper Illinois River to protect the Great Lakes. Implementation of these new tools and information is planned, including the use of sound and CO_2 in a lock chamber at one of the high-head dams (such as Starved Rock) to deter fish from entering and passing upstream through the dam, and the application of CO_2, sound, and algal attractants to contain AC at strategic locations and times to facilitate removal or deny them access to critical habitats (spawning, overwintering, or nursery). Advanced surveillance technologies at strategic locations including (1) telemetry with automated real-time receivers and additional passive arrays to inform contract fishing and rapid response, and (2) NGS and qPCR to rapidly screen samples and supplement ongoing surveillance efforts for juvenile and larval Asian carp will be integrated with existing tactics. USGS will work with partners to develop (1) databases for standardized sampling and removal efforts, (2) decision support tools for informing population control and mitigation for barge entrainment, and (3) performance measures for evaluation of objectives as part of adaptive IPM. Finally, USGS will participate with partners to develop an adaptive IPM process using structured decision making including formally defining objectives, alternative actions and associated performance measures to determine the efficacy of integrated tactics and inform future actions.

Sumamry of Actions by Objective

(1) Implementation and evaluation of new tactics and behavioral information for monitoring, surveillance, control and containment.
    - Complex sound and CO_2 as deterrents at dams and other strategic locations
        - Conducted a partner workshop to establish the current state of knowledge of and steps needed to implement complex sound in the lock approaches of strategic dams to prevent Asian carp passage.
        - Procured speakers and monitoring equipment for the deployment of complex sound in a lock approach.
        - Conducted surveys of ambient noise levels at Brandon Road L&D and Starved Rock Lock and Dam as a pre-requisite to implementing complex sound as a deterrent.

- Conducted site visit and ambient noise survey at abandoned lock at Cooperas Creek to prepare for complex sound trials with Asian carp present to test the application at appropriate scale for lock approach deployment.
- Deployed speaker array on gate structures of a controlled backwater in the Illinois River in preparation for a field effectiveness study.
- Established working group with USFWS to identify sites for field application of CO_2 in a lock chamber and other strategic locations that will be included in the permitting process.
- Conducted site visit and study planning for a field trial of CO_2 to prevent Asian carp movement into life cycle-critical habitats

- Real time telemetry, and telemetry database and visualization tool to inform removal and rapid response.
  - Deployed three real-time telemetry receivers in the Upper Illinois River. Sites included Starved Rock and Brandon Roads lock approach channel and just upstream of Dresden Island Lock and Dam.
  - Incorporated the real-time receiver data stream into the Asian carp Telemetry database and visualization tool.
  - Identified additional sites for placement of automated real-time receivers. Potential sites for next year's installations included Wilmington Dam on Kankakee River, above and below the electrical barrier in the CAWS, Dresden Pool above Rock Run Rookery, above Brandon Road Lock and Dam, in Rock Run Rookery, and in Morris Pit in Marseilles Pool.
- Microparticle application
  - Completed study of ambient particle availability by season and habitat type to inform microparticle development and application.
- Advanced monitoring techniques
  - Genetic tools were used to verify the identity of morphometrically identified Bighead Carp eggs and larvae collected in standardized monitoring in the upper Illinois River.
  - Developed protocols to use genetic tools (NGS and qPCR) to efficiently screen ichthyoplankton tows for the presence of Asian carp eggs and larvae.
  - Completed light trapping studies to assess movement rates and habitat selection of bighead carp and Grass Carp larvae.
- Unified method
  - USGS scientist traveled to China for training in the Unified Method of carp capture and worked with the IL DNR to accomplish the first trial of the method here in the United States.
  - Completed telemetry study during the application of the Unified Method in Hansen Materials Pit in the Marseilles Pool of the Illinois River.
- Algal attractants and sound to aid in removal efforts
  - Conducted field trials and reconnaissance to assess the usefulness of algal attractants to enhance monitoring and control tactics.

(2) Understanding behavior and reproduction of Asian carp in established and emerging populations to inform deterrent deployment, rapid response, and removal efforts.

- Continued studies on reproduction, adult habitat and sources of recruitment.
- Continued studies to evaluate native predators and juvenile habitat.
- Continued studies on use of Judas fish to enhance capture.

(3) Development and evaluation of databases, decision support tools and performance measures.

- Initiated the development of (1) an Asian carp database to house monitoring and assessment data for the upper Illinois River and (2) decision support tool to inform mitigation measures to minimize the entrainment of Asian carp eggs and larvae by barge traffic.
- Participated in development of annual and contingency monitoring and response plans for the Illinois River, including a tabletop exercise of the contingency plan.
- Contributed to the development of a spatially explicit state-based population model to inform removal efforts in the upper Illinois River.

(4) Development of adaptive IPM using structured decision making.

- In collaboration with the USFWS, IL DNR, and other basin (state) partners, initiated development of Integrated Pest Management using Structured Decision Making as a nationwide basis for developing action plans for Asian carp management.

Proposed Actions for FY 2017 by Objective:

(1) Implementation and evaluation of new tactics for monitoring, surveillance, control, and containment.

- Complex sound and CO_2 as deterrent at dams and other strategic locations
  - Complete analysis and reports of 2015 field trials using sound and CO_2.
  - Complete analysis and summary of initial sound mapping to establish complex noise baselines around Illinois River sites selected for control technologies.
  - Apply and evaluate the use of complex sound at the abandoned lock at Cooperas Creek in the Illinois River.
  - Apply and evaluate the use of complex sound at Starved Rock Lock and Dam.
  - Continue planning for the application of CO_2 at a lock chamber in the upper Illinois River.
- Real time telemetry, and telemetry database and visualization tool to inform removal and rapid response.
  - Deploy real-time telemetry receivers in the Upper Illinois River at a minimum of here of the following sites: Wilmington Dam on Kankakee River, above the electrical barrier in the CAWS, above the electrical barrier in the CAWS, below the electrical barrier in the CAWS, in Dresden Pool above Rock Run Rookery, above Brandon Roads Lock and Dam, in Rock Run Rookery in Dresden Pool, and in Hansen Material Pit in Marseilles Pool.
  - Incorporate the data stream from the added real-time receivers into the Asian carp Telemetry database and visualization tool.
  - With management agencies, identify additional sites for placement of automated real-time receivers.
  - Release the telemetry database and visualization tool to management and collaborating research agencies.
  - Complete field testing of satellite-capable geotags for tracking Asian carp to inform removal efforts.
- Microparticle application
  - Coordinate and collaborate with state and federal natural resource management agencies to deploy antimycin-latent microparticles in a field setting to accomplish a specific management action.
  - Evaluate the potential use of microparticles as a passive and unique fish marker for differentiation of discrete fish populations.
- Advanced monitoring techniques

- Use genetic tools to verify the identity of morphometrically identified Bighead Carp eggs and larvae collected in standardized monitoring in the upper Illinois River.
- Disseminate protocols to use genetic tools (NGS and qPCR) to efficiently screen ichthyoplankton tows for the presence of Asian carp eggs and larvae.
- Disseminate protocols for light trapping to assess movement rates and habitat selection of Bighead Carp and Grass Carp larvae.

- Assessments of Unified Method
  - Prepare and submit manuscript describing the Chinese Unified Method and its potential use in the United States work with IL DNR to perform second trial of the method.
  - Complete analysis and report on telemetry study during the application of the Unified Method in Hansen Material Pit in the Marseilles Pool of the Illinois River.
  - Initiate evaluation of potential performance measures to assess the Unified Method.
- Algal attractants and complex sound to aid in removal efforts
  - Continue to conduct field trials and reconnaissance to assess the usefulness of algal attractants and complex sound to enhance monitoring and control tactics.

(2) Behavior and reproduction of Asian carp in established and emerging populations to inform deterrent deployment, rapid response, and removal efforts.

- Complete analysis and reports on Asian carp feeding, food availability, movement, habitat, reproduction, recruitment, and behavior during removal efforts.
- Complete analysis and reports on field and pond studies assessing native predators to control Asian carp.
- Present findings and initiate discussions with managers on the feasibility of stocking or enhancing habitat for native predators to control Asian carp.
- Complete analysis of movements of transplanted telemetered “Judas” Silver Carp to those of Silver Carp captured and released in the same Mississippi River pool in 2015.
- Continue to develop triploid Silver Carp for potential use as Judas fish.
- Initiate development of lethal implanted tag designed to cause death of telemetered fish at a designated time in the future.
- Continue/initiate detailed active and passive telemetry studies in the upper Illinois River and Mississippi River basin to assess longitudinal and lateral movements of Asian carp.
- Continue or initiate studies on otolith microchemistry to determine movements through strategic dams and sources of recruitment to emerging and established populations of Asian carp.
- Continue or initiate evaluations of the efficacy of removal efforts in reaches with emerging and established populations of Asian carp.

(3) Development and evaluation of databases, decision support tools and performance measures.

- Continue development of an Asian carp database to house monitoring and assessment data for the upper Illinois River
- Continue development of a decision support tool to inform mitigation measures to minimize the entrainment of Asian carp eggs and larvae by barge traffic.
- Continue development of annual and contingency monitoring and response plans for the Illinois River, including tabletop exercises of the contingency plans.
- Continue to contribute to development of a spatially explicit state-based population model to inform removal efforts in the upper Illinois River.

- Develop an Integral Projection Model to evaluate alternate management strategies, namely use of YY-males, for Asian carp.
- Initiate development of a habitat suitability decision support tool for Asian carp using 2D hydrologic and water quality data.
- Initiate benthic mapping of the Illinois River as input to an Asian carp habitat suitability model.
- Initiate the evaluation of performance measures associated with tactical objectives established by managers as part of adaptive IPM.

(4) Development and support of adaptive IPM to control Asian carp using structured decision making.

- In collaboration with the USFWS, IL DNR, USACE, and other basin (state) partners, conduct a multi-basin workshop on using IPM with Structured Decision Making (SDM) to develop action plans for Asian carp management in Springfield, Illinois, January 18-19, 2017.
- Conduct workshops to transfer information and identify steps needed to implement new monitoring, surveillance, control, and containment technologies.

Potential Out-year Actions (Subject to Future Appropriations) by objective 1-4:

(1) Implementation and evaluation of new tactics for monitoring, surveillance, control, and containment.

- Complex sound and CO_2 as deterrent at dams and other strategic locations.
  - Complete analysis and reports for 2017 field trials using sound and CO_2 at Cooperas Creek and Emiquon.
  - Continue to apply and evaluate the use of complex sound at Starved Rock Lock and Dam.
  - Apply and evaluate the application of CO_2 at a lock chamber in the upper Illinois River.
- Real time telemetry, and telemetry database and visualization tool to inform removal and rapid response.
  - Deploy real-time telemetry receivers in the Upper Illinois River at a minimum of three locations identified by management agencies.
  - Incorporate the data stream from the added real-time receivers into the Asian carp Telemetry database and visualization tool.
  - With management agencies identify additional sites for placement of automated real-time receivers.
  - Update the telemetry database and visualization tool.
  - Continue on field testing of satellite-capable geotags for tracking Asian carp to inform removal efforts.
- Microparticle application
  - Report on the 2017 field application of antimycin-latent microparticles.
  - Complete the evaluation of microparticles to uniquely mark fish to differentiate populations and initiate field assessment of the use of microparticles to mark populations of Asian carp at and near the invasion front.
- Advanced monitoring techniques
  - Use genetic tools to verify the identity of morphometrically identified Bighead Carp eggs and larvae collected in standardized monitoring in the upper Illinois River.
  - Continue on the studies of genetic tools (NGS and qPCR) to efficiently screen ichthyoplankton tows for the presence of Asian carp eggs and larvae.
- Assessments of Unified Method

        - Complete analysis on telemetry study during the second application of the Unified Method in the Illinois River.
        - Continue evaluation of potential performance measures to assess the Unified Method.
        - Continue evaluation and adaptation and improvement of Unified Method for applications outside backwater areas.
    - Algal attractants and complex sound to aid in removal efforts
        - Continue with field trials to assess the usefulness of algal attractants and complex sound to enhance monitoring and control tactics.

(2) Behavior and reproduction of Asian carp in established and emerging populations to inform deterrent deployment, rapid response, and removal efforts
    - Continue with detailed active and passive telemetry studies in the upper Illinois River and Mississippi basin to assess longitudinal and lateral movements of Asian carp.
    - Continue with studies on otolith microchemistry to determine movements through strategic dams and sources of recruitment to emerging and established populations of Asian Carp.
    - Continue with evaluations of the efficacy of removal efforts in reaches with emerging and established populations of Asian carp.
    - Continue studies evaluating native predators to control Asian carp.
    - Continue on studies of Judas fish as controls.
    - Continue on study to develop triploid Silver Carp as Judas fish.
    - Continue development of lethal implanted tag designed to cause death of telemetered fish at a designated time.

(3) Development and evaluation of databases and decision support tools.
    - Continue development of an Asian carp database to house monitoring and assessment data for the upper Illinois River.
    - Continue development of a decision support tool to inform mitigation measures to minimize the entrainment of Asian carp eggs and larvae by barge traffic.
    - Continue development of annual and contingency monitoring and response plans for the Illinois River, including tabletop exercises of the contingency plans.
    - Contribute to completion of a spatially explicit state-based population model to inform removal efforts in the upper Illinois River.
    - Conduct management workshops on the use of the spatially explicit state-based population model.
    - Continue to develop an Integral Projection Model to evaluate alternate management strategies, namely use of YY-males, for Asian carp.
    - Continue development of a habitat suitability decision support tool for Asian carp using 2D hydrologic and water quality data.
    - Continue benthic mapping of the Illinois River as input to an Asian carp habitat suitability model.
    - Initiate development of maps predicting locations of ideal habitat for larval and juvenile carp recruitment, according to river stage and distance from proposed spawning sites, to be used for controls based on predator stocking or microparticle deployment.

(4) Development and support of adaptive IPM to control Asian carp using structured decision making including performance measure evaluation

- Continue evaluation of performance measures associated with tactical objectives established as part of adaptive IPM.
- Conduct workshops to transfer information and identify steps needed to implement new monitoring, surveillance, control, and containment technologies.

Milestones and Deliverables:

(1) Implementation and evaluation of new tactics for monitoring, surveillance, control, and containment.

- Complex sound and CO_2 as deterrent at dams and other strategic locations.
  - Reports and presentations on 2015 field trials using sound and CO_2 at Morris, Illinois.
  - Report and presentations on sound maps and characterization of ambient sound at key locations along the Illinois River.
- Real time telemetry and telemetry database and visualization tool to inform removal and rapid response.
  - Integrated advanced and intensified surveillance system that can be used to help inform removal and rapid response for Asian carp in the upper Illinois River.
  - Telemetry database and visualization tool v1.0.
- Advanced monitoring techniques
  - Report and presentation on molecular methods to efficiently screen ichthyoplankton tows for the presence of Asian carp.
  - Protocols for light trapping to assess movement rates and habitat selection of Bighead Carp and Grass Carp larvae.
- Assessments of Unified Method
  - Report and presentation describing the Chinese Unified Method and its potential use in the USA.
  - Report and presentations on telemetry study during the application of the Unified Method in Hansen Material Pit in the Marseilles Pool of the Illinois River.

(2) Behavior and reproduction of Asian carp in established and emerging populations to inform deterrent deployment, rapid response, and removal efforts

- Report and presentations describing the Chinese Unified Method and its potential for use in the USA, along with description of hurdles to use of the method here. Report and presentations on larval lateral dispersal, to be used in modeling locations of potential nursery habitats.
- Report and presentations on gut evacuation rates in two predators of Asian carp native to the United States (research that was required for interpretation of mesocosm and field studies).
- Report and presentations on habitat use by small juvenile carp in the presence and absence of predators and efficacy of seven different native species in their relative predation rates on three Asian carp and on gizzard shad. Reports and presentations to regional and national managers on adult Asian carp feeding behavior, food availability, movement, and habitat use in relation to surveillance and control tactics for Asian carp.
- Reports and presentations to regional and national managers on environmental cues and extent of reproduction of Asian carp in emerging populations in relation to surveillance and control tactics for Asian carp.
- Report and presentations on movement through dams and sources of recruitment for an emerging population of Bighead Carp in relation to surveillance and control tactics for Asian carp.

- Report and presentation on the behavior of Asian carp during application of the Unified (fishing) Method in the west Pit of Morris in the Marseilles Pool.
- Reports and presentations to regional and national managers on juvenile Asian carp habitat, sources of recruitment and predation by native fishes in reaches with established and emerging populations.
- Report and presentations on movements of transplanted telemetered Judas Silver Carp to those of Silver Carp captured and released in the same pool.

(3) Development and evaluation of databases, decision support tools and performance measures

(4) Development and support of adaptive IPM to control Asian carp using structured decision making

- Workshop to discuss adaptive integrated pest management with structured decision making as a means to develop annual work plans for Asian carp control. Springfield, Illinois, January 18-19, 2017.

Expected Completion Date for Project: Ongoing

Outcomes/Outputs:

- Recommendations to management agencies on incorporating new tactics for monitoring, surveillance, control, and containment.
- Databases and decision support tools.
- Detailed understanding of Asian carp behavior and reproduction in emerging and established populations to inform controls.
- IPM program for Asian carp using structured decision making as a basis for annual action plans and defining research and information needs.

Potential Hurdles:

- Scaling of evaluated technologies to use in field trials and long-term deployments.
- Obtaining needed permits/access to conduct field trials.
- Interagency coordination to conduct implementation trials and implement IPM.
- Hydrological conditions during studies.

45. Engineering Design of Fish Acoustic Deterrents for Lock Approaches

Lead Agency: USGS/USACE

Agency Collaboration: USFWS, IL DNR, USCG

Funding Table:

Funding	Agency Funding	USGS Asian Carp GLRI Funding	USACE Asian Carp GLRI Funding
FY 2017	**$0**	**$160,000**	**$685,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017

**Upon consideration of initial results, additional research may be proposed

Project Explanation:

Several potential control technologies are being considered to prevent Asian carp movement through navigation structures in the Upper Illinois Waterway. The USGS has conducted numerous laboratory and field tests using complex sound to deter Asian Carp, however, if this technology is to be used at or around a lock and dam, proper design and testing should be completed. The use of this technology at a lock within a navigation channel offers additional complexities over the typical field installation testing. This project would allow testing and monitoring of a new control technology in the approach channel of the Brandon Road Lock. This location was selected because Brandon Road Dam has an impassible head differential even during a 0.2 percent annual chance exceedance and the only opportunity for upstream transfer is through the lock chamber. In contrast to other locations such as Dresden Island and Starved Rock, open water events where passage through the dam occurs with smaller flood events.

This testing will allow for the development and testing of a sound model, evaluation of deployment configurations, and assessment of impacts to native fish and any telemetered Asian Carp in the Dresden Island Pool over the testing period. During the testing period, a limited assessment of impacts to navigation can be evaluated because the Brandon Road Lock is on a regulated navigation channel with on average 3,500 cuts (lockages) per year. The majority of the traffic is commercial cargo (tugs and barges). The testing will also include an evaluation of issues associated with navigator and lock operator safety, such as possible interference with marine radios and other communication devices and other technology interferences that may impact navigation. Another objective of this project is to provide all potential parties with field experience in the deployment of these ANS control technologies and to inform engineering considerations of future deployments.

Summary of Actions to Date:

- Field-scale testing of complex sound were completed under a different template at Morris, Illinois in 2015.
- Preliminary evaluation by the USGS and USACE of which control technologies were ready for large-scale field testing.
- Decision to pursue testing of complex sound for the first trial. Possibilities for future field testing include water jets to clear barge gaps and carbon dioxide.
- Initial ambient sound recordings were completed in September 2016 at Brandon Road lock.

- Project kick-off meeting in September 2016 at USACE Chicago office with USGS, USACE, FWS, USCG, USEPA, and IDNR.

Proposed Actions for FY 2017:

- Complete all permitting and/or regulatory requirements for deployment of complex sound. (USGS/USACE)
- Collect input data for a quantitative model of the study area incorporating ambient acoustics, boundary conditions (walls, channel, air-water interface), and potential interfering factors such as turbulence during lock releases (USGS).
- Install initial speakers on Brandon Road Lock miter gates and in the approach channel and monitor sound field produced for approximately seven days to provide the modelers with information on how sound travels through the channel (USACE with installation support from USGS).
- Complete quantitative sound propagation model of the study area. Can use the information gathered during this assessment (refraction – sound moving in 360 degrees and bouncing off of objects- rates) to inform designs at other locks (USACE with advice on some parameters from USGS).
- Develop plans for a second speaker installation to identify gaps in the sound field (USACE/USGS).
- Coordination and communication engineering considerations—speaker location, power, monitoring equipment location, minimizing navigation impacts (USACE/USGS).
- Gather existing data and bolster current fish monitoring plan to provide baseline data to determine impacts of underwater sound, when implemented (preliminary pre-study assessments) (USGS).

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

- Install speakers for a a 2-day test on Brandon Road Lock miter gates and approach channel to field-test sound model with tow and barge activity. Contract for barge and tug services to travel up and down the approach channel to assess how the sound field is impacted by navigation (USACE with USGS field support for installation of hydrophones).
- Update the sound propagation model based on field measurement. After tailoring it to site specific characteristics of different locations, this model serves as a platform that can be used to design sound deterrents in lock approaches (USACE).
- Further monitor and evaluate the fish population at and around Brandon Road Lock with special attention to fish movement when speakers are on or tested. Reevaluate fish monitoring plan (USGS).
- The USACE will develop an after-action report of information needed for the development or incorporation of these technologies in future USACE control actions, if they are deemed applicable.
- The USACE and USGS will develop a publication based on the results from these deployments and monitoring data collection.
- Fish monitoring at Brandon Road Lock and Dam will continue, and a more extensive evaluation of the response of both resident native fishes and Asian carp will be developed if additional speakers are installed.

- Based on results of the effort, additional complex sound deterrent trials may be proposed at Brandon Road Lock and Dam to further assess engineering and navigation feasibility.

Deliverables:

- Full scope of work developed for implementation and monitoring during field trial.
- Equipment purchases and installation of the initial seven day data collection effort.
- Robust sound propagation model to inform design.
- Scope of work for second speaker installation to field-test sound model.

Expected Completion Date for Project: FY 2020

Expected FY 2017 Milestones:

- Regulatory requirements fulfilled by February 2017.
- Initial installation of speakers complete in Brandon Road Lock and Dam study area by March 2017 for 7-day trial and data collection.

Outcomes/Outputs:

- Robust, field-tested sound propagation model that could be used to design a larger array or sound deterrent in lock and navigation channels.
- Longer-term deployment information for technologies currently under development. USGS and USACE reports documenting the effectiveness, design considerations and other information. Considerations for future larger-scaled design and deployment will be highlighted.
- Provide USACE and other parties with field experience in the deployment of these ANS control technologies.

Potential Hurdles:

- Timeliness of funding with respect to field testing schedule
- Installation costs
- NEPA and other regulatory/permitting evaluations
- Coordination with navigation and real estate
- Timeliness of contracting

54. Development of Chemical Methods for Control of Aquatic Invasive Species during Locking Operations (Previously Hot Water, Chlorine and Ozone Use for Lock Treatment)

Lead Agency: USGS and USACE

Agency Collaboration: USFWS, The Nature Conservancy

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$70,000**	**$100,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:

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 U.S. Geological Survey 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, ozone, and chlorine (sodium hypochlorite) for lethal AIS control in lock operations.

Summary of Actions to Date:

- Developed protocol for conducting toxicity tests on hot water and ozone
- Conducted initial assessment of engineering requirements for hot water and/or ozone
- Consulted with USEPA to determine which chemicals would have the highest probability of achieving registration for treatment of vessels during lock operation
- Initiated sourcing of representative test organisms for each of the different taxa to be tested
- Constructed system test and verified operational readiness for testing hot water and ozone
- Initiated toxicity tests on fish and invertebrate species
- Initiated planning to conduct plant toxicity tests
- Developed husbandry methods for taxa and life stages (representative selected species of amphibians, crustaceans, fish, mollusks, phytoplankton, and zooplankton) of interest as needed.

- Conducted toxicity tests on hot water and ozone, singly and in combination, against fish and invertebrates to determine effectiveness.

Proposed Actions for FY 2017:

- Complete toxicity tests with chlorine (sodium hypochlorite) and hot water-chlorine combinations
- Consultation with USEPA to determine best course of action for registration of vessel treatment technologies during lock operation
- Prepare summary report on test results

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

- 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.
- Prepare a manuscript on the results of the study

Deliverables:

- Completion of toxicity tests and evaluation of data
- Project completion report
- Manuscript on test results
- Initiate studies to support registration of selected chemicals

Expected Completion Date for Project: December 2018

Expected FY 2017 Milestones:

- Completion and evaluation of toxicity tests by June 30, 2017.
- Initiate registration of one or more chemicals to support treatment technologies by July 1, 2017
- Transfer of technology to support engineering designs by September 30, 2017

Outcomes/Outputs:

- Registration of one or more chemicals for treatment of vessels during lock operations

Potential Hurdles:

- Availability of test organisms
- Potential registration requirements for the selected chemical(s) may be cost prohibitive depending on the number/type of studies required

55. Communication and Demonstration of New Technologies for the Control and Monitoring of Asian Carp

Lead Agency: USGS

Agency Collaboration: USACE, USFWS, SIU, UIUC, Purdue, State Departments of Natural Resources or Fisheries

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**20,000**	**30,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:

As new control technologies have and will be developed to control and monitor the Asian carp — such as complex sound, carbon dioxide deterrent, 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:

- Engage in the CAWS Advisory Group on how USGS Asian carp control technologies can be used to reduce the risk of spread into the Great Lakes.
- Published a fact sheet with an overview of USGS Asian carp science.
- Updated USGS Asian carp websites with new findings and publications.

Proposed Actions for FY 2017:

- Develop video describing the handheld eDNA early detection kit.
- Help to facilitate and host multi-agency Asian carp scientist meeting in Springfield, Illinois in January.
- Provide updates to the USGS Great Lakes Research Institute (GLRI) Asian carp website.
- Present ongoing technology transfers or informational meetings for state and other partners through webinars and workshops.

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

- Work with the USFWS and USEPA to set up Asian carp early detection, risk assessment, or control technology transfers or informational meetings for appropriate federal and state managers and other partners through webinars and workshops.

Expected Completion Date for Project: ongoing

Expected FY 2017 Milestones/Deliverables:

- Asian carp scientist meeting in January 2017.
- eDNA handheld early detection kit video by September 2017.
- USGS GLRI website updates by September 2017.

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:

- Many partners have limited travel budgets and may not be able 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	Asian Carp GLRI Funding
FY 2017	**$70,000**	**$80,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017

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 indicate that these fish are the result of natural reproduction in the Mississippi River Basin. Age and growth data from captured fish indicate 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 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 kilograms (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 a serious threat to native mollusk populations. The intention of this project is to develop an effective bait for Black Carp that could be used to protect endangered mussels, but have little potential effect on native fishes or the public.

In addition, this project includes evaluation of the existing population through genetics, aging methods, ploidy analysis, and gonad histology.

Summary of Actions to Date:

The Columbia Environmental Research Center (CERC) has been working for 3 years with the USFWS and Southern Illinois University to process Black Carp captured by recreational or commercial fishers and by state agencies 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. CERC and the USFWS have developed a protocol that has been submitted through MICRA to state collaborators that provides methods for handling the fish and for transmitting the fish to CERC. In addition, the State of Illinois offers a bounty of $100 per fish for Black Carp submitted through the protocol by commercial or recreational fishers. These fish have tested for ploidy (by the USFWS) and tested for hatchery vs. wild origin by otolith stable isotopes (by southern Illinois University). CERC provides meristic data, database management, aging, and gonad histology (to determine age of maturation and timing of spawning), gut content analysis, and has collected tissue samples for genetic analysis and for potential future trophic analysis through stable isotopes, and gut liquid contents for potential determination of diet through DNA technology (because most submitted Black Carp have empty guts). Approximately 50 fish have been collected, nearly half of them in 2016. In addition to those fish, 47 young-of-year Black Carp were captured in 2016 by an MDC collaborator, who has agreed to make

genetic material available for sibling and parentage analysis. The following actions were completed in 2016:

- Established agreement with aquaculturist in Arkansas to work with Black Carp in Arkansas facility, to begin in calendar 2017.
- Obtained permit from the state of Missouri to hold Black Carp at CERC and to perform laboratory tests with them.
- Developed prototype of the glass bead (a sealed glass tube).
- Purchased Black Carp from commercial facility.
- Continued to work with collaborators on commercially captured and state agency-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.

Proposed Actions for FY 2017:

- Using readily available *Corbicula* clams, determine bait particle size selectivity for Black Carp, including largest particles eaten readily compared to target size Black Carp (important because larger baits will exclude more non-target fish, and simplify attachment of toxic bead)
- Test prototype beads for delivery of toxicant. Determine propensity of hollow glass beads to be broken when attached to a bait and eaten by Black Carp. If necessary, assess different attachment methods and determine method most likely to result in breakage by pharyngeal teeth.
- Determine isomers of antimycin present in purchased antimycin, for determination of relative toxicity of the bait.
- Complete trials of oral toxicity of antimycin to Black Carp. Assess behavior of carp that consume piscicide-bearing glass beads. Determine minimum dosage required to result in mortality of most Black Carp that consume and break the bead.
- Initiate testing of acceptability of different baits, such as boilies and different live mollusks
- Continue to work with collaborators on commercially captured Black Carp, to provide aging and diet information from captured fish, to inform directions of diet selectivity research.
- Perform gonad histology on captured Black Carp large enough to be potentially mature; if possible, determine age at maturation and time of year that fish are spawning.
- Perform sibling parentage analysis of Black Carp genetic material to determine minimum number of spawning individuals among approximately 100 wild-collected fish.

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

- Complete food item selection, including unionid mussels with morphology similar to threatened or endangered species.
- In laboratory, assess non-target mortality in other fishes that might consume the bait (catfishes, common carp, and freshwater drum).
- In Arkansas ponds, design and test trays for efficacy in retention of bait and acceptability as feeding stations to native Black Carp.
- Initiate pond tests with toxic baits (live or artificial).
- Submit publications on food particle size selection and oral toxicity of piscicides to Black Carp.

- Submit publication on genetic work on Black Carp.
- Initiate investigation of registration of Black Carp toxic bait, and feasibility of deployment of baits.
- 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.
- Perform gonad histology on captured Black Carp large enough to be potentially mature; if possible, determine age at maturation and time of year that fish are spawning.
- If Black Carp diets from gut analysis of wild fish is still unsatisfactory, develop Black Carp DNA blocker, the first step in the analysis of Black Carp gut fluids to determine diets.
- Complete pond tests with toxic baits.
- Begin preparation of publication on efficacy of technique, including potential non-target toxicity.
- Assess the effects of antimycin bead attachment on unionid mussels, determine attachment method with low impact on survival.
- Begin Black Carp eDNA collections near important concentrations of mussels, including endangered mussels. Compare to other locations of low mussel density.
- Continue development of procedures using DNA analysis of gut contents to assess diets.

Deliverables:

- Complete trials of oral toxicity of antimycin to Black Carp.
- Assess behavior of carp that consume piscicide-bearing glass beads.
- Determine minimum dosage required to result in mortality of most Black Carp that consume and break the bead.

Expected FY 2017 Milestones: Ongoing work with milestones expected in out years**.**

Outcomes/Outputs:

- The expected product would be a bait that 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 bead or tube containing antimycin).
- Regulatory hurdles in deployment of the developed bait.
- Unknown difficulties in development of artificial baits that are attractive to Black Carp
- Finding alternative live baits that will not themselves become invasive.

71. Develop and Implement Education Materials and Lesson Plans in Coordination with Teachers to Further the Asian Carp Response in the Midwest

Lead Agency: NPS, FWS and Illinois DNR

Agency Collaboration: USFWS, Illinois DNR, and all ACRCC partners

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0/TBD**	**$75,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:

Building on the successes of the ACRCC Communications Group, NPS proposes to work with teachers to develop and deliver education materials to expand communications about the urgency of this issue. NPS works closely with Teachers and could help build lesson plans that utilize the ACRCC messages in educating students and community members about preventing the spread of Asian carp.

Proposed Actions for FY 2017:

- Hire term education specialist position with NPS.
- Compile existing resources, materials and information on asiancarp.us website.
- Contact stakeholders in the Great Lakes region who work on this issue to assess approaches and possible collaboration.
- Design Asian Carp Traveling Trunks for educators.
- Create Asian Carp Lesson Plan for middle and high school educators.
    - Research and focus groups to understand need and appropriate target audience
    - Develop a pilot lesson(s)
    - Test the pilot by teaching the lesson several times. Work with teacher(s) to test and provide feedback.
    - Revise as necessary and create final lesson plan(s)
    - Make the lesson plan(s) widely available by posting online.
- Host a one-day teachers workshop (ideally with credit) to teach the content, lesson, and provide the materials necessary for teachers to implement in their own classrooms. Workshops could be done in multiple locations.
- Explore Citizen Science engagement approaches.
    - Develop and begin implementation of a detailed lesson plans that primarily are aimed at prevention and early detection information and deliver these lesson plans via web-based systems.
    - Further develop Citizen Science engagement through these lesson plans.
    - Develop a social media strategy specifically targeted at Teachers and students. The strategy will include best practices, content, and messages for communicating with these audiences over platforms that favor visuals and concise, consistent messages.

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

- Build and Distribute Asian Carp Traveling Trunks.
- Host at least three more one-day teacher workshops (ideally with credit) to teach the content, lesson, and provide the materials necessary for teachers to implement in their own classrooms.

- Continue adding existing resources, materials and information on asiancarp.us website
- Begin Citizen Science program, if FY17 discussions support this effort.
  - Possible work includes: Expand implementation of citizen science to additional communities.
  - Develop lesson plans for citizen science activities involving the monitoring of Asian carp; Create a toolkit for citizen science to allow teachers, community leaders, and other educators to implement their own programs

Expected Completion Date for Project: T**BD**

Expected FY 2017 Milestones:

- Design Asian Carp Traveling Trunks for educators by June 2017.
- Create Asian Carp Lesson Plan for middle and high school educators and hold one-day teacher workshop to teach the content, lesson, and provide the materials necessary for teachers to implement in their own classrooms by August 2017.

Outcomes/Outputs:

- Asian Carp Traveling Trunks for educators.
- Compilation of educational resources on asiancarp.us website.
- Asian Carp Lesson Plan for middle and high school educators.

Potential Hurdles:

- Coordination of a large number of perspectives to build lessons around those messages.

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 MRP and monitoring efforts and plans.

Funding Table

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$2,000,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Work will include a continuation of extensive monitoring efforts in elevated risk areas to detect the presence of Asian carp and remove them, as necessary. These areas are those previously identified through waterway characterization as preferable Asian carp habitat, extensive sampling, or where previous eDNA sampling indicated the presence and persistence of Asian carp DNA in the area at the time of sample collection. Monitoring of these elevated areas will include personnel services, equipment, commodities, and contracts to meet accomplish 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 zooplankton, 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 heighted awareness directly downstream of electrical barrier system.
- Identify sampling protocols to evaluate Lake Michigan harbors and nearshore areas for
- Continue to statistically evaluate monitoring program and evaluate for efficiencies in program, gears, and coordination of efforts.
- 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, test contingency plan, and 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 in 2017.

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

Proposed Actions for FY 2017 and Out-years:

Fixed Site Monitoring Upstream of the Dispersal Barrier

These activities will continue in 2017at the same level as 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 inspring (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

twenty-four 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 has been included in the 2016 Monitoring and Response Plan and shared and vetted with ACRCC partners.

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 IIA and IIB 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 the 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:

- Update program documents.
- Develop supplementary documents.
- Support related meetings.
- Facilitate public meetings.
- Present Incident Command System training and exercises.

Expected FY 2017 Milestones:

- Evaluation of threat in CAWS both above and below the electric barrier system.
- Maintain high level of surveillance and increase efficiency and information from surveillance efforts.
- Contract commercial fishing surveillance in the CAWS both above and below the electric barrier system.
- Application of new gear into surveillance as warranted.
- Monthly reporting of monitoring results to www.asiancarp.us and informing ACRCC partners.
- MRWG meeting to share and communicate significant findings as well as identifying needs to modify or update current monitoring plans as needed. Quarterly updates via teleconference or face to face.
- Support and facilitate Action Plan development and implementation.

Outcomes/Outputs:

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

Potential Hurdles:

- Unidentified pathways for expansion of Asian carp.
- Timeline of funding and prevention of timely allocation of resources.
- Very large system to find very rare fish.
- Changes in population dynamics (significant increases in abundances of Asian carp moving close to or toward the barrier; or presence of small (< 4 inch) Asian carp in the vicinity of the barrier

would challenge ability of current plan to further restrict lake-ward movement of Asian carp populations (would need to implement additional or other control techniques).

- Administrative challenges to identify new Lake Michigan position.

New Actions in 2017:

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

31. Illinois River Stock Assessment/Management Alternatives

Lead Agency: Illinois DNR

Agency Collaboration: Southern Illinois University, Feeding Illinois

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$300,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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 a 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 percent 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.

In 2014 the project gathered 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 website 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 website.

Proposed Actions for FY 2017:

- Gather and share (communicate) basic information regarding ongoing market driven economy, industry developments, and carp populations to decision makers and managers to understand existing effort to prevent upstream migration and to facilitate information of ongoing efforts to public sector.
- Data analysis is ongoing but Asian carp abundance appears to be holding at a low level as in 2012-2014, and decreasing in the most upstream reaches. Record recruitment suggests many smaller and juvenile fish may have the opportunity to migrate upstream and challenge our ability to remove/harvest within Upper Illinois River. Evaluation of this data throughout 2016-2017 will highlight areas in need of further or even modified targeted efforts to further goal of contracting population of fish away from sensitive areas or pathways toward Lake Michigan.
- Specifically gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams) to prevent upstream movement, in part identified in the Great Lakes/Mississippi River Interbasin Study (GLMRIS) and support decision making processes in developments of alternative and/or additional measures. These will include:
  - Telemetry efforts
  - Hydro-acoustic/side scan sonar efforts
  - Traditional and contracted monitoring efforts
  - Mark-recapture studies
  - Collating dam operation guidelines to facilitate operational control (if practicable)
  - Provide rapid response and emergency hydro-acoustic efforts if necessary
  - Real time water quality monitoring along with hydroacoustics may allow for correlation of habitat and fish biomass that can further enhance removal and modeling efforts
- Information from these efforts can inform harvest strategies and inform managers on potential for infrastructure modification, operations, or design at or near lock chambers or other locations where fish may by-passing bottlenecks.
- Provide insights from recently developed spatially explicit movement model and provide review results, with suggestions on how to 1) validate model 2) inform harvest strategy to maximize results

Expected FY 2017 Milestones:

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

Outcomes/Outputs:

- Ability to transfer knowledge, management actions, and control technologies obtained from Asian carp activities to national or international levels.
- Conveyance of information to the ACRCC regarding control efforts to reduce the density of Asian carp approaching the Great Lakes.
- Prediction of effects of harvest and other control efforts on movement of Asian carp populations toward the Great Lakes.

- Determination of potential impact of Asian carp on native fish and other ecosystem parameters if the carp invades the Great Lakes.
- Reduced upstream passage of Asian carp.
- Overall reduced populations of Asian carp in upper 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 2017:

- Efforts will be heightened in 2017 in applying model results to removal efforts as appropriate.
- Real-time water quality monitoring along with hydroacoustics surveys may allow for correlation of habitat and fish biomass that can further enhance removal and modeling efforts

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	Asian Carp GLRI Funding
FY 2017	**$0**	**$1,400,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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 website 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 website.

Efforts were 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.

Proposed Actions for FY 2017:

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. This project allows for personnel services, equipment/gear and commodities for agency support, and contracts for fishing as well as any necessary contracts for fish removal or staff monitoring personnel.

Expected FY 2017 Milestones:

- Annual observance of reduction of biomass of Asian carp detected in river reaches below the electric barrier system thus reducing the threat of challenges to the barrier 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.
- Further develop orchestrated removals e.g. Unified Fishing Methods in new areas. At least one unified fishing method will be performed in 2017.

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.
- Ensure significant personnel/crews with experience fishing multiple gears in riverine conditions are able to respond rapidly for early detection and rapid responses.
- Assess 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.
- Perform 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 2017

- Efforts were heightened in 2016 to remove more Asian carp in several ways, 2017 sampling will continue to consider the following but anticipates 2016 levels of efforts, perhaps assigned in new areas as data and fish populations suggest:
  - 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.

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

Lead Agency: Illinois DNR

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$150,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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.

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.

Additional emphasis on small fish detection occured 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 were coordinated with USFWS small fish sampling crews to facilitate comparisons of efforts to maximize ability to detect and characterize this life stage.

Proposed Actions for FY 2017:

- Will fish pound nets in new locations e.g. Peoria Lake and possibly unified fishing method.
- Further 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.
- Continue 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 FY 2017 Milestones:

- Demonstrate gears and unique deployments to use in lower Illinois Waterway where fish abundance is high to further enhance removal.
- 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 gear may be more expensive and require additional equipment to deploy as compared to traditional fisheries gear.
- Gear may catch fish where they are abundant, but may not increase ability to catch fish significantly where they are very rare.
- Gear may not be safe to deploy in various habitats.

New Actions in 2017:

- Deployment of a mobile, electric barrier system depends upon initial deployments and findings in fall of 2016.
- Evaluation of mobile, electric barrier system efficacy on fish and safety.
- Additional unified fishing methods in new locations as practicable.
- 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.

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	Asian Carp GLRI Funding
FY 2017	**$0**	**$300,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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 website 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 website.

Proposed Actions for FY 2017:

- 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 FY 2017 Milestones:

- Increase enforcement and establish expectations regarding live fish sales in Illinois.
- Establish consistent enforcement and understanding in Illinois and train surrounding states in same consistent enforcement techniques.
- Increase coordination with City of Chicago, and USFWS in these issues.

Outcomes/Outputs:

- 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	Asian Carp GLRI Funding
FY 2017	**$0**	**$500,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: The USACE characterized the likelihood that a viable aquatic pathway exists at Little Killbuck Creek, Ohio, and that would allow transfer of AIS between the Great Lakes and Mississippi Rivers Basins. This was accomplished by evaluating the hydrologic and hydraulic characteristics of the site based on readily available information, and conducting a species-specific assessment of the abilities of potential AIS to arrive at the pathway and cross into the adjacent basin. The potential aquatic pathway site is located in Medina County, Ohio, just north of the Wayne County boundary and approximately 30 miles southwest of Cleveland. At the north end of the location is the village of Lodi and at the southern end is the village of Burbank (in Wayne County). The land use in the vicinity of the Little Killbuck Creek location is primarily agriculture, patches of woodland, wetlands, and rural residential development.

There is a medium probability of an aquatic pathway existing at this location. The rating indicates the following two probabilities exist: (1) an intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a ten percent annual recurrence interval storm; and/or (2) a location with a wetland spanning the basin divide which maintains significant ponds that are likely to become inter connected with streams on both sides of the basin divide from a ten percent annual recurrence interval storm. Based on site investigations, there is an existing agricultural ditch system at an active farm spanning the divide and connecting both basins from between a 2 and 5 percent annual recurrence interval event. Pumps within this drainage system are utilized to transfer water from the fields into either basin while check valves create the ability to bring water from either basin into the ditch system for irrigation. Additionally, roadside ditches in the vicinity of the pathway span the divide and allow wetland systems to become hydrologically connected during storm events.

As a result of this medium rating for the probability of an aquatic pathway existing at Little Killbuck Creek, the viability of this pathway for specific AIS of concern was then evaluated by looking at the biological requirements and capabilities of the 12 AIS listed below.

- Silver Carp
- Bighead Carp
- Black Carp
- Northern Snakehead
- Skipjack Herring

- Inland Silverside
- Threespine Stickleback
- Ruffe
- Tubenose Goby
- Parasitic Copepod
- Viral Hemorrhagic Septicemia virus
- European fingernail clam
- European stream valvata

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, Bighead 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 ODNR 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: ODNR met with the Medina SWCD and the local NRCS representative to discuss the LKC GLMRIS study.
- September 19, 2013: ODNR, 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: ODNR 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 ODNR Director met with the primary landowner and media to discuss the project.
- March 17, 2014: ODNR met with Medina SWCD and NRCS to discuss the NRCS alternatives.
- April 24, 2014: ODNR, 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 ODNR 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 completed the preliminary design for closing the LKC connection.
- January 27, 2016: Met with the primary landowner to discuss the preliminary design. The landowner was supportive of moving ahead with the final design.
- September 1, 2016: The consulting firm NTH was selected to develop final designs for closing the LKC connection.
- September 30, 2015: Kabil Associates completed the preliminary design for closing the LKC connection.
- January 27, 2016: ODNR met with the primary landowner to evaluate and determine the preferred alternative for closure. This alternative is based on cost and potential impacts to local landowners.
- September 1, 2016: ODNR will contract with NTH 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 framework funding (F13AP00884 - $250,000.00 and F15AP00874 - $96,117.00) and an additional $150,000 in FY2016 funding.

Proposed Actions for FY 2017:

- April 2017: ODNR anticipates having 50 percent plans developed.
- May 2017: ODNR 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.
- August 2017: ODNR anticipates having final design plans for the closure of the LKC connection.
- August 2017: The contractor will submit the necessary permits for the project.
- August 2017: ODNR and NRCS will work with affected parties to develop compensation packages for project impacts.

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

- ODNR will initiate closure of this connection.
- Closure will be completed.

Expected FY 2017 Milestones:

- August 2017: Final closure design will be completed.

Outcomes/Outputs: Closure of the LKC connection to impede 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.

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 (MDNR); U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (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	Asian Carp GLRI Funding
FY 2017	**$0**	**100,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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, ODNR). 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, ODNR, 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, which currently cannot be validated. 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, ODNR, 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, MDNR and ODNR 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 MDNR, 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, ODNR and MDNR 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 ODNR regarding targeted response efforts including:

1) Grass Carp continue to exist in Lake Erie at low abundance levels (if invasion is occurring, they are very early in the invasion curve).
2) Multiple agencies can effectively implement a broad or targeted response action while preserving staff health and safety.
3) Existing information is not adequate to affect meaningful actions for control/eradication
4) 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 the vision of an effective control/eradication strategy (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 ODNR 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:

1) Grass Carp continue to be in low abundance and widely distributed during non-spawning periods (LEC/USFWS surveillance).
2) Some natural reproduction for Grass Carp is occurring in Lake Erie (USGS/MDNR otolith microchemistry)
3) Grass Carp are utilizing specific tributaries periodically for reproduction (USGS/UT Sandusky River egg sample collections).
4) 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 (MDNR/ODNR acoustic telemetry).

For this project, ODNR is proposing to combine previous knowledge with additional information gained through our 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 described below were funded and are ongoing, in collaboration with MDNR, ODNR, USGS, UT, Michigan State University, and Central Michigan University.

Ploidy, Natal Origin, surveillance project

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

Habitat Use Project

1) Identify tributary use of Grass Carp in western Lake Erie.
2) Determine how far upstream fish migrate and locate areas of spawning aggregation.
3) 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 ongoing 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.

In FY 2015, the MDNR and ODNR continued to collaborate with partners to address the objectives listed above. 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 ODNR 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 and 2016, 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 Grass Carp the collection of larvae.

In FY 2016, information was developed 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) provided both space and time-bound predictions of adult Grass Carp aggregations. The specific actions for FY2016 include:

- Continued to supplement ongoing USGS/UT early life history sampling for Grass Carp in the Sandusky River.
- Further developed and analyzed hydraulic models and coupled with egg stage development information, predicted locations of fertilization for collected eggs.
- Analyzed all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry, in partnership with Central Michigan University and USGS.
- Estimated age, growth rates, and maturity status of all Grass Carp removed from the Great Lakes, in partnership with USGS.
- Communicated results and represented Ohio at regional Asian Carp meetings (i.e., ACRCC, Great Lakes Panel for Aquatic Nuisance Species, GLMRIS Executive Steering Committee, etc.).
- Hosted a Sandusky River Grass Carp Action Planning Meeting in Port Clinton, Ohio with representatives from Ohio DNR, Michigan DNR, Illinois DNR, Ontario Ministry of Natural Resources and Forestry, Michigan State University, University of Toledo, USFWS, USGS, and Great Lakes Fish Commission in September 2016. The status of current Grass Carp research and monitoring activities was discussed as well as a group discussion regarding FY2017 and FY2018 potential planned responses based on the research / monitoring results.

Proposed Actions for FY 2017:

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 Gras 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 targeted traditional gear sampling plan using information from FY 2016 activities at specified locations in the Sandusky River.

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

- Continue to supplement ongoing USGS/UT early life history sampling for Grass Carp in the Sandusky River to measure potential reproductive response of action
- Analyze all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry in partnership with CMU and USGS

- Estimate age, growth rates, and maturity status of all Grass Carp removed from Lake Erie, in partnership with USGS
- 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 a planned exercise using traditional gear at specified locations in the Sandusky River, building on the efforts in Item 5 listed above in 2017.
- Incorporate findings into Ohio's Asian Carp Tactical Plan Risk/Return Matrix.

Expected FY 2017 Milestones:
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 planned AIS 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 resources 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 (and other Bighead cCarp) management and control throughout the basin.

Potential Hurdles:
- 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.

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

Lead Agency: USCG

Agency Collaboration: USACE, Illinois DNR

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$73,000**	**$0**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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 acquires additional resources to establish a temporary vessel traffic service that tracks delayed vessels and facilitates the orderly resumption of traffic after the closure is lifted.

Sector Lake Michigan and Marine Safety 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 a RNA (33 CFR 165.923) on the waters located adjacent to, and over, the electric fish barrier. The RNA prescribes requirements for vessels passing over the barrier to protect them from hazards associated with the barrier. This Temporary Interim Rule also established a safety zone that restricts vessels from transporting non-potable water across the barrier with the intention of discharging the water on the other side.
- 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.
- The draft NPRM, which is still under review by Dpi and Dl, will update the current restrictions listed under 33CFR 165.923. In particular, the proposed NPRM removes current requirements that have been deemed unnecessary or ineffective from the RNA. They also clarify discrepancies between sections .923 and .930, harmonizing the boundary limits for the Safety zone and RNA to alleviate boundary confusion. These changes reflect information collected from field units, industry, and the USCG R&D marine safety risk assessment in 2013. Selected items included in the proposed NPRM to be listed under section .923 instead of the Safety Zone are:
  - Removing bow boat requirements for flammable liquid cargoes. Facility handling such cargoes ceased operations in 2012.
  - Reclassifying the restrictions on "non-potable" water discharge under Section 923 with the RNA.
  - Potential removal of wire rope to prevent electrical arcing and considering other means of maintaining electrical connectivity between tows.
  - Establishing a no wake zone to all vessels in RNA.

Proposed Actions for FY 2017: 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.

Proposed Actions Potential Out-year Actions (Subject to Future Appropriations): Onging efforts..

Deliverables: The USCG will continue to manage the waterways through its authorities when Asian carp control measures are being tested, constructed, or operated.

Expected Completion Date for Project: None. Activities are carried out on an as-needed basis

Expected FY 2017 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.
- The USCG will tailor its ability to carry out short-term waterway management closures/restrictions. However, any long-term closures would be extremely difficult to sustain enforcement.

41. Brandon Road Lock and Dam Risk Assessment

Lead Agency: USCG

Agency Collaboration: USACE, Illinois DNR

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$2,000**	**$200,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Research how new species control technologies can influence the scope of potential risk-loss opportunities at Brandon Road Lock and Dam 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. Investigate whether control measures or potential changes to present operational procedures lead to marine-safety risk scenarios that need further evaluation.
4. Tabulate and develop risk scenario matrices.

Summary of Actions to Date: The Great Lakes & Mississippi River Interbasin Study (GLMRIS) 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 and 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 of a technology malfunction.

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, testing, and evaluating alternative control measures for submission in their Tentative Selective Plan (January 2017). Consequently, there is no timeline established for USACE control evaluations, construction, or final safety testing.

Proposed Actions for FY 2017: USCG seeks RDC assistance in the following areas:

- Early identification of USACE engineering and safety 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.

Proposed Actions Potential Out-year Actions (Subject to Future Appropriations): Develop quantitative planning forecast documentation to identify, prioritize, and analyze how strategic changes to mitigation and implementation of mitigation measures relate to marine safety risks.

Deliverables: A *preliminary* marine safety risk assessment for the area of the Des Plaines River in the vicinity of Brandon Road Lock and Dam, taking into consideration commercial and recreational vessel operations and activities, and how the range of invasive species control measures, now under consideration, might affect the safety of waterway activities. Follow-on work to this preliminary assessment will include additional data collection and analysis of existing standard operating procedures, and examining the feasibility of alternative vessel operational procedures.

Based on an approved Tentatively Selected Plan:

- 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.

Expected Completion Date for Project: Ongoing

Expected FY 2017 Milestones:

- Q1 2017: Completion of preliminary risk assessment

Outcomes/Outputs: Assist the USACE in the test design process to minimize the need for independent USCG follow-up testing and reduce the USCG approval process 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.
- At this time, beyond a preliminary risk assessment, there are too many variables and uncertainties to accurately quantify risk. Each of the variables associated with the proposed control measures need individualized examinations before combining them into an assessment that evaluates them as a system. A full-scale qualitative risk assessment would not be possible until barrier testing (at this time USACE estimates to be in 2022), based on the need to accurately identify the extent of the electrical field in the modified waterway.

42. Electric Barrier Construction and Operation Risk Assessment

Lead Agency: USCG

Agency Collaboration: USACE, USEPA

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$2,000**	**$200,000****

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

** Funding level includes ***additional*** safety testing, if necessary, to augment USACE ERDC-CERL tests.

Project Explanation: Coordinate CG and USACE safety and electric field testing for "new" CSSC Barrier I at Romeoville, Illinois. 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 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 to initially 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

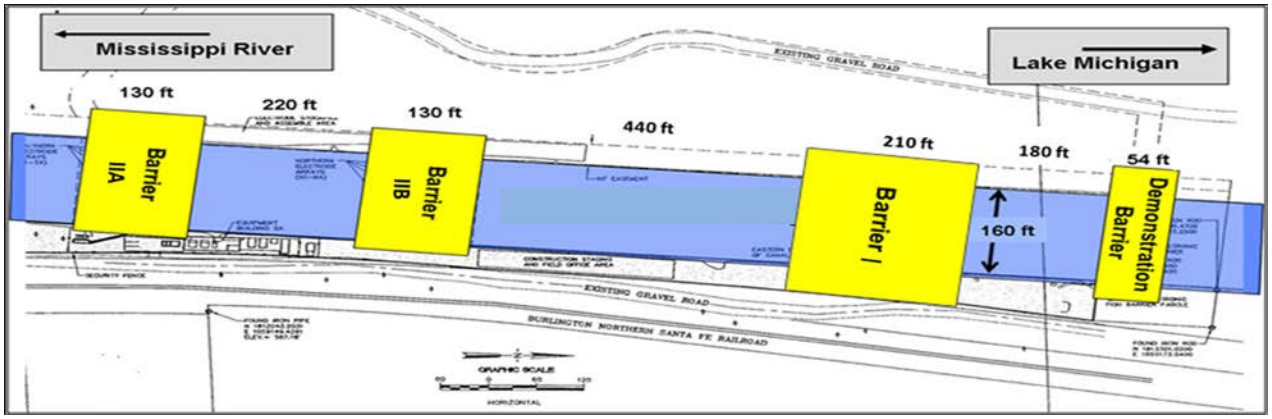
completed a formal, quantitatively-based marine safety risk assessment related to operation of the barriers.

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 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 early FY 2018) the USACE intends to conduct a series of engineering and safety tests to determine the physical effects of vessel traffic interaction with the electrified waters near the barrier system. The 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.



Proposed Actions for FY 2017: USCG seeks RDC support in:

- Help the USACE develop appropriate safety tests to evaluate risks posed by the barrier system vessel traffic, personnel and facilities operating on or in the vicinity of the electric barrier once Barrier 1 is activated.
- Interpret the results of preliminary USACE engineering & safety 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, mariners, or waterfront facilities and personnel.
- Recommend additional mitigation measures (to update 33 CFR §165.923) as appropriate based on USACE and, potentially, RDC testing.

Proposed Actions Potential Out-year Actions (Subject to Future Appropriations): Continue safety testing and analysis and update risk assessment model.

Deliverables:

- Participation in safety testing plan development and execution. Review, comment, and recommendations on USACE ERDC work.
- An updated marine safety risk assessment for the area of CSSC in the vicinity of the Barrier IIB, taking into consideration commercial and recreational vessel operations and activities, as well as the facilities operating in the vicinity of the barrier, and evaluate how the addition of this barrier might affect the safety of waterway activities.

Expected Completion Date for Project: Marine Safety Operational Risk Assessment: FY 2018

Expected FY 2017 Milestones: None.

Outcomes/Outputs: Assist the USACE in the test design process to minimize the need for independent USCG follow-up testing and reduce the USCG approval process 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: None

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

Lead Agency: NOAA GLERL

Agency Collaboration: Army Corps of Engineers; University of Michigan CILER; USGS-GLSC, Michigan DNR

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$179,905**	**$159,590**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Invasion of Asian carp into the Great Lakes could have substantial economic and ecosystem impacts. Quantifying this impact through modeling is important, in part, to provide economic justification of proposed large capital federal investments in infrastructure, such as the Brandon Road Lock and Dam project, to ensure a hydraulic separation between the Great Lakes and Mississippi River watersheds. Recent modeling studies have shown that on Lake Erie, Asian carp could comprise 34 percent of the fish biomass in 20 years, severely impacting existing commercially and recreationally valuable species. Modeling of potential effects of Asian carp on other Great Lakes is needed to fully evaluate risk to Great Lakes ecosystems and fisheries. At present, NOAA GLERL and its university partners have the unique capability and experience needed to conduct this modeling in the time frame required by the US Army Corps of Engineers.

With additional funds in FY17, NOAA proposes to continue modeling the potential risk of Asian carp (bighead, silver, and grass) on Great Lakes food webs, expanding to Lake Ontario and Lake St. Clair. NOAA will use the Ecopath with Ecosim (EwE) model to simulate Silver and Bighead Carp effects on the Lake Ontario food web. In future years, NOAA also proposes to simulate effects of grass carp on the Lake St. Clair food web. Lake St. Clair 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.

Summary of Actions to Date: NOAA has completed EwE model simulations of Silver and Bighead Carp effects on Lake Michigan, Lake Huron (Saginaw Bay and main Basin) and Lake Erie, and are writing up results of that analysis. Two other types of ecosystem models were also used to assess effects of Silver and Bighead Carp on Great Lakes food webs in Lake Huron, Lake Erie and Lake Michigan. The EwE model assesses Silver and Bighead 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 (IBM) was used that includes temperature as a forcing variable and tracks bioenergetics growth and metabolism in individual Silver and Bighead Carp and selected fish species within nearshore or offshore habitats. The Atlantis Ecosystem model was also used to simulate population dynamics and predator prey interactions of Asian carp and key resident fishes within heterogeneous habitats in each Great Lake, and include effects of lake physics and chemistry. Atlantis model simulations of Silver and Bighead Carp effects on the Lake Michigan ecosystem were completed, and results for a journal paper are being developed. NOAA has finished configuring the Atlantis model for Lake Erie and are beginning configuration of the model for

Lake Huron. NOAA is writing up IBM model simulations of Asian carp effects on a nearshore fish community in Saginaw Bay, and are configuring the IBM model for nearshore habitats in Lake Erie and Lake Michigan. Those model simulations will be run and results written this year.

Proposed Actions for FY 2017:

- Apply the EwE model to simulate Asian carp effects on the Lake Ontario food web.

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

- Write up model results from simulating Asian carp effects on Lake Ontario's food webs.
- Apply the EwE model to simulate grass carp effects on the Lake St. Clair food web.

Deliverables:

- Food web models for Lake Ontario.
- Estimates of potential Asian carp population size in Lake Ontario.
- Effects of Asian carp on the fish community in Lake Ontario.

Expected Completion Date for Project: Sept. 2019

Expected FY 2017 Milestones:

- Review data to configure Lake Ontario EwE model.
- Configure balance Lake Ontario EwE model.
- Complete Lake Ontario EwE model simulations.
- Summarize and distribute results for Lake Ontario EwE model.
-

Outcomes/Outputs:

- Risk assessments models for Asian carp to inform state and federal agencies in the Great Lakes on the level of ecological and economic threat.
- Risk assessment data to inform the USACE's GLMRIS evaluation of ecological effects of a proposed Brandon Road Lock and Dam Asian Carp control project.

Potential Hurdles:

- Model development timeline may be affected by delays in receiving funding.
- Inability to secure access to existing EwE model for Lake Ontario will require developing new, or updating old, models to complete work, thus extending the project's timeline.

60. Grass Carp Eradication in Western Lake Erie

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

Agency Collaboration: Ohio Department of Natural Resources (ODNR), Michigan State University Department of Fisheries and Wildlife; Central Michigan University, U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS)

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$150,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation:

Despite multiple ongoing Grass Carp research efforts in western Lake Erie, critical knowledge gaps 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 implement actions that will be identified during the scheduled structured decision making (SDM) workshops that will result in an adaptive management framework for Grass Carp control in Lake Erie. Implementation will be in collaboration with our partner agencies while continuing to support efforts to obtain information. As a reminder, the structured decision making workshops and development of an adaptive management framework is an FY16 Asian Carp Action Plan funded project that will identify activities that are deemed most effective at controlling Grass Carp in western Lake Erie. Partner collaborations will include analyzing captured individuals to determine ploidy status, natal origin, growth dynamics, and movement patterns. Commercial fishers will be used to increase targeted sampling efforts using large seines (about 3,000 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 ACRCC framework) to remove Grass Carp. Sampling and control 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 through the Great Lakes Restoration Initiative. 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 low sample sizes during previous studies increases the level of uncertainty in control plans and proposed work will attempt to decrease those uncertainties to increase control efficacy. In 2017, the additional information gained from the proposed project will be summarized and used to implement Grass Carp control efforts in western Lake Erie as well as to help evaluate success of meeting objectives identified during the SDM workshops in 2016. In addition to finalizing and implementing 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 MDNR, ODNR, Michigan State University, and Central Michigan University are addressing the following objectives,

Ploidy, Natal Origin, surveillance project: Central Michigan University

1. Identify the utility of genetic surveillance tools (i.e., eDNA) for guiding Grass Carp sampling efforts in western Lake Erie.
2. Determine the ploidy status for all Grass Carp caught in western Lake Erie.
3. Determine the natal origins for any Grass Carp caught in western Lake Erie.

Habitat Use Project: Michigan State University

4. Identify tributary use of Grass Carp in western Lake Erie.
5. Determine how far upstream fish migrate and locate areas of spawning aggregation.
6. 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.

Funds from the FY 2016 Asian Carp Action Plan were not received until September 21, 2016; as such, Michigan DNR was unable implement some of what was proposed for 2016. Although funds were delayed, MDNR funds were used to conduct early life history sampling on the River Raisin and nearshore areas of Lake Erie and the proposed work is now underway with contracts being developed. Additionally in FY 2016, the MDNR and ODNR 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, participated with sample collections, and assisted with development of reports and presentations. The two agencies played a critical role as liaisons between the commercial fishermen and university investigators. The ultimate goal of these research projects is to eradicate Grass Carp. In 2016, 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 MDNR partnered with commercial fishermen to retain Grass Carp captured from western Lake Erie for biological analyses. Specifically, 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 2016 the MDNR 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 MDNR and ODNR has been communicated during regional meetings (e.g., ACRCC and Great Lakes Panel for Aquatic Nuisance Species) and professional

conferences (e.g., Midwest Fish and Wildlife Conference and National Meeting of the American Fisheries Society).

Proposed Actions for FY 2017:

In FY 2017, our goal is to implement objectives identified in the adaptive management framework for Grass Carp eradication in Lake Erie, which is in currently in development. 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:

1) Increase targeted sampling for Grass Carp using Lake Erie commercial fishermen.

2) 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 on-going sampling in the Sandusky River, OH.

3) Analyze all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry, in partnership with Central Michigan University and USGS.

4) Estimate age, growth rates, and maturity status of all Grass Carp removed from the Great Lakes, in partnership with USGS.

5) Determine spatial and temporal patterns in Grass Carp habitat use to inform control efforts in hopes to increase effectiveness.

5) Travel to meetings 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.).

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

Plan to continue same sampling and analyses efforts described in FY 2017 actions to inform management actions per the proposed Adaptive Management Framework for Grass Carp Eradication in Lake Erie, which will be developed in 2016.

Deliverables:

- Increased commercial fishing Grass Carp control
- Increased information on life history and habitat use for feral Grass Carp in Lake Erie
- Finalized and initial implementation of Grass Carp Adaptive Management Framework for Lake Erie
- Increased communication and collaboration on Grass Carp control efforts among partner agencies in Lake Erie

Expected Completion Date for Project:

The adaptive management process is a fluid process with continuous actions to evaluate the success of meeting identified objectives. As such, the proposed implementation and evaluation of the project will be dependent on sampling/monitoring results. Michigan DNR expects that the adaptive management framework will be drafted and reviewed in 2017 and likely finalized in early 2018. The implementation, however, will be initiated prior to the framework being finalized, so annual evaluation and progress

reports will be provided and collective information collected through 2019 will provide insightful information on Grass Carp control in Lake Erie.

Expected FY 2017 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 2017 because of delays in FY 2016 funding. Michigan DNR also expects to achieve outcomes associated with activities 1-5 above on an annual basis, which will also assist with implementing the Grass Carp framework. 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 implementation of the Adaptive Management Framework for Grass Carp Eradication in Lake Erie will provide data for specific metrics that will allow for the proper evaluation of management actions, which is needed to inform the adaptive management process. The framework and evaluation process will likely be a management process 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 resources 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, or other Asian carp, management and control throughout the Great Lakes 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 spatial and temporal patterns emerge that can aid control efforts

69. Facilitation Support for the Chicago Area Waterway System Advisory Committee

Lead Agency: Great Lakes Commission

Agency Collaboration: The CAWS Advisory Committee includes approximately 35 public and private stakeholders that benefit from and have responsibilities related to the CAWS, as well as regional stakeholder groups representing commercial, recreational, and environmental interests. The City of Chicago, Illinois DNR, Illinois DOT, Illinois EPA, Indiana DEM, Indiana DOT, the Army Corps of Engineers, U.S. DOT, and the Indiana Wildlife Federation (John Goss) are ex officio members of the committee. The committee's resource group includes U.S. and Canadian federal, state and provincial agencies, tribal authorities, and regional agencies. See the attached list.

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2017	**$0**	**$75,000**	**$100,000 from the Joyce Foundation**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: The Great Lakes Commission convened the CAWS Advisory Committee in 2014 to provide a constructive forum for diverse stakeholders to build consensus on and advance progress in developing both interim control measures and a long-term solution to prevent AIS transfer through the CAWS. The Committee includes representatives from 35 public and private stakeholders that benefit from and have responsibilities related to the CAWS, as well as regional stakeholder groups representing commercial, recreational, and environmental interests. The committee aims to resolve issues and find common ground; review and provide input on both interim and long-term control alternatives; build consensus on the best path forward; secure leadership from key implementation partners; develop funding alternatives and recommendations for specific actions; and showcase opportunities to improve benefits from the CAWS while preventing AIS transfer.

Summary of Actions to Date: Since 2014, the Advisory Committee has released a series of consensus recommendations related to the Brandon Road Feasibility Study and a framework for a long-term solution to prevent AIS transfer through the CAWS while maintaining current uses of the system. With support from its technical consultant, HDR Inc., it prepared a comprehensive summary of technical evaluations assessing the risk of AIS transfer and impacts to navigation from potential ANS control measures and implications for associated issues. It sponsored a case study of the Fargo-Moorhead Flood Diversion Project that illustrated how multiple jurisdictions organized a cost-share partnership for a large water management project. Finally, it is contributing to a detailed outline of hydrologic, hydraulic, and water quality investigations needed to evaluate the conceptual elements for a long-term solution that it recommended for further study. More broadly, the committee provides a credible forum for reporting and receiving input on actions to prevent AIS transfer through the CAWS, including the work of the ACRCC, the USACE GLMRIS/Brandon Road Feasibility Study, and USGS.

In January 2016, the Advisory Committee finalized recommendations for next steps to develop a long-term solution to halt AIS transfer through the CAWS and transmitted them to the President and Congress. The committee concluded that a system of possible control points in the CAWS to address AIS transfer warranted further study and requested that funding be provided to the Corps of Engineers to complete the necessary studies. The committee emphasized evaluation of whether an AIS lock or system of AIS locks

can be effective at two-way prevention, compared to other alternatives; and whether and how control points could be implemented consistent with the mid-system locations identified in several GLMRIS alternatives. Previous recommendations related to the Brandon Road Feasibility Study. Other actions in FY 2016 included completion of technical evaluations related AIS controls in the CAWS; a case study of multi-jurisdictional cost sharing; work on an outline of technical investigations needed to further evaluate the elements recommended for a long-term solution; and an assessment of the Advisory Committee process.

Proposed Actions for FY 2017: A recent independent assessment of the Advisory Committee found great value from the group and strong support among the members to continue meeting. The proposed functions of the committee moving forward are to increase members' knowledge about the issues and about one another's concerns; foster communication and relationships among stakeholders; serve as a resource for agencies involved in AIS control in the CAWS; and taking collective action on areas of agreement. The committee's work plan focuses on the following key issues: hydrology, hydraulics, water quality implications of deploying AIS controls in the CAWS; AIS lock treatment system concepts; multijurisdictional financing options and mechanisms for securing nonfederal cost share; nonstructural AIS control actions; impacts to maritime transportation from AIS controls in the CAWS, including potential modal shifts; and impacts from AIS in the Great Lakes and Mississippi River. The Tentatively Selected Plan under the Brandon Road Feasibility Study, anticipated to be released by the Corps of Engineers in January 2017, will be a major focus of the committee, and its review and comments may form the basis for additional recommendations, should there be consensus among the members. The next Advisory Committee meeting is scheduled for October 14 at USEPA's offices in Chicago.

Proposed Actions Potential Out-year Actions (Subject to Future Appropriations): The committee will continue to review and provide input on prevention and control actions developed by federal and state agencies. This will include a major focus on the USACE feasibility analysis for the proposed plan for Brandon Road; overall work conducted by the ACRCC; AIS lock treatment concepts; outcomes from hydrology and hydraulic investigations of impacts from AIS controls in the CAWS; cost share options for construction of controls at Brandon Road; impacts to maritime transportation in the CAWS; and general review of the status, impacts and trends of AIS in the Great Lakes and Mississippi River basins.

Deliverables: The following general deliverables would apply to each fiscal year:

- Planning and facilitation support for a minimum of four Advisory Committee meetings
- Convening of monthly calls with the steering committee for the Advisory Committee
- Planning and facilitation of workgroup meetings and webinars, as needed
- Coordination with relevant agencies and organizations to secure information and speakers for Advisory Committee meetings and webinars
- Preparation of correspondence and statements from the Advisory Committee, as requested
- Mediation of key issues with Advisory Committee members
- Coordination with the Great Lakes Commission as convener of the Advisory Committee

Expected Completion Date for Project: The function and contributions of the Advisory Committee are anticipated to remain valid while federal and state agencies and other stakeholders continue to review, develop and deploy measures to prevent the transfer of AIS through the CAWS, including the work of the ACRCC and the Corps of Engineers under the Brandon Road study and the larger GLMRIS study.

Expected FY 2017 Milestones: The following are general milestones that would be anticipated in each fiscal year. Exact dates for meetings may vary based on the needs of the Advisory Committee members.

Project Oversight	Ongoing, Aug. 2016-Sept. 2017
Steering Committee	Monthly, Oct. 2016-Sept. 2017
Advisory Committee and Workgroup Meetings and Webinars	
Advisory Committee meeting #1	Oct. 14, 2016
Advisory Committee meeting #2	January 2017
Advisory Committee meeting #3	May 2017
Advisory Committee meeting #4	July 2017
Workgroup Meetings	Three, to be convened as needed, Aug. 2016-Sept. 2017
Webinars	Three, to be convened as needed, Aug. 2016-Sept. 2017
Mediation of Specific Issues	Ongoing, Aug. 2016-Sept. 2017
Communications and Logistical Support	Ongoing, Aug. 2016-Sept. 2017
Quarterly Progress Reports	To be submitted quarterly, per IL DNR requirements, Aug. 2016-Sept. 2017

Outcomes/Outputs:

- Facilitation support for four meetings per year of the full Advisory Committee and additional workgroup meetings and webinars
- General support for Advisory Committee operations (calls with steering committee, meeting agenda development, consultation with members, coordination with agencies, etc.)
- Mediation of specific issues and preparation of consensus letters and statements
- An ongoing, credible forum for stakeholder review, comment and engagement on federal, state and nongovernmental efforts to prevent AIS transfer through the CAWS
- A single, representative stakeholder forum for presenting the work of the ACRCC, Corps of Engineers-Brandon Road/GLMRIS, USGS and others
- Opportunities for high-impact, consensus recommendations from stakeholders on actions to prevent AIS transfer through the CAWS

Potential Hurdles:

- Continued funding for technical support to the Advisory Committee (currently provided separately through foundation support)
- Complete and timely reporting from federal agencies on relevant work (e.g., proposed actions under the Brandon Road Feasibility Study and long-term GLMRIS study)

72. Asian Carp Economic Development and Marketing Efforts

Lead Agency: USEPA

Agency Collaboration: IL DNR

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding
FY 2017	**$0**	**$100,000**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

Project Explanation: Additional work is needed to further and promote economic development of alternative uses of Asian carp. The end goal is to remove 20 to 50 million pounds of Asian carp per year from Illinois waterways to reduce environmental impact of this invasive species. To continue efforts to increase fishing of Asian Carp from Illinois' waterways, the ACRCC proposes to conduct a gap analysis framework and develop of an action plan. The chief aim of the analysis is to identify gaps and barriers in the business environment and market place that, if addressed, will enable fishers and processors to establish or expand Asian Carp-product-based business enterprises that will result in the annual fishing of millions of tons of the Asian Carp from the state's waterways. This analysis will be conducted under the guidance of the USEPA and IL DNR. It is not intended to be an academic or pure research exercise, but rather a focused, results-oriented analysis that will culminate in actionable recommendations aimed at significantly increasing business activity and fishing of this invasive species.

Summary of Actions to Date:

- IL DNR manages business proposals for new uses of Asian carp with assistance from the Greater Peoria Economic Development Agency.

Proposed Actions for FY 2017:

Work will begin with a review of existing research, data, former business plan submittals, and interviews of key stakeholders who can assist in elucidating the business processes involved in bringing carp products to market, and have knowledge and insight to contribute to the identification of challenges facing these enterprises. The aim of this knowledge gathering will be to assemble the necessary background information to construct a business process flow and identify sticking points that prevent businesses from utilizing Asian Carp. This research will identify where additional information and study will be needed to construct a business process flow. This research also will identify resources that potentially can assist business development such as financing, incentives, tax credits, redevelopment assistance, brownfield funding, training programs, and the like. At least one site visit to meet in person with stakeholders and a tour will be needed to understand conditions.

<u>Business Process Analysis</u>

Employing the assistance of Southern Illinois University (SIU), or other subject matter expert(s) (SME), direct other needed research and data collection identified in the first phase of work. This research is intended to be efficiently conducted and to be business oriented, as opposed to pure research or to advance the science or study of the fish itself.

Using the data and information gathered, construct the referenced business process flow. This process flow will identify the key inputs and steps that business enterprises need to take to identify a product(s)

and their pricing; develop a buyer(s) and distribution outlets, needed capital, facilities, equipment and personnel; and implement their plan, pursuing the necessary approvals, setting up operation, and initiating production. Identify the impediments preventing businesses from taking advantage of this resource and bringing products to market. Where appropriate, quantify barriers and gaps, market conditions conducive to fishing and producing products from Asian Carp, and volatility of those conditions that can threaten or cause solutions to fail.

Action Recommendations

Following the identification of gaps and barriers, prepare recommendations to remedy or reduce identified impediments. Through these recommendations, a clear, actionable plan will be proposed that will utilize existing resources, personnel, and stakeholders as well as creative solutions that may go beyond the bounds of existing efforts. Composed under the guidance of USEPA/IL DNR, this action plan will lay out a strategy or, if desired, a set of options likely to affect marked change in business activity and fishing of Asian carp, that will result in a significant yet sustainable reduction in the species population. The goal of this plan will be the fishing of Asian carp at a volume of 20 – 50 million pounds per year, creation of employment in fishing and related industries, redevelopment of underutilized land and facilities, and increase in tax revenues to the State of Illinois and its communities. A second site visit will be made to present the report.

Business Proposal Review

Contractor business proposal review services to support IDNR to evaluate business ventures. Such services may include, but not be limited to, review and evaluation of business plans and proposals, conference call and/or email communication with the business to discuss proposal, capacity of proposing business to undertake proposed venture, the business' and overall plan soundness, capitalization, performance analysis, as well as other resources businesses may avail themselves of to advance their ventures.

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

Lead the implementation of one or more action plan recommendations to increase the staff capacity and provide needed expertise. This assistance will be defined once the action plan is completed and the department decides which recommendations to pursue.

Deliverables:

- Gap analysis report
- Action Plan with recommendations for economic development efforts.

Expected FY 2017 Milestones:

- March 2017: Gap analysis and action plan report submittal.

Outcomes/Outputs:

- Create a framework to proactively stimulate wide-scale fishing and aid in responding to numerous business inquiries
- Create community and economic benefit through:
- Redevelopment of underutilized land and facilities
- Employment creation in fishing and related industries

- Increase tax revenues to the State of Illinois and its communities

Potential Hurdles:

- Support from coordinating agencies.
- Subject matter expertise input.

43. Program Support for Asian Carp Activities

Lead Agency: USEPA and USFWS

Agency Collaboration: ACRCC member agencies

Funding Table:

Funding	USFWS Agency Funding	Asian Carp GLRI Funding
FY 2017	**$75,000**	**$290,910**

*Assumes FY 2016 funding levels are carried forward and ultimately appropriated for FY 2017.

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.

Summary of Actions 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.

Funding was 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.

Proposed Actions for FY 2017: Funding will be used for Asian carp efforts to include the following:

- Response Actions, if determined necessary.
- Contract support for USEPA.
- Contract support for ACRCC.

Expected FY 2017 Milestones: None

Outcomes: None

Potential Hurdles: None

Appendix C

2017 Long Term Planning Horizon

Appendix C
FY 2017 Asian Carp Action Plan: Long-Term Planning Horizon

LONG-TERM PLANNING HORIZON

The FY 2017 Action Plan summarizes the actions that federal, state, and provincial agencies plan to implement during U.S. federal fiscal year (FY) 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 funding. The FY 2017 proposed funding was generally determined by assuming flat from the FY 2016 enacted budget. All funding numbers included in this Action Plan are subject to final appropriations decisions.

The table below outlines the many new or continuing initiatives that fall under the three focus areas of the Action Plan and includes measures of progress, completion timeframes, and future significant actions. Additional key project information and funding can be found in Appendix A and B of the FY 2017 Asian Carp Action Plan.

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Pathway Closure and Control Measures				
Construction of a new electric barrier	USACE	Completion of Permanent Barrier I	TBD	2017 – Construction of the main building for Barrier I is scheduled for completion in 2017.
Operate and maintain current barriers	USACE	All barriers will be functioning at optimum levels.	Ongoing	2017 and onwards– Continued operation and routine operations of the Demonstration Barrier and Barrier II.
Address barge entrainment	USFWS, USACE, USGS	Effective control mechanisms and BMPs will be identified and a management strategy will be developed to address barge entrainment. Existing tools and data to understand the possibility of Asian carp egg/larval entrainment will be used.	Decision support tool complete and available for use in 2018; additional refinement with new flow models or other data would be on-going. Annual software and model maintenance required.	2017 – Analysis of barge entrainment factors that leads to development of recommended guidelines for navigation BMPs, and a subsequent preliminary assessment of efficacy of those implemented actions in collaboration with maritime industry. Continued research on the efficacy of measures to mitigate against barge entrainment, including field demonstrations. Additional potential out-year actions will be directed by additional questions generated from ACRCC member agencies, CEQ, DOJ, and the maritime industry in response to findings from studies conducted during FY 2016 and FY 2017
Development of control options at Brandon Road	USACE, USGS	Chief's Report will be completed for the Brandon Road study.	Ongoing	2017 – USACE is scheduled to release the tentatively selected plan (TSP) for the GLMRIS-Brandon Road Study in the form of a draft report. When it is released, the public will have 45 days to submit comments. USGS will test sound technology and habituation of Silver and Bighead Carp in enclosures in preparation for Brandon Road deployment Potential out-year actions: USACE will endorse a recommended plan following completion of agency, policy, technical and public review of the draft report and NEPA document. This step is known as the Agency Decision Milestone.
Brandon Road technology assessment	USACE, USGS	Assess the applicability and feasibility of adding broadband sound as a deterrent at Brandon Road Lock.	Ongoing	2017 – USGS and USACE collaborating to design a deployment of complex sound at Brandon Road to assess the engineering feasibility of such a system. Potential out-year actions: USGS and USACE deploying and monitoring of complex sound at Brandon Road.

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Development of a Risk Assessment for Brandon Road Proposed Actions	USCG	Quantitative marine safety risk analysis pertaining to personnel and vessels operating in the vicinity of the installed fish barrier system and associated control technologies.	6-9 months after installation of Brandon Road Lock and Dam electric barrier and associated control technologies.	2017 - A preliminary marine safety risk assessment for the area of the Des Plaines River in the vicinity of Brandon Road Lock and Dam, taking into consideration commercial and recreational vessel operations and activities, and how the range of invasive species control measures, now under consideration, might affect the safety of waterway activities. Potential Out-year actions: Update the preliminary risk assessment to address planned and potential mitigation strategies still under development. Based on an approved the USACE's Tentatively Selected Plan, interpret the results of the USACE control measure testing during installation and/or after construction and conduct additional safety testing if USACE evaluation is insufficient or fails to properly evaluate associated risks to vessels and mariners. Also, recommending risk mitigation measures as appropriate based on USACE and, potentially, RDC testing.
CSSC New Barrier Risk Assessment	USCG /USACE	Completion of in-water and longshore testing with analysis of results as pertains to marine safety. Recommendations as to how results may affect or warrant changes to existing Safety Zone/RNA language.	9 months after initial barrier operational testing.	2017 - Test planning Potential Out-year actions: Test planning continuation, execution, and reporting.
Closure of Little Killbuck Creek pathway	Ohio DNR	Little Killbuck Creek closure will be completed.	Connection closed by October 2019	2017 and onwards: Ohio DNR anticipates having final plans developed and will work on permitting and final planning for the project. Ohio DNR will select a contractor to complete closure actions for the Little Killbuck Creek.
Closure of Ohio Erie Canal pathway	USACE	Ohio Erie Canal closure will be completed.	Connection closed by 2019	2017 – Complete regulatory requirements. Potential Out-year actions: Award construction contract.
Asian Carp Response				
Contract fishing, seining and netting.	Illinois DNR	Contract fishing and seining/netting will be on-going	Ongoing	2017 – Removal of 1 million pounds or more of Asian carp from upper Illinois Waterway to significantly reduced risk of fish transfer between basins. Potential Out-year actions – Continued removal of Asian carp.

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Development of chemical attractants	USGS	Chemical attractants used in the field to enhance delivery of microparticles and enhance physical removal using netting	Work is expected to continue past 2019 to refine methods to integrate attractants with microparticles and other removal gear	2017 and onwards – Conduct field applications of microparticle in combination with a food attractant to evaluate effectiveness in natural habitats and dosage application rate. Continue field trials with algal attractant using various types of harvesting gear and determine the most effective removal gear.
Development of contingency response plan and emergencies actions	Illinois DNR, GLFC	Contingency Plan was included in 2016 MRP	Ongoing, updated as determined necessary by the Monitoring and Response Work Group	2017 and onwards– Contingency Plan will be reviewed annually and updated as necessary to provide the most adequate support for response actions.
Control illegal transport	USFWS, USGS, State Natural Resource Agencies	Strategies to effectively enforce Lacey Act to support Asian Carp Management goals will be refined and enhanced by current technology. Regional enforcement efforts, standardization of fish hauling inspections and permit enforcement will be coordinated.	Ongoing	2017 – Develop standard operating procedures for Law Enforcement use of handheld eDNA devices; continue multi-agency enforcement efforts and communication. Potential out-year actions: Deployment of eDNA handheld devices for federal law enforcement as well as state law enforcement use; continue multi-agency enforcement efforts and communication.
Development of complex sound to alter behavior of Asian carps.	USFWS/ USGS	Sound will be evaluated for capacity to alter behavior of Asian carps under laboratory and field conditions; this includes evaluation of effective sound combinations to reduce Asian carp passage through critical chokepoints; and to herd fish to increase physical removal efforts	Pilot field study using complex sound in a river system completed.	2017 – Evaluate complex sound at Copperas Creek field site to inform implementation at a lock and dam. – Initiate identification and testing of alternative sounds (other than boat motor) or alternative patterns of sounds. – Complete research regarding Sound Pressure Levels to inform ongoing work and evaluate carp behavioral responses. Potential out-year actions: Large-scale implementation and evaluation of broadband sound at a lock approach or other identified area and long term monitoring strategies deployed. - Refinement of technology and development of additional uses will continue.

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Development of New Control Strategies and Technologies				
Development of carbon dioxide (CO_2), including registration	USGS, USACE, USFWS	CO_2 applied to reduce Asian carp passage in field locations determined by management agencies CO_2 registered as barrier/deterrent and lethal control for Asian carps and other nuisance fishes in Illinois by USEPA and other appropriate regulatory agencies. CO_2 applied to reduce overwinter survival of Asian carps and other fishes (non-selective lethal control) in field locations.	Contingent on Management Agency decisions to deploy a CO_2 barrier or to use CO_2 as a non-selective fish toxicant implemented in 6-24 months. (Engineering consultation, construction, required permits, and public comments will determine timeline.)	2017 – Conduct applied field demonstrations using CO_2 to (1) block Asian carp access to backwater areas, (2) support Asian carp fishing removal efforts, and (3) reduce overwinter survival of Asian carp in backwater areas. - Submit Section 18 permit for limited use of CO_2 in open water application as determined by management agencies and conduct studies for Section 7 Endangered Section Act concerns, as needed. Potential out-year actions: Continue evaluating CO_2 effectiveness for deterring Asian carp movement to address abiotic/biotic variables unique to specific barrier locations.
Evaluation of hot water, ozone and other chemicals, including registration	USGS	Acute toxicity testing completed for hot water, and ozone for evaluation for potential use in a two-way means of controlling passage of invasive species between basins.	Acute toxicity tests for target species completed. Registration completion dependent on the type of registration required (6 to 24 months	2017 – Complete toxicity tests on fish, invertebrates, and plants with focus on determining the best conditions/concentrations. Potential out-year actions: Assist management agency with data development/registration of one or more of these control methodologies with USEPA.

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Development of microparticles, including registration	USGS, USFWS, USEPA	Microparticle formulations developed that hold one or more control agents, are registered by appropriate regulatory agencies, and available for use by management agencies to control Asian carp.	Field trials initiated in 2017 will inform field application and formulation modification. Registration of an initial antimycin-laden formulation will continue beyond 2018.	2017 – Continue field trials of microparticles and food attractant to determine microparticle efficacy/efficiency to deliver a control agent (antimycin) to Asian carps. Obtain Experimental Use Permit for the application of antimycin microparticles at sizes relevant to management action and continue registration activities. Conduct field trials to evaluate potential ecological impacts of antimycin delivery through microparticles. Potential out-year actions: Complete large, management-scale application of microparticles to assess efficacy to control Asian carps. – Continue field trials on microparticle refinement, ecological impacts, and studies to support registration. - Registration of an initial antimycin-laden formulation.
Identify potential control technologies for Black and Grass Carp	USGS	Potential control strategies will be developed and implemented in collaboration with management agencies. FluEgg simulation model will be expanded to predict spawning and egg/larvae survival. One or more formulations of toxic bait is developed for use in controlling black and grass carp.	Enhanced FluEgg model delivered in 2017. Mapping of Lake Erie vegetation completed in 2018. Experimental Use Permit for use of antimycin-laden bait or particles may be obtained in 2018 to support larger research applications as early as 2020.	2017 – Incorporate mortality component into FluEgg and begin to assess factors that may affect FluEgg outputs. Continue mapping aquatic vegetation in Lake Erie. Develop vegetation model to interpolate areas of aquatic vegetation with inadequate imagery coverage in Lake Erie. -Continue formulation development of a toxic particle to target grass carp. Determine effectiveness of bait size, levels of antimycin toxic to Black Carp, and delivery technique for oral dose of toxicant by Black Carp. Potential out-year actions: Model aquatic vegetation for areas of Lake Erie lacking aerial imagery for Black/Grass Carp potential habitat mapping Initiate controlled studies of application of antimycin-laden baits or particles to Black Carp and Grass Carp. This work would continue, if successful to include assessments of the impacts to non-target organisms.

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Development of eradication strategies for Grass Carp in Sandusky Bay and Western Lake Erie	Michigan DNR, Ohio DNR,	Control strategies will be determined and implemented for Grass Carp in Sandusky Bay and Western Lake Erie.	Adaptive management framework document finalized in early 2018. Implementation of the adaptive management framework will be ongoing. MDNR contract and commercial fishers will be ongoing work.	2017 – Continue and supplement ongoing early life history sampling for Grass Carp in the Sandusky River. -Develop and implement intense, targeted traditional gear sampling plan using information from activities at specified locations in the Sandusky River. -Analyze all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry. Estimate age, growth rates, and maturity status of all Gras Carp removed from Lake Erie. -Conduct SDM Workshops. Develop adaptive management framework document based on outcomes from SDM process. -Partner with commercial fishers for removal of Grass Carp in Lake Erie waters. Conduct early life history sampling for Grass Carp in Michigan tributaries to Lake Erie. Potential out-year actions: Continue and supplement ongoing early life history sampling for Grass Carp in the Sandusky River to measure potential reproductive response of action. Analyze all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry. Estimate age, growth rates, and maturity status of all Grass Carp removed from Lake Erie. Implement control/monitoring actions identified during SDM workshops conducted in 2017 and that are documented in the adaptive management framework that will likely be finalized prior to the field season in 2018. Partner and contract with commercial fishers for removal of Grass Carp in Lake Erie waters.
Assess potential for use of Chinese "Unified Method" for enhancement of capture and removal of Asian carp.	Illinois DNR, USGS	Replicated removal efforts which demonstrate increased removal of Asian carps (catch per unit effort or targeted removal before critical life history events [spawning]) and reduced impact to native, non-target animals	Adaptive management framework anticipated prior to the field season in 2018.	2017 – Building on training from Chinese scientists and experience from first trial in 2016, assess the method for its potential in Asian carp population management and barrier defense in the North American political and physical environment. Conduct unified fishing event, using an adaptive strategy to further improve capture rates. Potential out-year actions: Implement Unified Method harvest in progressively larger Illinois River locations and coordinate other fishing methods with strategies informed by Unified method results.
Monitoring and Assessment				

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Monitor Great Lakes	USFWS, Great Lakes States	On-going monitoring will be used to assess risk in the Great Lakes to Inform potential focused monitoring and response actions as needed.	Ongoing	2017 and onwards – Data entered into central multi-agency database. Annual agency reports summarizing sampling efforts and findings
Monitor Chicago Area Waterway System (CAWS)/Upper Illinois River	Illinois DNR, USFWS USACE,	CAWS/Upper Illinois River monitoring will continue to assess the risk of Asian carp movement.	Annually	2017 and onwards– MRWG assembles annual interim summary reports to develop the next years Monitoring and Response Plan, including Contingency Planning. Annual updates as prudent and appropriate.
eDNA monitoring	USFWS	Continue operation of the interagency genetic early detection surveillance program for Bighead and Silver Carp in the Great Lakes and Upper Mississippi River and the Ohio River.	Ongoing	2017 – Addition of Black Carp into the Regional Surveillance program; all data incorporated into the multi-agency database. Develop new qPCR Grass Carp marker. Potential out-year actions: Incorporate data into the multi-agency database.
Refine methods for the use of eDNA to detect Asian carps	USGS	Hand-held eDNA field detection kits deployed to law enforcement officers of one or more Great Lakes state. Use eDNA to detect spawning events.	Initial transfer of this technology was completed in 2016; Refinements expected to continue through 2018 as technology improves.	2017 – Complete training and transfer of point-of-use Asian carp eDNA detection kits to state and federal management agencies. Twelve kits are available, of which four remain available for allocation. Initiate development of Grass Carp and Black Carp markers, components, and protocol for detection kits. Potential out-year actions: Transfer methods and protocol for Black Carp and Grass Carp detection to users.

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Deploy monitoring resources based on on-going risk assessment activities	MRWG (IL DNR; USFWS; USACE; INHS; SIU; WIU)	Establish a multi-gear/multi agency comprehensive monitoring program to adequately and effectively describe locations of all life stages of Bighead and Silver Carp in the upper Illinois Waterway and CAWS to prevent the establishment of these species in Lake Michigan.	Ongoing	2017 and onwards-Continue seasonal intensive monitoring of the CAWS as outlined in the MRP with both fixed and random site monitoring in both June and September 2017. – eDNA monitoring of the CAWs below the Electric Dispersal Barrier – Larval fish monitoring – Distribution and movement tracking of Asian carp through the CAWS – Removal actions based on triggers outlined in the MRP – Barrier defense actions – Telemetry monitoring of Asian carp at the Electric Dispersal Barrier – Gear effectiveness evaluation –Population assessment
Deploy Contingency response resources as needed	MRWG (IL DNR; USFWS; USACE; INHS; SIU; WIU)	Provide for the safe and effective deployment of assets to inform ACRCC and management agencies upon notification of changes that may heighted risk of Bighead and Silver Carp movement into new areas.	Ongoing, as necessary	Conduct contingency response actions based on triggers established in the MRWG Contingency Response Plan. Provide annual review/comparisons of current and baseline conditions. In absence of triggered responses, review and update contingency plan with most current information. Provide at least one tabletop exercise to increase communication and training on contingency actions.
Develop a data repository and decision support tools for Asian carp	USGS, IL DNR	Develop a web-enabled database and archive of Asian carp and other species collection data to inform Asian carp management	Data mining and compilation, database framework and visualization tool development completed in 2017. Database maintenance and refinement of visualization tools will be ongoing.	2017 – Work with researchers to compile existing Asian carp data to create a comprehensive database framework that will include existing and future data; Develop data visualization tool using database. Potential out-year actions: Continue development of comprehensive Asian carp database and visualization tools.

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Deploy real-time acoustic telemetry monitoring of Asian carp	USGS, USFWS, ILDNR, SIU, WIU	Real time tracking data from automated acoustic network are available in a web-enabled decision platform to inform response actions. Manual tracking in upper Illinois River pools to inform contract fishing and assess population levels. Development of Geotags for real time Asian carp tracking	Migration of the telemetry database and visualization tools completed in 2017 Maintenance of the database and refinement of visualization tools will be ongoing.	2017 – Install three additional real time receivers and complete range testing on newly installed receivers. Consider an additional receiver in the Sandusky River system. – Complete beta testing on web-based decision platform. All data from acoustic receivers will be incorporated to an online database for reference on USGS server. Tag Asian carp and initiate manual tracking in upper Illinois River to inform contract fishing. Initiate Geotag field test in Dresden Pool. Potential out-year actions: Install three additional receivers and complete range testing on newly installed receivers. Roll out web-based decision platform for informing contract fishing and continue development of web-enabled access and visualization. Tag Asian carp and continue manual tracking. Make first population assessments. – Complete field testing and make recommendations regarding capabilities of Geotags to be used as part of integrated pest management. - Development of visualization tools.
FluEgg Model Development	USGS	Continue assessment of egg and larvae behavior to enhance dispersal modeling in FluEgg model to better predict larval fish locations and identify potential nursery areas.	On-going	2017 – Process and analyze larval fish data to determine ability of to disperse laterally from the spawning river to nursery habitat and complete a publication on results. Using live eggs and larvae, model water flow in a laboratory setting to determine effects of settling on eggs, and on larval drift and dispersal. Potential out-year actions: Incorporate flume data into models of dispersal.
Using Acoustic Technology to Determine Asian Carp Behavior	USGS	Enhance capture efficiency of standard harvest techniques	On-going	2017 – Determine the behavior of Asian carp to avoid nets based on underwater sonar imaging technology; Determine how to change net design and deployment to take advantage of these behaviors and result in enhanced captures.

Actions	Agency(s)	Measures of Progress	Estimated Completion Timeframe	Potential FY 2017 and Out-year Actions
Develop and Assess Sterile Judas Bighead and Grass Carp	USGS	Develop and assess sterile Judas Bighead Carp and Grass Carp to assist in location and removal of fish, and assess the potential that grass carp form winter aggregations that might be targeted for removal.	On-going	2017 – Assess male triploid and diploid Bighead Carp in the laboratory for sterility and then evaluate in a reservoir to determine winter habitats and spawning movements. Potential out-year actions: Finish acoustic telemetry study of diploid and triploid Grass Carp. Recapture Grass Carp from winter habitats to retrieve archival tags and determine success at capturing tagged and untagged grass carp If verified sterile, with cooperating states, determine effectiveness of triploid Bighead Carp in locating other Bighead Carp where they are rare; publish data and provide guidance on this method.
Black Carp Monitoring Strategy and Marker Development	USFWS, Illinois DNR, USGS	Black Carp monitoring strategy will be developed to assess risk of Black Carp risk of range expansion incorporating use of a Black Carp marker for environmental DNA (eDNA), once completed.	On-going	2017 – Specific strategy for Black Carp to be developed. Identify recommendations for efficient capture of Black Carp from the gear and demographic study; incorporate early detection monitoring using eDNA, continue use of bounty program to obtain specimens for age, growth, sexual maturity, ploidy analysis, and stomach content analysis. USGS will receive Black Carp that are captured and with USFWS and SIU will take a variety of data and samples to determine age, diet, sterility, genetic analyses, including genetic analysis on stomach contents to determine diets. USFWS to perform genetic and ploidy analysis Potential out-year actions: Continued implementation of Black Carp Monitoring Strategy. Begin process of gut analysis by DNA by development of DNA blockers.
Grass Carp Monitoring	USFWS, IL DNR, USGS	Grass Carp monitoring strategy will be developed to assess risk of Grass Carp in the Great Lakes and other areas of the Illinois River, and the Upper Mississippi River/Ohio River basins.	On-going	2017: Interagency Grass Carp strategy to be developed. Grass Carp eDNA marker available for use in monitoring. Potential out-year actions: Continued implementation of Grass Carp Monitoring Strategy.

Actions	Agency(s)	Measures of Progress	Completion Timeframe	Annual Actions
Communications and Outreach				
Continue AsianCarp.us website.	USFWS	The AsianCarp.us website will be maintained as the primary public internet portal for the ACRCC; the website will be updated and scope expanded to include data and other content from other geographic areas of the United States, including the Ohio River and Upper Mississippi River basins.	Ongoing	2017 – Update to include additional content from UMRB and ORB. Update platform to include other social media outreach tools. Potential out-year actions: Update to include additional content from other basins as appropriate
Creation, implementation and coordination of a strategic ACRCC communications plan	USFWS	Scheduling and coordinating outreach events, creating branded communication products, enhancing the ACRCC's social media strategy and ultimately increasing the reach of ACRCC messaging. Provide Congressional and Executive Office briefings, as needed. Seek opportunities to engage industry and non-governmental organizations.	Communications work is ongoing	2017 – Creation of ACRCC strategic communications plan including enhanced social media strategy. -Creation of ACRCC branded communication products -Provide Congressional and Executive Office briefings, as needed. -Seek opportunities to engage industry and non-governmental organizations. Potential out-year actions: Updated ACRCC strategic communications plan
Continue CAWS Advisory Committee.	USEPA	Continue to work with CAWS Advisory Committee on Brandon Road efforts and a long term, acceptable two-way barrier system. Quarterly committee meetings.	Ongoing	2017 – Increase members' knowledge about the issues and about one another's concerns; foster communication and relationships among stakeholders; serve as a resource for agencies involved in AIS control in the CAWS; and taking collective action on areas of agreement. The group will focus on the Brandon Road feasibility study expected in January 2017. –Potential out-year actions: Continue to review and provide input on prevention and control actions developed by federal and state agencies.
Interbasin Collaboration				

Actions	Agency(s)	Measures of Progress	Completion Timeframe	Annual Actions
Identify opportunities for broader coordination on Asian carp strategic planning with other basinwide Asian carp partnerships (Ohio River and Upper Mississippi River Basins.)	USFWS, USEPA	Increase in coordination on a number of new control technologies, management practices, and model partnerships identified for implementation for Asian carp prevention and control in other basins commensurate with available resources.	On-going	2017 – Facilitate regional interbasin strategic planning to develop common management objectives, performance measures, and annual projects for use in coordinating across basins (to include Great Lakes, Mississippi River, and Ohio River basins). Potential out-year actions: Continued intra- and inter-basin coordination on development/refinement of strategies (including management objectives, performance measures, and annual projects); and, project development and implementation. Additional basins in the United States will be further included, as appropriate, in support of the goals and recommendations of the National Plan.
Identify and facilitate process for development of a broader regional/national scale strategic approach to the management of Asian carp.	USFWS	Build on existing basinwide Asian carp strategies and the National Plan, and identify and address gaps and vulnerabilities. Provide interbasin coordination to develop regional and national goals, objectives, and tactics to identify data, communication or capacity gaps for effective implementation of the National Asian Carp Management Plan: to include Great Lakes (ACRCC), Ohio River basin, and Upper Mississippi River basin, and other priority locations, as appropriate.	On-going	2017 – Facilitate regional interbasin strategic planning to develop common management objectives, performance measures, and annual projects for use in coordinating across basins (to include Great Lakes, Mississippi River, and Ohio River basins). Develop a draft National Asian Carp Implementation Strategy, to incorporate framework of the National Asian Carp Plan of 2007 and priority actions, objectives and recommendations of basin-specific Asian carp strategies. Potential out-year actions: Finalize National Asian Carp Implementation Strategy.
Risk Assessment				

Actions	Agency(s)	Measures of Progress	Completion Timeframe	Annual Actions
Evaluate potential risk of Bigheaded Carp establishment and effects on Lake Ontario food webs and fisheries. Evaluate risk of Grass Carp establishment and effects on Lake St. Clair food webs and fisheries	NOAA	Use food web models to evaluate potential establishment and impact of Bighead Carp on food webs in Lake Ontario, and of grass carp in Lake St. Clair.	2017: Food web model simulations of Bigheaded Carp establishment and effects on Lake Ontario food webs are completed and reported. 2018: Food web model simulations of Grass Carp in Lake St. Clair are completed and reported.	2017 – Develop and apply, or use existing Ecopath with Ecosim food web models for Lake Ontario to evaluate Bighead Carp establishment and impact on food webs in those lakes. –Potential out-year actions: Develop and use an Ecopath with Ecosim food web model for Lake St. Clair to evaluate grass carp establishment and impact on the Lake St. Clair food web and fishery.
Evaluate potential risk of Black Carp establishment and effects on Great Lakes food webs	NOAA	Use food web models to evaluate potential establishment and impact of Black Carp on food webs in Lake Michigan, Huron and Erie.	2017 - 2019: Complete food web model simulations of Black Carp establishment and effects on Lake Michigan and Lake Huron.	Potential out-year actions: Use existing Ecopath with Ecosim food web models for Lake Michigan and Huron to evaluate Black Carp establishment and impact on food webs in those lakes. Use existing Ecopath with Ecosim food web model for Lake Erie to evaluate black carp establishment and impact on the Lake Erie food web. Results for model simulations of Black Carp effects are submitted for publication. Complete food web model simulations of Black Carp on Lake Erie food web.

Notes:

ACRCC	Asian Carp Regional Coordinating Committee
BMP	Best management practice
CAWS	Chicago Area Waterway
DNR	Department of Natural Resources
GLMRIS	Great Lakes Mississippi River Interbasin Study
INHC	Illinois Natural History Survey
MRP	Monitoring and Response Plan
MRWG	Monitoring and Response Workgroup
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
SIU	Southern Illinois University
SDM	Structured Decision Making
TBD	To Be Determined
TSP	Tentatively Scheduled Plan
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UMRB	Upper Mississippi River Basin
USGS	U.S. Geological Survey
WIU	Western Illinois University