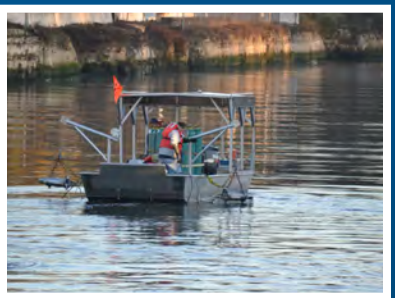
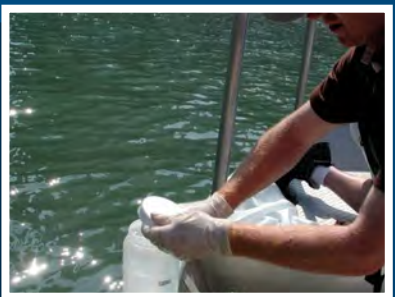
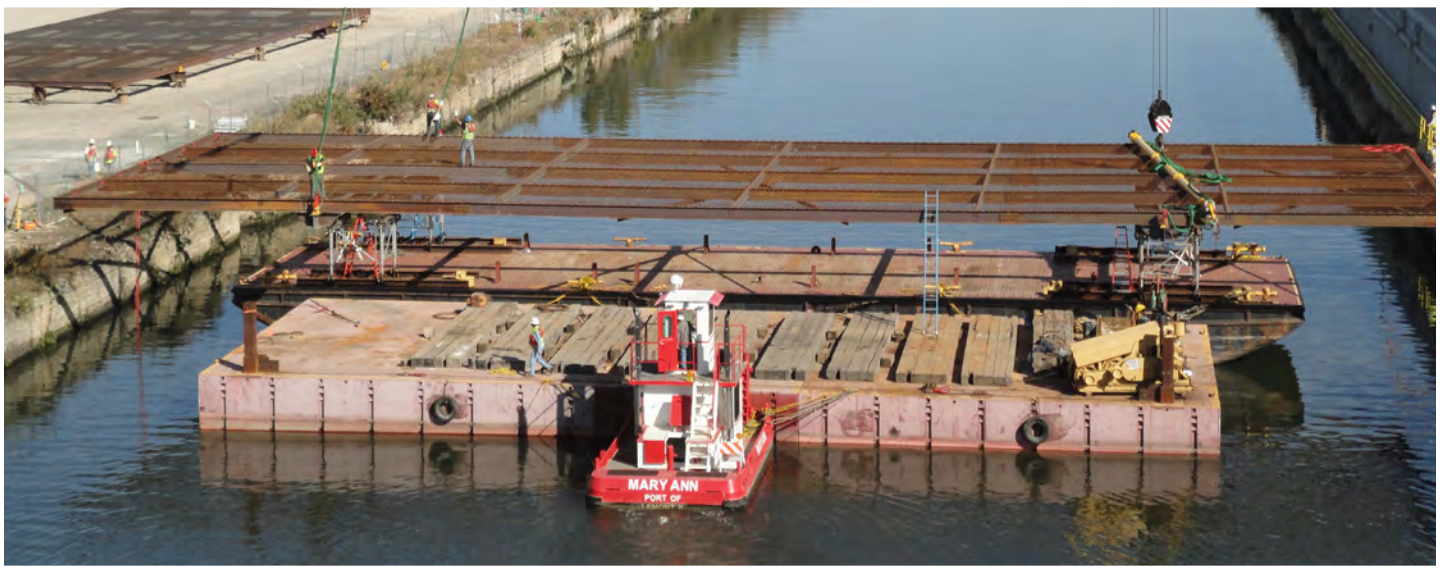




ASIAN CARP

Control Strategy Framework

July 2013



THE ASIAN CARP REGIONAL COORDINATING COMMITTEE

FY 2013 Asian Carp Control Strategy Framework

July 2013

Contributing Members:

City of Chicago
Department Fisheries and Oceans Canada
Great Lakes Fishery Commission
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
Metropolitan Water Reclamation District of Greater Chicago
National Oceanic and Atmospheric Administration
United States Army Corps of Engineers
United States Coast Guard
United States Department of Transportation/Maritime Administration
United States Department of Agriculture
United States Environmental Protection Agency
United States Fish and Wildlife Service
United States Geological Survey
White House Council on Environmental Quality

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EXECUTIVE SUMMARY

Asian carp, particularly bighead, silver, and black carp, pose a significant threat to the waters that they invade. One of the most severe aquatic invasive species (AIS) threats facing the Great Lakes today is movement of Asian carp species through the Chicago Area Waterway System (CAWS) and possibly other pathways that can connect the Great Lakes to the outside Mississippi River Basin.

The Obama Administration is implementing an unprecedented and comprehensive set of actions to prevent introduction and establishment of Asian carp populations in the Great Lakes. These actions are being carried out by the Asian Carp Regional Coordinating Committee (ACRCC), with support from federal, state, provincial, and local agencies, and from private stakeholders and citizens. The ACRCC implements actions for protecting and maintaining the integrity and safety of the Great Lakes ecosystem from an Asian carp invasion via all viable pathways. The ACRCC management strategy and current and future actions are reported annually in the Asian Carp Control Strategy Framework (Framework) (accessible at asiancarp.us). The best science available is applied to develop this Framework.

Actions that comprise the Framework's strategy are based upon the three typical stages of species invasion. Each Framework action item is categorized within one of the following stages of invasion and one of the management actions below that it would impact the most:

- Prevention and development of prevention technologies
- Monitoring and development of monitoring technologies
- Development of control technology and impact mitigation
- Other supporting actions (education, outreach, and regulatory support).

The ACRCC seeks development of an effective and fiscally sustainable Asian carp prevention and control program throughout the Great Lakes Basin. The near-term goal is to prevent entry of Asian carp to the Great Lakes, which will give the ACRCC time to complete the research and development necessary to meet the long-term goal of eradication/management through physical, chemical, and biological controls. Because Asian carp are already well established throughout the Mississippi River Basin, this program will be essential to decrease spread of Asian carp and prevent introduction of Asian carp into new waterways and inland lakes.

On-the-ground actions include studying and implementing options or controls that could prevent spread of Asian carp between the Mississippi River and Great Lakes Basins—possibly including hydrological separation to permanently solve the potential Asian carp problem at connection points along the CAWS, as well as to address other AIS. Engineering controls, biological controls, and responses to prevent further population expansion throughout the two basins are also under development and are undergoing field testing to deal with possible Asian carp introductions to the Great Lakes via other vectors such as human transport or unintentional releases.

The ACRCC has specified the following actions within the 2013 Framework:

- Provide a sound strategy for addressing the threat of an Asian carp invasion into the Great Lakes such that the Framework continues to provide direction to participating agencies and to provide modes of actions to reduce threats and identify areas of possible future mitigation of Asian carp population expansion.
- Identify an array of alternatives through the Great Lakes and Mississippi River Interbasin Study (GLMRIS) to prevent spread of aquatic nuisance species between the Great Lakes and Mississippi River basins.
- Identify efforts that supplement direct management action, such as education and outreach, or increased regulatory structure.
- Develop an effective and fiscally sustainable Asian carp control program throughout the Great Lakes Basin.
- Increase program sustainability through Framework action items such as robust control and removal efforts, and novel technology to detect and/or remove existing populations; and improve accuracy of known extent of Asian carp populations (including Dual-Frequency Identification Sonar [DIDSON], hydro-acoustic, and other remote sensing technologies). Other mitigating action items contribute to the program base and can be implemented if an emergency arises—including rotenone stockpiling, net development, and advanced fishing strategies. Further development of biological control agents will help to eradicate novel populations where they arise or to deplete existing stocks.
- Identify ongoing or potential collaboration among ACRCC entities, and specify partner roles.
- Document, track, and communicate actions of ACRCC partners in applying full authorities, capabilities, and resources to prevent introduction and establishment of Asian carp in the Great Lakes.
- Further engage with governmental, industrial, environmental, and other stakeholders.
- Initiate development of a strategy for transferring technology, decision support tools, and/or information to resource managers.
- Apply technologies and lessons learned to areas below the electric dispersal barriers and to concurrent national Asian carp efforts, where applicable.
- Build upon developed collaborative roles in the Great Lakes Basin to fully prepare for other basin-wide efforts as these arise.

This Framework is a product of the best science available. Widespread agreement exists among scientists and stakeholders that prevention measures are critical to avoid the potential economic, environmental, and social costs associated with Asian carp establishment in the Great Lakes.

In addition to the efforts described in this document as part of ACRCC strategy, the Great Lakes states and the province of Ontario continue to undertake additional efforts against Asian carp and other invasive species. Through a cost-share grant program, the U.S. Fish and Wildlife Service (USFWS) has provided assistance to states for creating and implementing an Aquatic Nuisance Species (ANS) taskforce and state-supported AIS management plans and activities. Since 2009, the Great Lakes states have invested over $26.7 million in assessment, prevention, and control of AIS —of which almost $900,000 has been committed to Asian carp control efforts. The following are previous or current efforts by the Great Lakes states and Ontario as part of their AIS prevention, management, and control programs:

- New response and rapid assessment plans developed by Great Lakes states
- State-led response actions and other control efforts
- AIS education and outreach, including increased signage to inform the public about various AIS
- Inspections and enforcement of laws regarding AIS
- AIS barrier studies and design
- AIS monitoring and surveillance.

This Framework is a living document and is a continuation of previous iterations of the Asian Carp Framework. It is designed to be inclusive, allowing government agencies and outside stakeholders to engage in developing and implementing all plausible control actions. In this Framework, potential hurdles for control and prevention are recognized, and a collaborative community is established through which a compelling plan of action can be continued for the CAWS. Preventing introduction of a self-sustaining Asian carp population into the Great Lakes requires an understanding of ecological, economic, and hydrological complexities—leading to the conclusion that a comprehensive approach (which cannot rely on only a single strategy) is necessary to prevent additional spread of Asian carp into areas currently uninvaded.

The ACRCC, with support from U.S. and Canadian federal, state, provincial, and local agencies and other private stakeholders and citizens, is working to create a sustainable Asian carp control program to prevent introduction of Asian carp into the Great Lakes via all viable pathways. This Framework lays out the strategies and proposed action items necessary to achieve that goal.

1.0 INTRODUCTION

Species of carp not native to the United States represent one of the greatest aquatic invasive species (AIS) threats to the waters of the Great Lakes. Asian carp may be introduced into the Great lakes through the Chicago Area Waterway System (CAWS) or other pathways that connect these waters the Mississippi River Basin. For the purposes of this Framework, Asian carp is limited to bighead and silver carp. However, efforts to contain black and grass carp, species of increasing concern, would also benefit from actions specified in the Asian Carp Control Strategy Framework (Framework).

The Framework has been prepared by the Great Lakes Asian Carp Regional Coordinating Committee's (ACRCC) participating agencies, states, and stakeholders (see Section 5 below) to specify actions for preventing and controlling Asian carp movement.

This section briefly presents potential impacts of Asian carp movement into the Great Lakes ecosystem, reviews the purpose of the Framework, overviews Asian carp ecology, and cites additional work proceeding outside of this Framework. Section 2.0 presents the ACRCC 2013 plan for strategic management of Asian carp throughout the Great Lakes Basin. Strategic management of Asian carp was divided into the following categories:

- Prevention and development of prevention technology
- Monitoring, including early detection/surveillance, and development of monitoring technology
- Development of control technology and impact mitigation
- Other supporting actions (education, outreach, and regulatory support).

Section 3.0 discusses the critical efforts underway as part of the overall Framework in the following areas:

- Electric dispersal barriers in the CAWS
- Great Lakes and Mississippi River Inter-Basin Study (GLMRIS)
- Monitoring and Removal
- Environmental Deoxyribonucleic Acid (eDNA) Calibration Studies (ECALS)
- Risk Assessment
- Scientific Research and Technology
- Enforcement Activities
- Federal and State AIS Management.

Section 4.0 identifies the agencies and stakeholders that participate in development of the Framework and coordinate activities of participating agencies and organizations.

Section 5.0 describes stakeholder actions likely to supplement the Framework, involve the public, and provide communication and outreach to parties outside of the participating intergovernmental agencies.

1.1 Mission Statement

The ACRCC, with support from U.S. and Canadian federal, state/provincial, and local agencies, and from other private stakeholder entities, will create a sustainable Asian carp control program for protecting the integrity and safety of the Great Lakes ecosystem by preventing introduction of a sustainable Asian carp population into the Great Lakes via all viable pathways. This Framework describes the strategies and proposed action items necessary to achieve that goal.

1.2 Situation

The geographic range of Asian carp species is expanding in the Mississippi River Basin and threatening invasion into the Great Lakes. Since the beginning of the 19th century, more than 180 non-native species have been introduced into the Great Lakes. Some of these species have become invasive: causing ecological or economic damage or threatening human health. These invasive fish, invertebrates, viruses, bacteria, and parasites can devastate native communities, as well as cause great economic damage to the Great Lakes commercial, sport, and tribal fisheries. The potential invasion of Asian carp is one of the most serious invasive species threats facing the Great Lakes today.

The ecological and economic damage in the Mississippi River watershed that followed Asian carp invasion is a forewarning of potential impacts of Asian carp on the Great Lakes. This warning has resulted in extensive mobilization of local, state, and federal agencies, and creation of the ACRCC—a unified team responsible for coordinating and conducting actions to prevent an Asian carp invasion into the Great Lakes.

The goal of the ACRCC is to execute an aggressive, multi-tiered strategy to prevent an Asian carp invasion into the Great Lakes, and to ensure vigilant monitoring for necessary response actions within the CAWS and other areas of probable early detection of expansion.

1.3 Framework Purpose and Proposed Outcomes

The Obama Administration is implementing an unprecedented and comprehensive set of actions to prevent introduction and possible establishment of Asian carp in the Great Lakes. The Administration's actions in the near term focus on preventing entry of Asian carp to the Great Lakes, which is providing the ACRCC time to conduct the research and development necessary to meet the longer term goal of carp eradication/management through biological, physical, chemical, and mechanical controls.

Implementation of the Framework actions documented herein have brought together experts and resources across U.S and Canadian federal agencies, the Great Lakes states, the Province of

Ontario, and local agencies to implement a coordinated plan of immediate preventative actions, as well as long-term efforts focused on eradication/management of the Asian carp. This Framework highlights the ongoing efforts of the ACRCC and its member agencies; it also provides strategic guidance regarding current and proposed actions to combat Asian carp within the Great Lakes Basin.

To coordinate prevention of Asian carp entry into the Great Lakes and control efforts in areas where they are already established, the ACRCC first released the Framework in early 2010. Previous Framework editions had listed respective goals, milestones completed, funding sources, and responsible agencies for each management action underway by ACRCC entities or collaborative partners. Increased knowledge of Asian carp and expansion of ACRCC membership since publication of the 2010, 2011, and 2012 Frameworks have exposed the need to describe how the projects have collectively addressed the Asian carp invasion. The 2013 version of the Framework is a product of recent actions, lessons learned, and a desire to move from a phase of research, monitoring, and evaluation to implementation of enhanced prevention and new control technologies to create a more sustainable and long-term approach to manage and, when possible, eradicate existing Asian carp populations.

With this Framework strategy, the ACRCC will move to implementation of control technologies, both mechanical and biological.

The ACRCC has specified the following actions within the 2013 Framework:

- Provide a sound strategy for addressing the threat of an Asian carp invasion in the Great Lakes such that the Framework continues to provide direction and actions to participating entities, and identify areas for future efforts.
- Develop an effective and fiscally sustainable Asian carp control program throughout the Great Lakes Basin and Mississippi River Basin.
- Identify efforts that increase regulatory structure and supplement direct management actions, including education and outreach.
- Begin efforts to move from research to implementation of control efforts.
- Develop a strategy for transferring technology, decision support tools, and/or information to resource managers.
- Identify ongoing or potential collaboration among ACRCC entities and specify partner roles.
- Document, track, and communicate the actions of ACRCC partners in applying full authorities, capabilities, and resources to prevent introduction and/or establishment of a sustainable Asian carp population in the Great Lakes.
- Further engage with governmental, industrial, environmental, and other stakeholders.

- Apply technologies and lessons learned to continuously improve actions below the electric dispersal barriers, as well as applicable national Asian carp efforts.

1.4 New in FY 2013

The 2013 Framework envisions an expansion of control and assessment strategies within both the U.S. and Canada. In 2012, Canadian agencies including the Department of Fisheries and Oceans (DFO)-Canada and the Ontario Ministry of Natural Resources (OMNR) joined the ACRCC and contributed to the ACRCC's prevention and control efforts. Several new proposed strategies (see Appendix B) derived from existing ACRCC members.

New efforts for 2013 include:

- Monitor evaluation and efficacy efforts (e.g., analysis of downstream commercial removal efforts and population front), seek independent review of efforts, and identify needs.
- Approve and implement the 2013 Monitoring and Rapid Response Plan (MRRP) for the CAWS and the Illinois River in order to monitor the leading edge of the Asian carp expansion.
- Support response actions led by states or other jurisdictions around the Great Lakes Basin.
- The State of Ohio is considering closure of the Ohio Erie Canal and Little Killbuck Creek connection, based on potential risks of AIS transferal from the Mississippi Basin to the Great Lakes Basin.
- Complete the permanent barrier I site design and award a construction contract.
- Develop final plans and begin implementation of measures within Eagle Marsh.
- Design and construct a mobile electric dispersal barrier that can be deployed in the CAWS or other waterways to move fish where fish containment/movement is desired. The barrier may also act as a temporary barrier for experimental or emergency situations.
- Conduct field testing of a carbon dioxide barrier to deter Asian carp.
- Apply for an Experimental Use Permit to conduct field application of an antimycin incorporated targeted delivery system formulation at designated application sites.
- Transition operations and processing of eDNA from U.S. Army Corps of Engineers (USACE) to U.S. Fish and Wildlife Service (USFWS) following completion of the new laboratory at LaCrosse, Wisconsin.
- Expand sampling efforts in southern Lake Michigan, western Lake Erie, and other potential invasion hotspots for presence of Asian carp.
- Create an eDNA video to help the public and the media better understand what eDNA is, how eDNA sampling and processing works, and to what extent eDNA results impact ACRCC management decisions.

- Develop a probabilistic model of eDNA sources in the CAWS to better understand what positive eDNA monitoring results imply about presence or absence of Asian carp in a water body.

1.4.1 Bi-National Expansion of Strategic Efforts

Prior to joining the ACRCC in 2012, Canadian federal and provincial agencies had already conducted several collaborative actions with U.S. partners to address key pathways for introduction of Asian carp into the Great Lakes and to advance science and understanding of the possible ecological risks associated with an introduction of Asian carp. Canadian participation in the ACRCC will improve bi-national collaboration to reduce the Asian carp threat by applying as much knowledge and as many actions as possible including science, surveillance, enforcement, policy, and public engagement. Further, in May 2012, the Canadian Government announced a new, five-year Asian Carp Program (2012-2017) to be led by DFO-Canada. This Framework reflects these additions to the ACRCC and seeks to increase bi-national efforts and enhance those already occurring under the recently updated Great Lakes Water Quality Agreement and the Great Lakes Fishery Commission (GLFC).

1.4.2 National Approach to Asian Carp Control

Beginning in 2013, the ACRCC will support a national approach to Asian carp control and management, as called for under the Aquatic Nuisance Species Task Force (ANSTF)-approved *Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States* (National Asian Carp Management Plan). Since inception of the Framework in 2010, efforts have primarily focused on the CAWS and the Great Lakes. ACRCC efforts apply some of the best science available to control and manage Asian carp. Through technology transfer encouraged by the ACRCC, these lessons learned will improve results of efforts outside the Great Lakes Basin. However, the ACRCC will remain focused on the goal of ensuring Asian carp do not become established within the Great Lakes.

1.5 Asian Carp Ecology and Potential Impact

Possible invasion of Asian carp into the CAWS and the Great Lakes poses numerous ecological and economic impacts that are under extensive study. Investigations also focus on potential invasion of Asian carp into other pathways between the Mississippi River and Great Lakes Basins. This section provides information about Asian carp and their potential impacts, and why the Obama Administration is committing financial and staff resources to prevent Asian carp introduction and establishment within the Great Lakes.

1.5.1 Distribution

In North America, the term Asian carp usually refers to bighead carp (*Hypophthalmichthys nobilis)*, silver carp (*H. molitrix*), black carp (*Mylopharyngodon piceus*), and grass carp (*Ctenpharyngodon idella*). They all are members of the family *Cyprinidae*. The two species identified for rapid response action under this plan are the silver carp and bighead carp because they pose the greatest threat to the Great Lakes. This Framework does not directly address grass

carp and black carp. Grass carp have been recorded in 45 states, and occurrences have already been reported within the Great Lakes. Black carp are not yet widely distributed, but may be a target of future Asian carp efforts.[1]

Bighead and silver carp species were first introduced in the Mississippi River watershed approximately 40 years ago to improve water quality in aquaculture and wastewater treatment facilities, as well as to serve the food industry. Escape of Asian carp from these facilities may have occurred in many ways, including inadvertent releases, intentional releases into reservoirs, overland flooding events, and/or releases from stocking, bait, or aquaria. Asian carp have rapidly spread within the Mississippi River watershed, and threaten the ecologic and economic value of the neighboring Great Lakes. For example, silver carp introduced to Arkansas sewage lagoons and aquaculture ponds in the early 1970s have since spread to 23 surrounding states, and as far north as South Dakota and Minnesota[2] and as far east as Ohio/West Virginia.

During 2012, monitoring of the Asian carp population in the Illinois River determined the following:

- The detectable adult population front is approximately 55 miles from Lake Michigan (at the I-55 bridge in the Des Plaines River and Dresden Island Pool).
- Presence of moderate to abundant numbers of adults was detected approximately 62 miles from Lake Michigan (at the Marseilles Pool), but no spawning, eggs, larvae, or small fish have been observed in this area.
- Verified spawning was identified approximately 152 miles from Lake Michigan (approximately Henry, Illinois). Fish of lengths greater than 6 inches were collected, and spawning activity is likely occurring below Starved Rock Lock and Dam.

Since the late 1990s, adult bighead carp have periodically been reported, captured, and removed from urban fishing ponds throughout Illinois, and have been found in fee fishing ponds (ponds where catchable size fish are stocked and usage fees are charged) in other Midwestern states. Recent sampling efforts by the Illinois Department of Natural Resources (DNR) in Chicago area fishing ponds resulted in catches of numerous adult bighead carp (48-80 pounds) from Flatfoot Lake in Dolton, Illinois, and three adult bighead carp (56-62 pounds) from Humboldt Park Lagoon in Chicago, Illinois. A growing body of evidence suggests that bighead carp were likely

[1] U.S. Coast Guard (USGS). 2012. Nonindigenous Aquatic Species Fact Sheet *Ctenopharyngodon idella* (grass carp). On-line address: http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=514

[2] Kolar, C.S., D.C. Chapman, W.R. Courtenay Jr., S.M Housel, J.D. Williams, D.P. Jennings. 2007. "Bigheaded Carps: A biological synopsis and environmental risk assessment." *American Fisheries Society Special Publication* 33, Bethesda, Maryland.

unintentionally introduced by contaminated shipments of channel catfish during the late 1990s and early 2000s. Changes in state and federal regulations banning shipment of live bighead carp appear to have stopped this pathway, as no sighting or captures of young bighead carp have been reported in recent years.[3]

In 2010, a single bighead carp was captured in Lake Calumet, just 6 miles from Lake Michigan.[4] However, following 3 years of extensive monitoring, the ACRCC has concluded that no evidence indicates an established Asian carp population upstream of the electric dispersal barrier system within the CAWS.

In fall 2012, Ohio and Michigan DNRs announced laboratory results that indicated presence of Asian carp eDNA in 6 of the 417 water samples collected during August 2011. Four samples from Sandusky Bay, in Ohio waters, tested positive for bighead carp eDNA, while two samples from north Maumee Bay, in Michigan waters, were positive for silver carp eDNA. These findings indicate presence of genetic material left behind by the species, such as scales, excrement, or mucous; however, these results do not necessarily imply establishment of Asian carp in Lake Erie. Initial surveys began immediately after these findings, including collection of water samples for eDNA analysis, as well as electroshocking and netting survey efforts. The eDNA surveys occurred in the Sandusky and Maumee River and Bay areas. During the surveys, Michigan DNR and Ohio DNR received assistance from USFWS and USACE.

Since 2010, Michigan DNR, Ohio DNR, USFWS, University of Notre Dame, Central Michigan University, and the Nature Conservancy have partnered to collect water samples from Great Lakes Basin waters for eDNA analysis. Sampling locations have included southern Lake Michigan, western Lake Erie, and tributary streams of lakes Michigan and Erie. The collaborative early-detection Asian carp surveillance program is funded by USFWS with a federal Great Lakes Restoration Initiative grant.

1.5.2 Diet and Life History

Asian carp can dominate fisheries in abundance and biomass. For example, bighead carp can live over 20 years, grow over 5 feet in length, and weigh 100 pounds or more. Bighead and silver carp are planktivorous, generally consuming microorganisms at the base of the food web, but can be opportunistic and consume a variety of food sources. Their dietary patterns may allow them to out-compete both small and large Great Lakes native fish. Maturity is

[3] Conlin, M. 2002. "Asian carp poised to invade the Great Lakes." *News from the Great Lakes Panel on Aquatic Nuisance Species: ANS Update*, 8(3).

[4] Illinois Department of Natural Resources, Division of Fisheries
Aquatic Nuisance Species Program. 2011. Bighead Carp in Illinois Urban Fishing Ponds. December.

reached between 2 and 7 years of age, depending on the climate and population levels. At maturity, bighead carp generally spawn during periods of flooding when water temperatures are between 64 and 82 degrees Fahrenheit. Multiple spawning peaks during a given year have been documented.

Silver carp are generally smaller than bighead carp, yet have similar feeding and spawning habits. Silver carp are often referred to as "flying fish." When disturbed by boat motors and startled, these fish will jump from the water, posing danger to boaters, anglers, and other recreational users.

1.5.3 Potential Habitat

To successfully complete their life cycle, Asian carp (silver and bighead carp) need access to suitable habitat for spawning. This is necessary for development and hatching of eggs, recruitment of larvae and early juveniles, and growth and survival of sub-adults and adults. The Great Lakes and inland bodies of water provide a diverse array of habitat types that would likely provide the necessary physical habitat components for all life stages of Asian carp. For establishment of Asian carp, however, these habitats must be available in such a way as to facilitate growth and survival; furthermore, sufficient food resources must also be available. Many areas of the Great Lakes likely would attract Asian carp, as these areas provide the specific reproductive, recruitment, and food resource requirements of the fish.

Exact spawning cues remain unknown; however, research has shown that spawning usually occurs at water temperatures between 64 and 82 degrees Fahrenheit during a rise in water level that is usually accompanied by an increase in turbulence and turbidity; to spawn, Asian carp find flowing habitats with flows over 2 feet per second in channels of rivers. Spawning habitat, therefore, includes access to areas providing these cues, as well as those providing a sufficient length of flowing water to allow development of eggs and early larvae (see Section 2.1 – Stages of Invasion for more information regarding Great Lakes tributaries that may provide suitable spawning habitat for Asian carp). Early life stages of Asian carp typically inhabit warm, productive, protected, backwater and wetland areas. Wetlands and backwater habitats adjacent to tributaries that can support spawning of Asian carp would be at risk of colonization by juvenile Asian carp. Recently, over a 2-year period, researchers at Purdue University investigating the Wabash River found that a rise in water level is not required for Asian carp to release eggs. The research found egg laying very consistent during the drought of 2012. However, success of hatching remains unknown when hydrograph is not on a rise.[5]

Using a bioenergetics model that considers only plankton as food resources, Cooke and Hill, University of Illinois, 2010 concluded that many open water regions of the Great Lakes may not support growth of juvenile or adult Asian carp due to low concentrations of plankton.[6] However,

[5] Coulter, A., R. Goforth, and J. Amberg. 2012. "Movements and Spawning of Bigheaded Carps in the Upper Wabash River, Indiana, USA: 2012 Update."
[6] *Ibid.*

more recent information in Cudmore et al. (2011) suggests that limiting potential food items to plankton may have produced misleading results. U.S. Geological Society (USGS) scientists have recently documented Asian carp feeding on *Cladophora* algae and detritus (organic material), indicating that Asian carp could grow not only in productive regions such as Green Bay, western Lake Erie, and some other embayments and wetlands, but also in areas where concentrations of dreissenid mussels exist. These alternative food sources provide additional nutrition for Asian carp in areas and times of low planktonic food availability. The results of current studies suggest potentially uneven distribution and impacts should Asian carp become established in the Great Lakes; however, the potential threat to the ecology and economy of the Great Lakes compels immediate precautionary actions to ensure that self-sustaining Asian carp populations do not become established.

1.5.4 Potential Risk to the Great Lakes Basin and other Inland Lakes

An Asian carp invasion may cause significant, permanent damage to the economic and ecological health of a region.[7] An increasing body of data indicates that an invasion into the Great Lakes by Asian carp could be financially, ecologically, biologically, and socially devastating. These categories of impact are interconnected, all significantly affecting one another. An active, multi-disciplinary approach will be necessary to prevent the negative impacts an invasion could exert on the Great Lakes.

The Great Lakes cover more than 94,000 square miles and host valuable tribal, recreational, and commercial fishing industries. If Asian carp are introduced into the Great Lakes Basin, controlling their spread and impacts on these industries could be nearly impossible. Establishment of Asian carp in the Great Lakes may have lasting and potentially negative effects. Current conditions in the Great Lakes and especially their tributaries and estuaries—including water temperature, food abundance, slow moving wetland regions, expansive area for migration, and lack of natural predators—may allow for rapid expansion of Asian carp populations.

Substantial financial and social costs are associated with actions needed to stop Asian carp from entering the Great Lakes. For instance, permanent closure of the Chicago area locks would greatly affect commerce and recreational use of Lake Michigan and the CAWS. About 7 million tons of cargo passes through the O'Brien Lock each year, as do more than 19,000 recreational boats, many of which are docked along the Calumet River and reach Lake Michigan through the lock. In addition, several cargo, ferry, and pleasure boats use the Chicago Lock. In 2010, 11,699 lockages and 36,334 vessels passed through the Chicago Lock—a traffic size second in the nation only to the Hiram M Chittenden Locks in Seattle, Washington. The locks are also used by USCG stations on Lake Michigan for responding to emergencies on the canal and for patrolling critical infrastructure facilities within the river system.

[7] Hansen, M. 2010. The Asian Carp Threat to the Great Lakes. Accessed September 18, 2011. On-line address: http://www.glfc.org/fishmgmt/Hansen_testimony_aisancarp.pdf. Great Lakes Fisheries Committee, Ann Arbor, Michigan.

Financial Risk

As Great Lakes leaders know from experience, it is difficult and expensive to deal with invasive species after they become established and eradication is unlikely. For example, over $300 million has been spent by the U.S. and Canadian governments since 1956 to control sea lampreys, an invasive species to the Great Lakes. Nonetheless, Dr. Michael Hansen, Chair of GLFC during 2010, concluded that this expenditure represents only a fraction of the billions of dollars in revenue lost because of the sea lamprey's direct role in decline of lake trout, a native keystone species.

Commercial and recreational fishing in the Great Lakes is an industry estimated to generate billions of dollars of revenue to the economies of both the U.S. and Canada. An invasion of Asian carp to the Great Lakes may be detrimental to the fishing industry and those financial assets. The potential financial risk to fishing alone indicates the significance of an Asian carp invasion to the Great Lakes region.

Social Risk

The social implications of an Asian carp invasion within the Great lakes range from indirect (outcompeting [thus impacting] native sportfish populations) to direct (physical harm to people). The Great Lakes Commission (GLC) estimates that nearly 1 million boats and personal watercraft operate on the lakes (GLC 2003),[8] thereby placing more than a million people in potential contact with the silver carp, a projectile fish. The hazards these projectile fish pose to recreational users on the Illinois River system would be compounded on the Great Lakes because of a significantly larger boating population, thus posing a larger health and safety issue.[9] The social risk that Asian carp represent to the Great Lakes is directly relevant to the financial risk as well. If Asian carp do make their way into the Great Lakes, recreational activities could be significantly affected, directly impacting revenue based on those activities.

Ecological and Biological Risk

Asian carp would be able to tolerate the Great Lakes Basin's climate, because the basin is well within their native climate range. Mean annual air temperatures supporting Asian carp populations range between -2 degrees Celsius (ºC) and 22ºC for bighead carp and -6ºC and 24ºC for silver carp—a range found in much of the United States and Canada, including the Great Lakes.[10] Biologists reported similar diets among Asian carp and native fishes in the Mississippi and Illinois Rivers, which suggests the Asian carp would likely compete with native fish for food.[11] Previous invasive species, including the zebra mussel and sea lamprey, have drastically changed the Great Lakes ecosystem, demonstrating the impact invasive species can exert on an ecosystem. Previous studies (e.g.; Mandrak and Cudmore [2004] and Cudmore and Mandrak [2010]) concluded that the ecological consequences of establishment of grass and silver carp on native species would be certain and profound, and would be reasonably certain and significant from

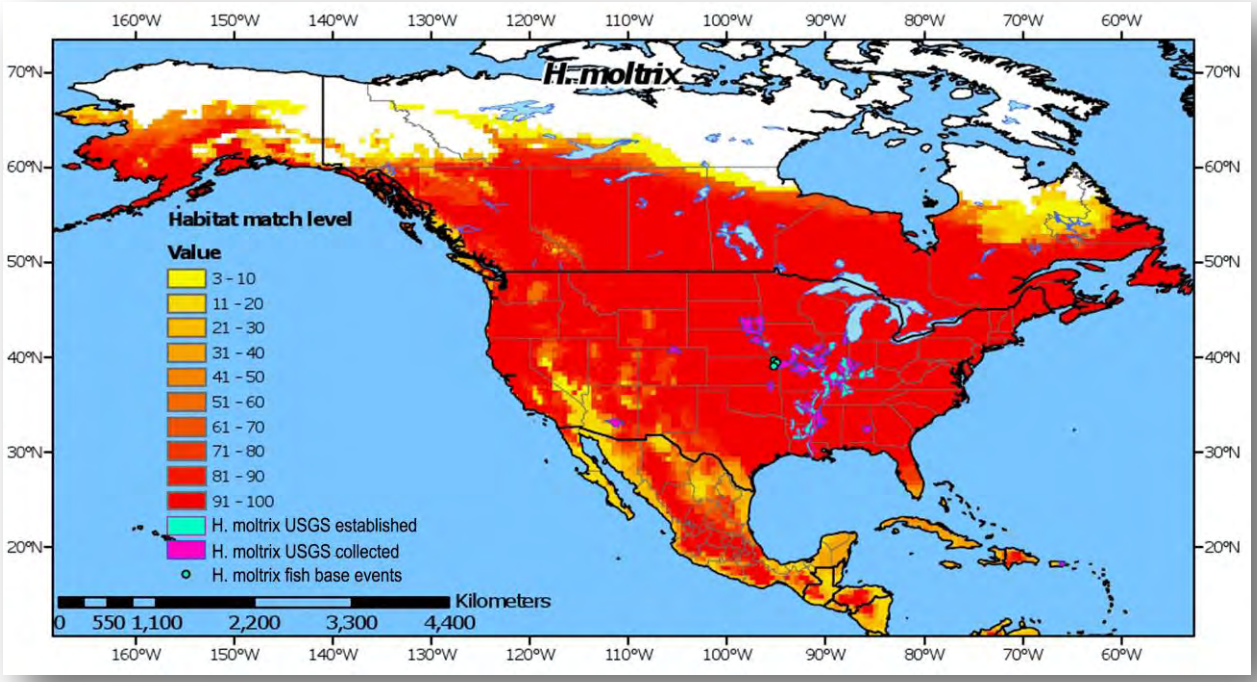
[8] Hansen, above n 7.
[9] *Ibid.*
[10] *Ibid.*
[11] *Ibid.*

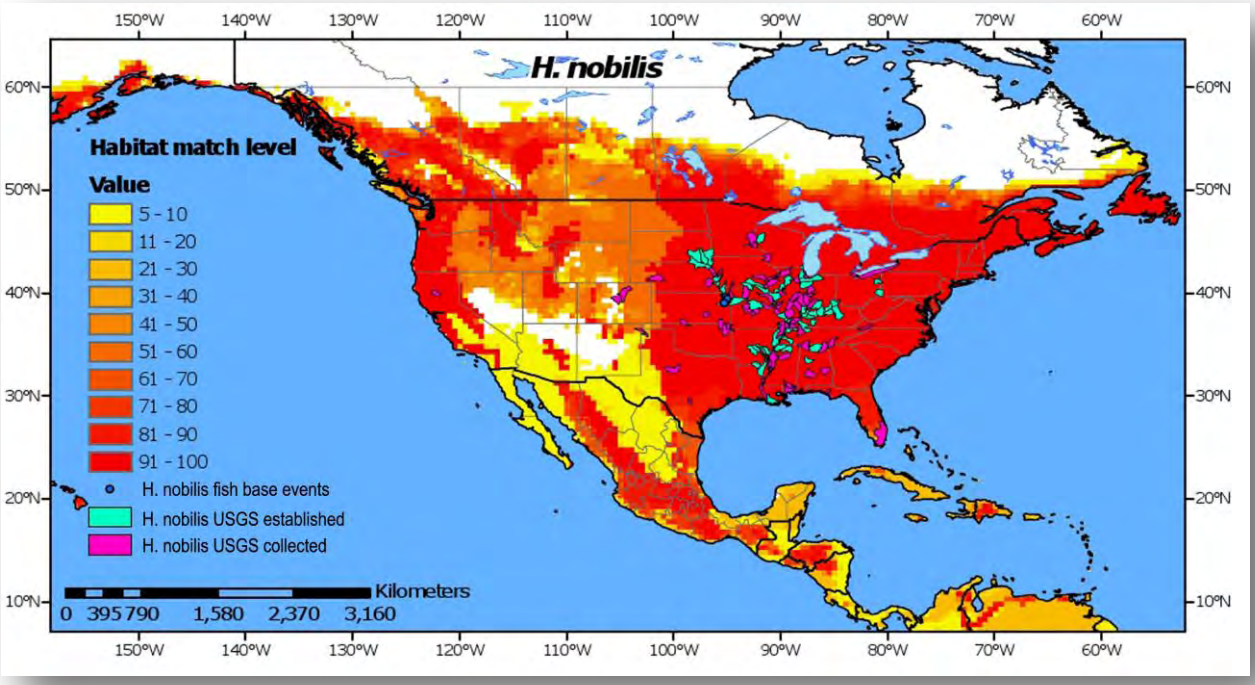
establishment of bighead and black carp. In a recent binational ecological risk assessment that examined the likelihood of arrival, survival, establishment, and spread of bighead and silver carps in the Great Lakes, Cudmore et al.[12] found that if bighead and silver carps become established in the Great Lakes, their spread likely would not be limited, and several ecological consequences would be expected. These consequences include competition for planktonic food leading to reduced growth rates, recruitment, and abundance of native planktivorous fish species. Overall risk was found highest for Lakes Michigan, Huron, and Erie, followed by Lake Ontario, then Lake Superior. To avoid the trajectory of the invasion process and to prevent or minimize anticipated consequences, Cudmore et al (2011) concluded that it is important to continue to focus efforts on reducing the probability of introduction of these species at either the arrival, survival, establishment, or spread stage (depending on location). Once established, invasive species are nearly impossible to eradicate, rendering prevention of Asian carp invasion that much more important. Herborg et al.[13] used ecological modeling to predict the suitable environmental habitats for Asian carp in North America. Exhibit 1 represents these habitats for the silver and bighead carp. This model clearly suggests that the Great Lakes provide habitat that is highly suitable for establishment of the Asian carp species.

[12] Cudmore, B. and N.E. Mandrak. 2011. Assessing the Biological Risk of Asian Carps to Canada. Pages 15-30 in D.C. Chapman and M.H. Hoff, editors. Invasive Asian carps in North America. American Fisheries Society, Symposium 74, Bethesda, Maryland.

[13] Herborg L. M., N. E. Mandrak, B. C. Cudmore, and H. J. MacIsaac. 2007. Comparative distribution and invasion risk of snakehead (Channidae) and Asian carp (Cyprinidae) species in North America. Canadian Journal of Fisheries and Aquatic Sciences. 64:1723-1735.

Exhibit 1. Predicted Suitable Environment for Asian Carp in North America





Note: Environmental suitability is represented as a number (out of a maximum of 100) of models that predicted a particular location as suitable. From top to bottom, (H. moltrix) silver carp and (H.nobilis) bighead carp.

The Great Lakes are home to many important species of commercial and sport fish such as whitefish, bloater chubs, and yellow perch, as well as sport fish including trout and walleye. Potential impact of Asian carp on the Great Lakes' sport and commercial fishing industry is evident in the Mississippi River Basin, where in a few short years following Asian carp introduction, many commercial fishing locations have been abandoned because native fish populations have significantly decreased. Presence of Asian carp is a concern because they are prolific, grow and mature quickly, and feed on phytoplankton and zooplankton. They may alter energy flow in the Great Lakes, which in turn could lead to undesirable consequences for sport and commercial fisheries. A 2002 workshop convened by the Great Lakes Protection Fund, as well as the 2003 Aquatic Invasive Species Summit convened by the City of Chicago and USFWS, determined that introduction of Asian carp into the Great Lakes ecosystem would threaten the sport and commercial fisheries and could result in ecological and economic damages exceeding those caused by the sea lamprey and zebra mussel invasion.[14] Cudmore et al. (2011) indicated that plankton-eating fishes would be forced to compete with silver and bighead carp for their primary food source. Both silver and bighead carp possess specialized adaptations rendering them extremely effective at consuming plankton, and they have a voracious appetite. Competitive interactions may significantly reduce the number of native fishes in the Great Lakes region, thereby impacting the delicate food web. For instance, reduction of native plankivorous fishes may reduce the number of predatory fishes, including yellow perch and walleye.

Work regarding Canadian freshwater fishes also suggests that invasive species are the second leading cause of decline (Dextrase and Mandrak 2008), and interactions of invasive species continues to be problematic in the Great Lakes (Mandrak and Cudmore 2010). Moreover, nearly 80 federally listed, threatened, or endangered fish, mollusks, plants, mammals, insects, and reptiles are within the Great Lakes, and many more species are listed as threatened or endangered at the basin level. Nationally, about 42 percent—400 of 958—of the species listed as threatened or endangered under the Endangered Species Act are considered at risk primarily because of predation or competition with exotic species.[15] Introduction of Asian carp to the region could further stress these organisms through mechanisms difficult to predict, and perhaps lead to their extirpation. One such fish of concern is the lake sturgeon, protected by the State of Michigan because its remaining populations are less than 1 percent of the original population as a result of overfishing and habitat loss. Many of these fish age to nearly 25 years for females and 12 years for males before reaching maturity and are bottom feeders with a diet including snails, mussels, and crustaceans. Because Asian carp populations could reach self-sustaining levels near the confluence of the Lake Michigan tributaries and canals in the Chicago vicinity, range expansion within the lake's watershed would be highly likely over time as a result of density-dependent dispersal. If higher concentrations of Asian carp are realized within an established area, Asian carp may move to new areas seeking suitable habitat and resources.

[14] Chick, J. H. 2002. Establishment of Asian Carp in the Upper Mississippi River and Potential Threats to the Great Lakes. Illinois Waterway Barrier Workshop hosted by the Great Lakes Protection Fund, in Chicago.
[15] Pimentel D., R. Zuniga and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics. 52: 273-288.

Through this natural dispersal process, populations of Asian carp may become established in embayments, estuaries, lagoons, and river mouths of medium to large rivers and streams proximate to the home range of an established population. These types of water bodies are found within Lake Michigan and throughout the entire Great Lakes Basin.

Isolated Instances of Bighead Carp Found in Ohio River and Western Lake Erie
In addition to the established populations throughout the Mississippi River and other basin waterways, bighead carp have been found in the upper portions of the Ohio River and Lake Erie. The single bighead carp found in the Upper Ohio River is believed to have traversed through the Mississippi River Basin and lock systems of the Ohio River. Three bighead carp were individually collected between 1995 and 2003 in western Lake Erie, with two additional unconfirmed sightings in 2002 and 2003. Since 2004, in response to these discoveries, USFWS has monitored western Lake Erie in Sandusky and Toledo, Ohio, using trammel nets. OMNR has continued to conduct extensive surveillance in the Ontario waters of the western basin as part of its regular fisheries survey programs. The Ontario Commercial Fisheries Association (OCFA), which operates extensively throughout the basin, has also been vigilant. These combined U.S. and Canadian surveillance efforts have not produced any additional collections of bighead or silver carp, suggesting a reproducing population does not exist in Lake Erie. Additional information on collection points is available in the USGS Nonindigenous Aquatic Species Database at http://nas.er.usgs.gov/.

ACRCC Risk Management

Although further delineation is necessary, the risk of an Asian carp invasion of the Great Lakes and associated basin waters exists. To proactively prevent invasion of Asian carp and reduce this risk of potentially damaging impacts on the Great Lakes, a suite of actions have been undertaken or are planned as part of the ACRCC management strategy. The 2013 Framework describes these actions and strategic distribution of these actions. Section 3.5 of this document also describes current and planned risk assessment activities to further delineate the risk to the Great Lakes Basin.

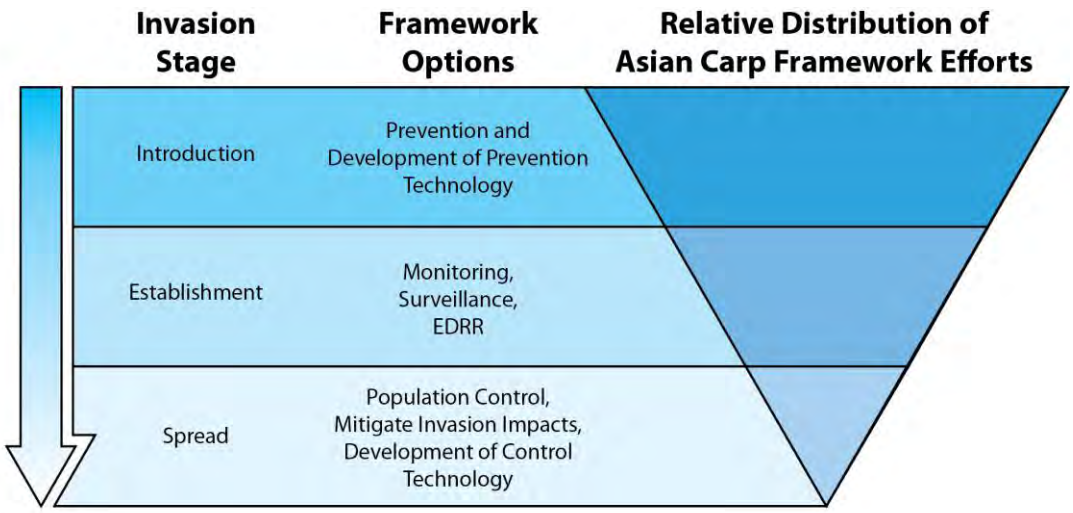
2.0 OPTIONS FOR STRATEGIC MANAGEMENT OF ASIAN CARP

To prevent further introduction and establishment of Asian carp, this section of the framework provides strategic guidance for selecting and executing specific actions, with emphasis on various actions. The stages of the invasion process are first introduced to provide insight to the strategic approach and management options at each stage.

2.1 Stages of Invasion Model

This section of the Framework provides strategic guidance for decisions regarding selection and implementation/distribution of actions. The stages of the invasion process are first described to reveal the strategic approach and management options at each stage. Common steps in biological invasion include: (1) arrival and *introduction* into a novel system, (2) successful reproduction and *establishment* within the novel system, and (3) *spread* throughout the system that results from increasing abundance and continued reproduction.[16] Exhibit 2 below depicts the common stages of an AIS invasion and the categories of management options that correspond to those stages. The inverted triangle illustrates the relative distribution of Asian carp management actions included in the Framework. That is, the largest number of Framework actions should focus on prevention and development of prevention technologies, followed by those to stop establishment, and finally by those developing technologies to minimize spread of Asian carp in the CAWS and Great Lakes (if this proves ultimately possible).

Exhibit 2. Conceptual Illustration of Framework Strategy

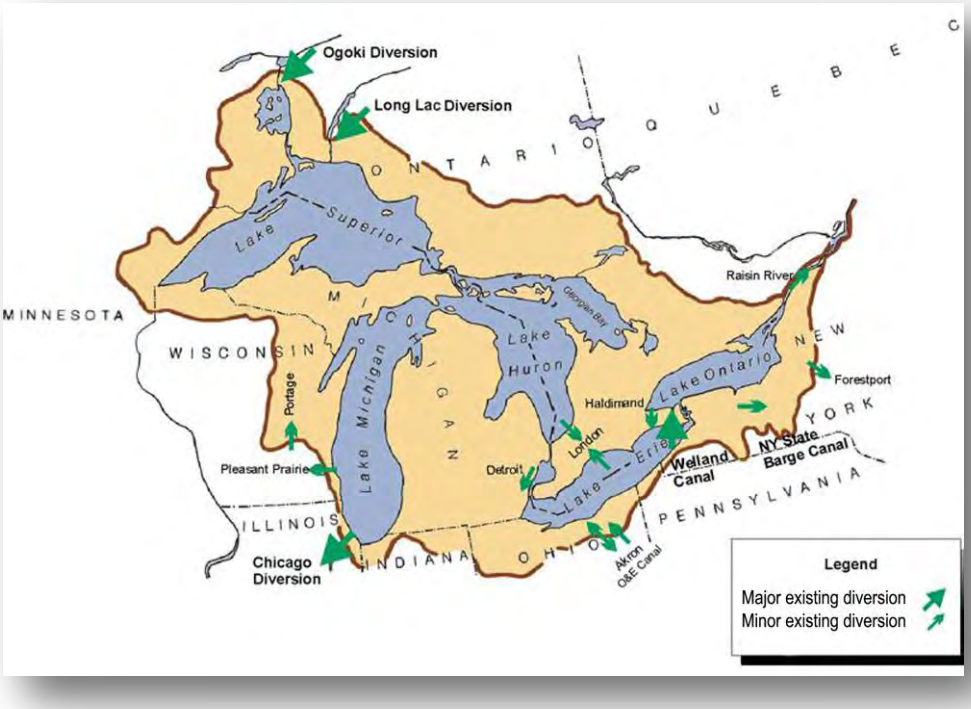


[16] Lodge, D.M., S.L. Williams, H. MacIsaac, H. Hayes, B. Leung, S. Reichard, R.N. Mack, P.B. Moyle, M. Smith, D.A. Andow, J.T. Carlton, and A. McMichael. 2006. "Biological Invasions: Recommendations for U.S. policy and management." *Ecological Applications* 16: 2035-2054.

First a species must arrive at and be introduced into the water body. *Introduction* of a new species into the Great Lakes waters can occur through various pathways, natural and man-made. Natural pathways include wind, currents, and other forms of dispersal for which a specific species' morphological and behavioral characteristics are beneficial. Man-made pathways for AIS transfer fall into two categories: intentional pathways and unintentional pathways. Intentional pathways are the result of deliberate actions to transfer a species, whereas unintentional pathways cause movement of a species as an indirect byproduct of human activity.

For Asian carp, possible pathways include artificial connections to the Great Lakes (Exhibit 3); Great Lakes tributaries (Exhibit 4); movement of organisms through the bait, live foodfish, or aquarium trade; intermittent hydrologic connections (e.g. Wabash-Maumee area); and organism transport by shipping and ballast water. Once a species has been introduced into a new ecosystem and can successfully reproduce, the stage of invasion advances toward *establishment*. Finally, an invasion progresses to the *spread* stage once an established population continues to increase in abundance and spread throughout the novel habitat. Note that Exhibit 4 below shows Great Lakes tributaries likely suitable for Asian carp spawning, considering that these tributaries have minimum lengths of approximately 62 miles. Other waterways not shown here could still be conducive to spawning or become potential corridors for movement to the Great Lakes.[17]

Exhibit 3. Artificial Connections to the Great Lakes



[17] Kolar, C.S., D.C. Chapman, W.R. Courtenay Jr., S.M Housel, J.D. Williams, D.P. Jennings. 2007. Bigheaded Carps: A biological synopsis and environmental risk assessment. American Fisheries Society Special Publication 33, Bethesda, MD.

Exhibit 4. Great Lakes Tributaries Likely Suitable for Asian Carp Spawning

2.2 ACRCC Strategic Approach

Early warning of Asian carp introduction allows Great Lakes managers and the ACRCC a unique opportunity to focus on preventing further introduction. Therefore, a majority of efforts underway and documented in this Framework are aimed at direct prevention of Asian carp introduction through its various pathways and at development of prevention technologies. Other Framework actions address establishment and spread stages of invasion. It is important to understand that this does not indicate Asian carp have advanced to these invasion stages—rather, the actions addressing establishment and spread are proactive and function to help manage any potential introduction into the Great Lakes Basin. Monitoring for Asian carp presence in the Great Lakes and its tributaries is prudent. Monitoring allows for early detection and rapid response (EDRR) actions that halt advancement to the establishment stage of invasion. Control technologies may also be used to reduce current Asian carp populations in infested waterways, potentially lowering the risk of a Great Lakes invasion. Development of long-term control methodologies is also important; thus, if introduction to the Great Lakes should occur, agencies would be armed with control tools that limit spread and minimize ecological and economic impacts. This also enables application of developed methods outside of the CAWS and the Great Lakes Basin. In this way, managers would be wholly prepared to minimize effects at each stage of invasion. Yet actions are appropriately focused first and foremost on prevention, as this is the goal of the ACRCC and is likely to be the most cost-effective approach over both the short term

and the long term. Representative actions underway or soon to commence as part of the FY 2013 strategy are referenced below; a complete list and descriptions of FY 2013 action items are in Appendix B of this document.

2.3 Great Lakes Strategic Approach

In the Great Lakes Region, the ACRCC will continue to provide leadership, as described in this Framework, in addressing possible connections to the Great Lakes as outlined by GLMRIS. These connections include the CAWS and 18 other possible connections identified by GLMRIS. Should waters of inland Ontario be affected by Asian carp, response actions would be jointly led by OMNR and DFO-Canada as described in Ontario's Asian Carp response plan.

Detection of Asian carp within the Great Lakes or tributaries below the first impassable dam will prompt the States of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, the Province of Ontario, the Great Lakes Indian Fish and Wildlife Commission, and the Chippewa-Ottawa Resource Authority to respond using existing processes outlined in *A Joint Strategic Plan for Management of Great Lakes Fisheries* (Joint Strategic Plan). Appropriate management strategies for Asian carp will also be determined through the lake committee process facilitated by GLFC. USFWS, USGS, and the National Oceanic and Atmospheric Administration (NOAA) are partner U.S. federal agencies signatory to the Joint Strategic Plan; DFO-Canada also has signed this agreement. ACRCC members likely will also play important roles in support of Great Lakes fishery management decisions related to invasive Asian carp agreed to by the lake committees.

The Joint Strategic Plan formalized need for a lake committee composed of senior fishery managers, typically reporting to the chief of fisheries for each jurisdiction, for each Great Lake. Because fishery management is within the purview of the Great Lakes states, U.S. tribal organizations, and the Province of Ontario, these jurisdictions are represented on lake committees. The lake committees cooperatively manage the interjurisdictional fisheries on each Great Lake. Federal organizations signatory to the Joint Strategic Plan provide important support to the decisions made by each lake committee, but do not sit on lake committees. In cases where management issues affect two or more lakes, a Council of Lake Committees meets to address those issues. Key principles of cooperative fishery management identified in the Joint Strategic Plan are accountability, sharing of information, consensus, and ecosystem-based management. Fishery management recommendations of the lake committees will be relayed to the ACRCC either by GLFC or by the agencies comprising each lake committee, as has been the case in Lake Erie in 2012 (see Section 3.3.2 for more information).

A good example of how this process worked occurred in 2012 when the University of Notre Dame found Asian carp eDNA in water samples collected during 2011 from Maumee Bay and Sandusky Bay, Lake Erie. Upon learning of these findings from Notre Dame, the States of Michigan and Ohio worked cooperatively to determine and implement the next management steps. The States asked for assistance from USFWS and USACE for surveys for Asian carp using conventional gear,

and for analysis of additional water samples for eDNA. Ohio and Michigan also informed the rest of the Lake Erie Committee (Ontario, Pennsylvania, and New York) about their response actions. The Lake Erie Committee then developed a position statement that envisioned how the five management agencies would handle the threat of Asian carp to Lake Erie into the future. The Lake Erie Committee holds monthly conference calls to discuss all fishery management issues on the lake, including ideal methods to properly prevent and manage Asian carp

Corresponding management actions may prevent occurrence or advancement of each stage of invasion (Exhibit 2). Recognition of these stages and the corresponding management options is likely to improve short- and long-term management planning[18]. The categories of management options are described in more detail below, and are organized according to management actions implemented during each stage of invasion.

2.3.1 Prevention and Development of Prevention Technologies

Management options to prevent *introduction* generally can be categorized as prevention actions and development of prevention technology. Actions that fall under these categories are: (1) investigating likely pathways through risk assessment or other means, (2) reducing the number of invasive species in known pathways (including reducing invasive species in neighboring watersheds to control the source population), (3) enforcing transport regulations (e.g., bait trade, live food-fish trade, and inter- and intrastate transport), and (4) deploying or investigating new prevention technology (see Sections 3.1, 3.3, and 3.5 for descriptions of some prevention and prevention technology efforts under way). To prevent Asian carp introduction, the ACRCC has employed a suite of these types of actions. Table 1 lists actions that prevent introduction and thus effectively address all invasion stages. In the short term, prevention of *introduction* prevents advancement to *establishment* and *spread* stages. Investment in preventative measures will reduce the abundance of Asian carp that may enter the Great Lakes, thereby assisting long-term efforts by reducing the propagule pressure, or number of individuals that normally would cause damage to the Great Lakes. For instance, installation and operation of the electric dispersal barrier operation in the CAWS deters movement of Asian carp to the Great Lakes and thus reduces the likelihood of introduction from this pathway.

In the long term, should introductions occur, management actions still function to deter species and lessen the impacts on the Great Lakes by reducing the number of species that could migrate to the Great Lakes. Ongoing risk assessment actions focusing on Asian carp will help target monitoring activities within critical areas, as well as identify follow-up on removal efforts that should occur. For example, Framework action item 2.4.5 identifies the likelihood of species introductions from various pathways. A potential use of these results could be to prioritize location and timing of action so that the pathway with larger relative risk can be minimized first. Table 1 below provides examples of current and proposed applications for prevention and

[18] Lodge, D.M., S.L. Williams, H. MacIsaac, H. Hayes, B. Leung, S. Reichard, R.N. Mack, P.B. Moyle, M. Smith, D.A. Andow, J.T. Carlton, and A. McMichael. 2006. "Biological Invasions: Recommendations for U.S. policy and management." *Ecological Applications* 16: 2035-2054.

development of prevention technology by member agencies in this Framework. Not all preventative actions address all life stages of Asian carp. This point highlights need for future work and development of long-term solutions to prevent further introduction of young-of-year fish, juveniles, and adult Asian carp into the Great Lakes. Notes: (1) many Framework actions described in this document can be categorized under more than one Management category; (2) each specific action indicates at least one of the dominant types of Framework actions completed as part of that work.

Table 1. Prevention and Prevention Technology Management Options

General Management Categories	Specific Actions	Selected Framework Actions*
Risk assessment	Identify potential pathways for Asian carp to enter Great Lakes	2.4.2, 2.4.3, 2.1.5, 2.5.1, 2.5.11, 2.5.17
	Identify and/or assess likelihood of species introduced via pathways	2.4.5, 2.1.7
Prevention	Reduce Asian carp abundance/ distribution/ movement in pathways (e.g. bait trade, tributaries, human-mediated transport/shipping)	2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.3, 2.3.5
	Enforce transport regulations	2.7.2, 2.7.3
Development of prevention technology	Implement barrier safety and operations testing, defense	2.2.3, 2.3.2, 2.3.4, 2.3.6, 2.3.7, 2.4.1, 2.5.2, 2.5.6, 2.5.19, 2.5.20
***View Appendices A and B for details of individual projects.**		

2.3.2 Monitoring and Development of Monitoring Technology

Management options to prevent *establishment* can be categorized generally as monitoring actions and development of monitoring technology that allows managers to rapidly detect early arrivals to the Great Lakes or tributaries. These critical actions allow management to delineate the current distribution of Asian carp in nearby watersheds and determine where removal and other preventative measures should occur. In addition, response actions such as electrofishing and netting can occur upon detection of individuals to remove the Asian carp from the newly invaded habitats. This helps prevent movement toward the Great Lakes and would help with rapid removal of any individuals already within the Great Lakes. Actions that fall under these categories are those that: (1) investigate areas in the Great Lakes likely to provide the suitable habitat requirements for Asian carp; (2) develop or refine methods, such as eDNA or bacterial source tracking, that can be used to detect carp presence; (3) track abundance using various forms of monitoring (electrofishing), movement (telemetry), and presence/absence (eDNA) of Asian carp in critical locations within and neighboring the Great Lakes; and (4) employ response actions that remove detected individuals (e.g., rotenone, electrofishing, netting). (See Sections 3.3, 3.4, 3.5, 3.6, and 3.8 below for more detail regarding some current monitoring and monitoring technology efforts). Selected Framework examples of these actions are listed in Table 2. Note:

categories of management actions that prevent introductions of Asian carp also inhibit advancement to *establishment* stages of invasion, and selected Framework numbers associated with these actions are shown (i.e. rapid response and removal follows early detection of individuals that have arrived at or near the Great Lakes). Many Framework actions within this document fall into more than one Management category; each specific action indicates at least one of the dominant types of Framework actions completed as part of that work.

Table 2. Monitoring and Monitoring Technology Management Options

General Management Categories	Specific Actions	Selected Framework Actions*
Risk assessment	Great Lakes Habitat Suitability modeling	2.4.5, 2.5.4, 2.5.5
Development of monitoring technology	eDNA refinement	2.5.3, 2.6.1, 2.6.4, 2.6.5
	Development of new detection methodology	2.5.15, 2.5.16
Monitoring for Early Detection	Electrofishing	2.1.1, 2.1.2,
	Telemetry	2.3.4,
	eDNA	2.1.1, 2.1.2, 2.6.1, 2.6.2
Response	Rotenone application	2.1.2, 2.1.3
	Other species removal efforts	2.2.1, 2.2.2
***View Appendices A and B for individual project detail.**		

2.3.3 Development of Control Technology and Impact Mitigation

It is necessary to investigate long-term control methodologies that can effectively eliminate Asian carp species or prevent their movement while minimizing damage to native biota. Actions that fall under these categories are: (1) investigating species-specific control methods, (2) determining efficacy of long-term hydrologic separation, and (3) testing other possible control mechanisms (e.g., application of hydro guns). (See Sections 3.2 and 3.6 below for a more in-depth look at some current control technologies and impact mitigation efforts). Development of these methodologies requires investigation and/or laboratory development and testing before deployment in the field. However, species-specific and permanent control tools are often necessary for successful long-term control of source populations. For example, species-specific lampricide was developed to control the harmful sea lamprey in the Great Lakes. The lampricide is applied annually at key tributary locations to mitigate impacts and to control the number of lampreys that arrive at the Great Lakes.

Selected Framework actions are listed in Table 3. Note: Selected Framework actions implemented as components of specific actions are listed. Many Framework actions described in this document fall into more than one Management category; each specific action indicates at least one of the dominant types of Framework actions completed as part of that work.

Table 3. Control Technology and Impact Mitigation Management Options

General Management Categories	Specific Actions	Selected Framework Actions*
Development of population control technology	Investigation of species-specific control methods	2.5.7, 2.5.8, 2.5.10, 2.5.12, 2.5.15, 2.5.20
	Permanent separation efficacy	2.4.2,2.1.6
	Other long-term control mechanisms	2.5.6, 2.5.19
***View Appendices A and B for individual project detail.**		

2.3.4 Other Supporting Activities (Education and Outreach)

Actions that support Asian carp management include those that increase public awareness of the threat from introduction of Asian carp. The ACRCC continues to inform and engage the public, stakeholder organizations, and governmental organizations in this regard. This is an unprecedented effort to disseminate information about preventing the spread of invasive species—via meetings, press events, and communications. Moreover, education and outreach can lead to behavior changes that may prevent release of the species through various pathways including the bait or the live food-fish trade (e.g. 2.7.1, 2.7.3). Actions that meet these objectives are listed in Table 4, which lists supporting actions for Asian carp management and selected Framework examples for each type.

Table 4. Other Supporting Activities

General Management Categories	Specific Actions	Selected Framework Examples*
Other Supporting Activities	ACRCC coordination, support, and public relations	2.5.18, 2.7.4, 2.8.1, 2.9.1
	Education and outreach to raise awareness of Asian carp threat	2.7.1, 2.7.3, 2.7.4, 2.7.5, 2.7.6, 2.7.7
***View Appendices A and B for individual project detail.**		

2.4 Summary

The ACRCC has implemented and will continue to conduct actions to directly prevent Asian carp introduction and establishment in the Great Lakes while pro-actively monitoring for evidence of Asian carp in the Great Lakes. The ACRCC is also investigating critical methods for long-term control of Asian carp. Actions have been conceived and implemented to address all stages of invasion by preventing introduction and utilizing technology to achieve long-term control.

3.0 CRITICAL EFFORTS UNDERWAY

This section provides summaries of efforts under way within the Framework and accomplishments since its inception in 2010. Much of this ongoing work will continue to generate critical knowledge and tools for the efforts against Asian carp.

3.1 Electric Dispersal Barriers in the Chicago Area Waterway

The CAWS is the only known continuous connection between the Great Lakes and Mississippi River Basins and, as such, poses the greatest risk for transfer of AIS.

The electric dispersal barriers are near Romeoville, Illinois, in the Chicago Sanitary and Ship Canal (CSSC) within the CAWS (see Exhibit 5). These are designed to deter inter-basin transfer of fish between the Mississippi River and Great Lakes Basins via the CSSC. The barriers are formed of steel electrodes secured to the bottom of the CSSC, do not inhibit waterway vessel traffic, and are controlled from an adjacent building (see Exhibit 6). Equipment in the control building generates a direct current (DC) pulse through the electrodes, creating an electric field in the water that discourages fish from crossing, as depicted below.

Exhibit 5. Electric Dispersal Barrier System Locations on the CAWS

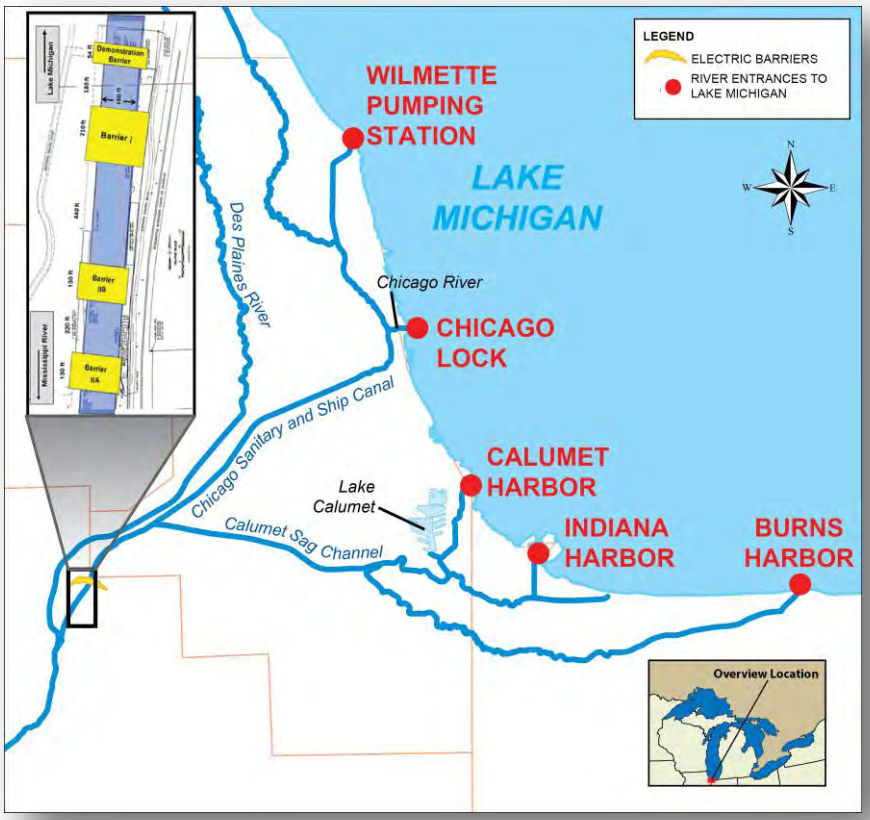
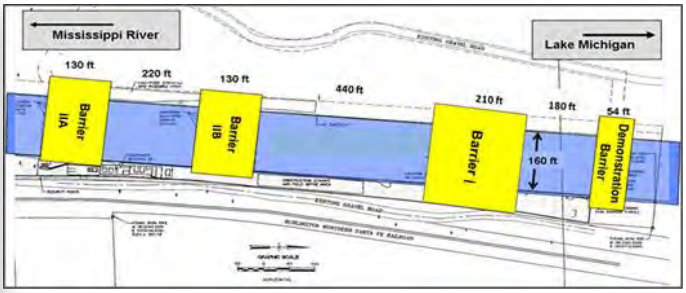


Exhibit 6. Electric Barrier Design



Barrier I, also known as the Demonstration Barrier, has been operational since 2002. Because of its original demonstration status, it was designed and built with materials not intended for long-term use. The Water Resources Development Act of 2007 authorized an upgrade of Barrier I to a permanent barrier. The first construction contract for Permanent Barrier I was awarded in 2012, and construction is scheduled to begin in 2013. Barrier IIA was placed into full-time operation in 2009. Barrier IIB was activated in April 2011.

The Water Resources Development Act of 2007 also directed USACE to analyze several technical, environmental, and biological factors to identify options or technologies that may reduce the impacts of hazards, and to assess efficacy of the electrical dispersal barriers. The study was divided into several segments, or interims, as described below.

Interim Report I identified areas of potential bypass and recommended construction of a fence and concrete barriers along the Des Plaines River and a stone blockage barrier in the Illinois and Michigan (I&M) Canal. These measures, completed in October 2010, reduce the risk of Asian carp bypassing the electric dispersal barriers during flooding.

Interim Report IIA, completed in September 2011, documents research to determine optimum operating parameters for the electrical dispersal barriers, considering safety and operational impacts of altering parameters and location of very small Asian carp, between 2 and 6 inches, in the upper Illinois River. Based on the findings of laboratory research, the operational settings of

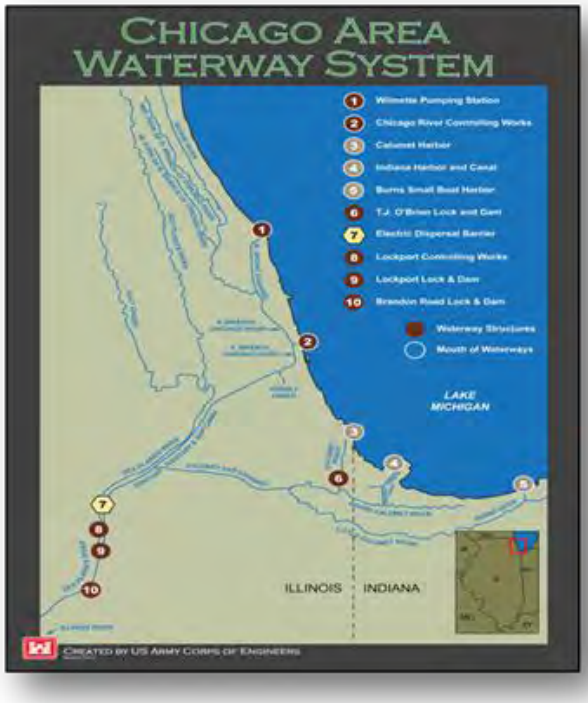
Barrier II were changed in October 2011 to those believed more effective at deterring very small fish.

Interim Report III, completed in July 2010, evaluates possible risk reduction through changes in operation of structures within the CAWS such as locks, sluice gates, and pumping stations. The report recommended construction and installation of bar screens for two sluice gates at both the O'Brien and Chicago Locks. Implementation of these recommendations was completed in January 2011.

Interim Report IIIA, completed in July 2010, considers how technologies such as bubbles, light, and sound barriers can inhibit Asian carp movement. The report recommends construction of an acoustic bubble curtain with strobe lights as a demonstration project. Funding and authority for implementation are required to initiate design of this project.

The comprehensive efficacy report will document improvements to increase efficacy of the electric dispersal barriers. Further, the report will include an evaluation of additional risk reduction measures addressing the open pathways to Lake Michigan: the Grand Calumet River, which outlets at the Indiana Harbor and Canal; and the Little Calumet River, which outlets at Burns Ditch. Completion of the Comprehensive Efficacy Report is expected in FY2013.

3.2 GLMRIS

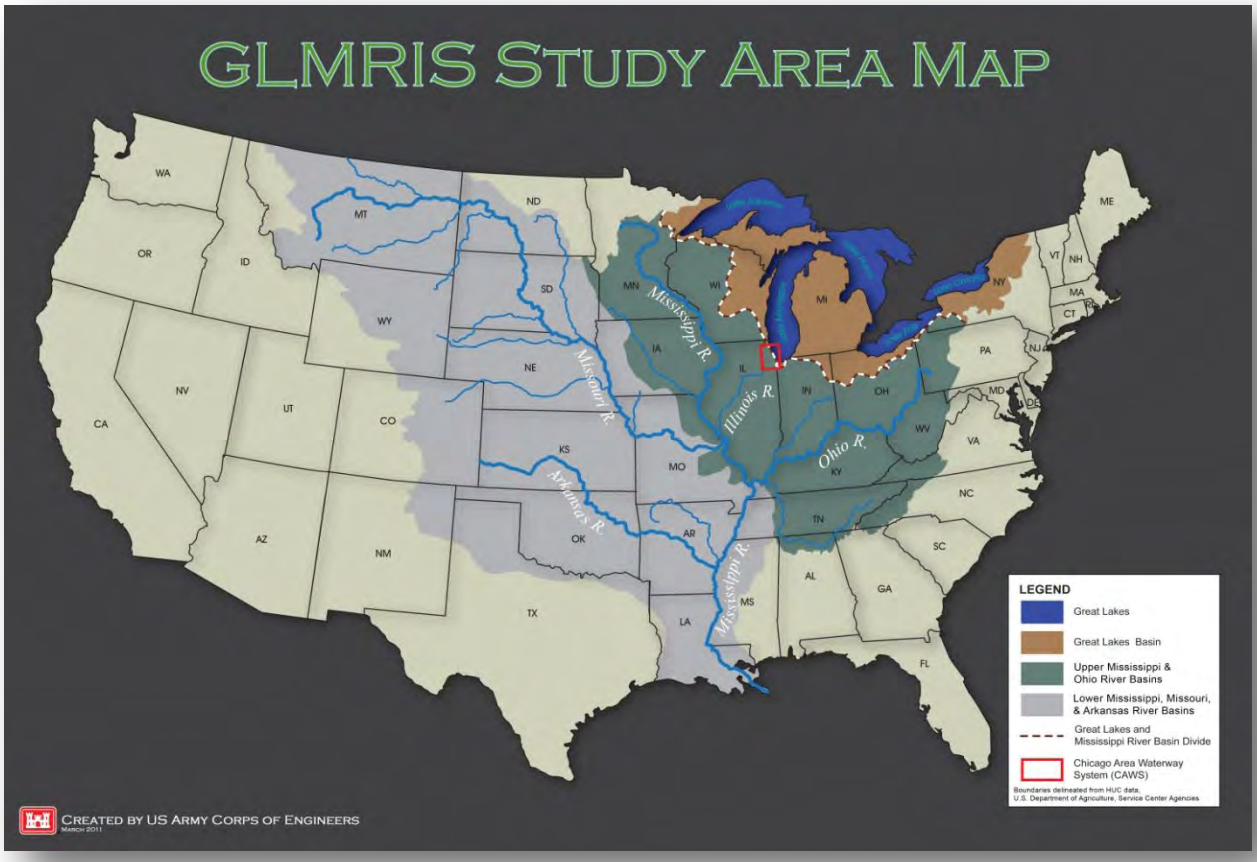


GLMRIS is a congressionally authorized feasibility study specified in the Water Resources Development Act (WRDA) of 2007. The authorization directed USACE to consult with appropriate federal, state, and local agencies, and with nongovernmental organizations (NGO) on the range of options and technologies available to prevent spread of AIS between the Great Lakes and the Mississippi River Basins through the CSSC and other aquatic pathways. The study will thoroughly identify potential hydraulic connections between the two basins, identify and explore existing and potential AIS of concern, and assess AIS control technologies. These control technologies include but are not limited to physical or hydrologic separation. Language in Section 1538(b)(5) of Public Law 112-141 (Moving Ahead for Progress in the 21st Century Act or MAP-21) directed expedited completion of the

GLMRIS Report no later than 18 months from enactment. In an October 2012 Interim Report to Congress, USACE described its strategy for completing GLMRIS within the congressionally mandated timeframe. MAP-21 further directs the Secretary to proceed directly to project preconstruction, engineering, and design (PED) if he or she determines a project evaluated in the completed GLMRIS report is justified. To date, 24 interim reports have been released and posted to the study website as the effort has progressed across the entire 1,500-mile basin.

The study is divided into two focus areas based on differences (in nature and complexity) between the hydrologic connection at the CAWS and the remainder of the inter-basin divide. Focus Area 11 is the CAWS, and Focus Area 2 encompasses all aquatic pathways outside the CAWS, commonly referred to as the Other Pathways. Exhibit 7 below shows the complete GLMRIS study area.

Exhibit 7. GLMRIS Study Area Map



The main purpose of GLMRIS is to develop an array of alternatives for preventing inter-basin transfer of AIS via aquatic pathways. While not directed solely at Asian carp, any alternatives identified would likely serve to prevent Asian carp movement into the Great Lakes via the CAWS or other aquatic pathways where Asian carp are a threat.

As part of GLMRIS, USACE is conducting a comprehensive analysis of AIS controls, and will analyze the effects of each AIS control, or combination of controls, on current uses of the CAWS and Other Pathways: (1) the CAWS, a continuous aquatic pathway between the Great Lakes and Mississippi River Basins, and (2) other aquatic pathways between these basins, as applicable. USACE will:

- Inventory current conditions and forecast future conditions within the study area
- Identify aquatic pathways that exist or may form between the Great Lakes and Mississippi River Basins from up to a 1 percent annual recurrence interval flood event
- Inventory current and future potential AIS of concern at applicable pathways
- Analyze possible AIS controls to prevent AIS transfer, to include hydrologic separation of the basins
- Analyze the impacts each AIS control may have on the environment and on existing and forecasted uses of the lakes and waterways within the study area.

Important considerations of GLMRIS include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species
- Commercial and recreational fisheries
- Current recreational uses of the lakes and waterways
- AIS effects on water users
- Effects of potential AIS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower, and conveyance of effluent from wastewater treatment plants and other industries
- Statutory and legal responsibilities relative to the lakes and waterways.

3.2.1 Focus Area 1: CAWS

The CAWS is the primary pathway of concern for potential inter-basin transfer of AIS. It is the most significant continuous aquatic connection between the Great Lakes and Mississippi River Basins, and therefore poses the highest potential for AIS transfer. Focus Area 1 addresses the goal of preventing transfer of AIS via the CAWS.

3.2.2 Focus Area 2: Other Aquatic Pathways

In addition to the CAWS, in 2010, 36 other potential aquatic pathways were identified along the Great Lakes and Mississippi River Basins divide. An expedited study in fall 2010 eliminated 18 of these pathways. Within Focus Area 2, probabilities of AIS transfer at

the remaining 18 pathways were evaluated in 2011-2012. One of these pathways, the Wabash – Maumee, was identified for expedited action. Coordination with applicable state resource agencies regarding the study results is ongoing to identify which potential pathways may warrant further action, including identification of possible measures to prevent further transfer of AIS.

The aquatic connection that forms across the Wabash – Maumee Pathway (aka Eagle Marsh) in Fort Wayne, Indiana, was identified in 2010 as the highest risk aquatic pathway within Focus Area 2. The risk posed by AIS at this location prompted Indiana DNR—supported by the United States Environmental Protection Agency (USEPA), National Resource Conservation Service (NRCS), USGS, USACE, Allen County, and the Little River Wetlands Project—to complete construction of a temporary barrier fence to prevent adult Asian carp movement across the marsh during flood events. As part of the Focus Area 2 effort, USACE has completed an Aquatic Nuisance Species Controls report for this pathway assessing what action or set of actions could best attain a long-term solution to prevent inter-basin transfer of AIS across the Eagle Marsh in Fort Wayne, Indiana. Included in the report are identifications of structural and non-structural measures and a systematic evaluation of the completeness, effectiveness, efficiency, and acceptability of each measure.

Representatives of the Council on Environmental Quality (CEQ), USEPA, Indiana DNR, Little River Wetlands Project, Maumee River Basin Commission, The Nature Conservancy, USACE, USGS, and USDA NRCS met in December 2012 to discuss alternatives for implementation of a long-term solution to prevent spread of AIS between the Great Lakes and Mississippi River Basins across the Eagle Marsh in Fort Wayne, Indiana. This group of stakeholders focused on two alternatives identified in the GLMRIS Eagle Marsh ANS Controls Report, both of which entail reconstructing and reinforcing existing berms within Eagle Marsh to maintain hydrological separation of the two basins during floods up to the magnitude of the 1 percent annual chance event. The result of the meeting was a determination that the quickest and most cost-effective means to implement a solution would be for NRCS to lead development of the project with appropriate support of stakeholder organizations.

3.3 Monitoring and Removal in CAWS

Many federal and state agencies and other stakeholder entities are working together to aggressively monitor for presence of Asian carp throughout the CAWS and the Great Lakes Basin. These efforts include a wide range of activities throughout the year scheduled to maximize removal efforts and target various life stages. Each of these actions is described below.

3.3.1 Efforts within the CAWS

State and federal agencies, universities, and consultants are conducting intensive monitoring of the CAWS as prescribed by the Monitoring and Rapid Response Workgroup's (MRRWG) annual MRRP. The MRRP was first created in 2010 by MRRWG and was revised annually for the 2011 and 2012 sampling seasons to incorporate data gathered to date and lessons learned from efforts during prior years. This section highlights many of the ongoing efforts in conjunction with and independent of MRRWG's MRRP.

Routine site electrofishing samples – Illinois DNR, USFWS, and USACE have coordinated their efforts and are sampling five fixed sites and additional random sites within reaches of the CAWS to detect presence of Asian carp and characterize the local fish population. In 2012, over 4,300 staff hours were spent electrofishing, with additional hours devoted to response efforts. Data from these efforts are being used to monitor for Asian carp and inform a fishery statistical-based model that will ultimately quantify the potential of Asian carp presence/absence and relative abundance. This effort is part of a larger CAWS monitoring program developed by MRRWG of the ACRCC. USACE also conducts monthly electrofishing surveys at the electrical dispersal barriers, which are outside of regular MRRWG monitoring at fixed sites.

Netting and commercial fishing efforts in the CAWS – Extensive monitoring of the CAWS above the electric dispersal barriers includes traditional fishing gear and nets (i.e., hoop, mini-fyke, gill, and trammel nets), as well as contracts with local commercial fishermen. In 2012, 3,188 staff hours were spent netting these waters, with additional hours devoted to response efforts; 81.7 miles of nets were set. Fixed sites and random sites are being sampled throughout the CAWS.

Response planning in the CAWS – MRRWG members have worked extensively with partner agencies and the ACRCC executive committee to develop a decision matrix to trigger a varying degree of response actions based upon field data or reported observations. MRRWG is working closely with the ECALS team to further evaluate the efficacy of eDNA as an informative tool within the CAWS. Response actions include intensive and focused sampling with traditional fishing gear and electrofishing, participation of contracted commercial netters, and (potentially) use of rotenone.

Des Plaines/CSSC electrical dispersal barrier monitoring – USFWS LaCrosse and Carterville Fish and Wildlife Conservation Offices (FWCO) have developed a response to address threats from overflow from the Des Plaines River into the CSSC, should flooding occur. USFWS and collaborating agencies will attempt to monitor, collect, and stop any Asian carp life forms that may cross between the two water bodies. In addition to monitoring the area, USACE completed a 13-mile barrier above the electric dispersal barrier in 2010 that is between the Des Plaines River and the CSSC at the areas deemed most susceptible to flood conditions. This is a steel-reinforced, concrete barrier, reinforced with heavy-duty fencing that allows water to flow, but will prevent transfer of Asian carp into the CSSC.

Des Plaines River sampling – USFWS LaCrosse FWCO monitors the Des Plaines River below the Hoffman Dam at Riverside, Illinois, in an effort to detect Asian carp adults that may migrate to the dam for spawning.

Asian carp removal and applications testing below the electric dispersal barriers – A great deal of effort has focused on the areas downstream of the electric dispersal barriers within the Illinois River to reduce pressure of Asian carp populations near the electric dispersal barriers. In addition to the monitoring and commercial fishing endeavors discussed in previous sections, strategy will refocus on removal from areas proximate to the electric barriers to farther downstream where populations are the greatest. A goal of the ACRCC is to expand a sustainable Asian carp biological control program throughout the Great Lakes and Mississippi River Basins. Given that Asian carp are already well established throughout the Mississippi River Basin, this type of control program will be essential to slow their spread and prevent their establishment within waterway systems where they are not yet present. As efforts expand, the areas downstream of the electric dispersal barriers will be at the forefront of this control program. The following examples highlight current and future efforts:

As part of the MRRWG program, Illinois DNR contracts commercial fishermen to remove Asian carp from the waterways below the electric barrier system. Since 2010, this program has deployed nearly 600 miles of nets, resulting in removal of over 1.3 million pounds (>641 US tons) of bighead and silver carp from the Illinois River between electric dispersal barriers and Starved Rock Lock and Dam. Most fish were caught at locations over 65 miles south of Lake Michigan and over 30 miles south of the electric barrier system. An additional pilot program will continue removal via commercial harvesting from Dec 2012 to March 2013 in an effort to exploit the Asian carp in

the winter. During the first week of this work (December 2012), two seine hauls removed over 60,000 pounds of Asian carp.

Farther downstream, areas in which Asian carp are well established are being used as locations for research of test control measures. These measures include remote sensing, gear comparison testing, and population modeling/fishing experiments applicable to leading edge controls. Also tested within other areas of the Illinois River and the Mississippi River Basin has been the efficacy of USGS seismic technology (also known as a water gun or cannon).

3.3.2 Great Lakes' Monitoring Efforts

Lake Erie Rapid Assessment and Monitoring Efforts

In July 2012, the University of Notre Dame's eDNA laboratory indicated that four water samples collected in Ohio's Sandusky Bay were positive for bighead carp eDNA, and two samples collected in Ohio and Michigan waters of Maumee Bay were positive for silver carp eDNA. In response to these positive eDNA findings, USFWS, Ohio DNR, and Michigan DNR initiated a rapid assessment in late July and early August 2012 that included collection of an additional 417 eDNA samples from both Sandusky River/Bay and Maumee River/Bay, as well as extensive gear sampling within these areas using electrofishing and gill netting. The gear sampling revealed no bighead or silver carp. In August 2012, eDNA results from Sandusky River/Bay indicated that 20 of the 150 samples were positive for silver carp eDNA. In early September 2012, extensive follow-up gear sampling occurred within areas of Sandusky River/Bay that had shown positive eDNA results; the sampling strategy utilized electrofishing boats to drive fish into set gillnets. No bighead or silver carp were found during this sampling. The eDNA results for Maumee River/Bay, received in September 2012, indicated 3 of 350 samples positive for silver carp eDNA in Maumee Bay. Additional follow-up sampling was not conducted in Maumee River/Bay during the 2012 field season. Bighead and silver carp monitoring and management activities for 2013 and beyond are coordinated through GLFC's Lake Erie Committee.

In 2012, in response to detection of Asian carp eDNA in the U.S. waters of Lake Erie, OMNR expanded its surveillance programs within the Canadian waters of Lake Erie and Lake St. Clair, and the Detroit, St. Clair, and Thames Rivers to monitor for Asian carp. The expanded program began in September 2012 and included index electro-fishing in the Detroit River, St. Clair River, and Thames River, as well as within near-shore areas of the Lake Erie western basin and Lake St. Clair. In addition, eDNA surveillance occurred at 124 sites (96 sites were monitored twice) within Lake Erie and the St. Clair corridor, focusing on areas with suitable habitat for Asian carp. No positive detections of Asian carp eDNA or live specimens occurred during these surveillance efforts.

In 2013, OMNR will continue its core surveillance programs within Lake Erie and the other Great Lakes. Working in coordination with U.S. partner agencies via the Lake Erie Committee, OMNR is assessing opportunities to expand current programs to include eDNA surveillance within key areas of Lake Erie. The agency has also developed an Asian Carp Response Plan to help guide its

future surveillance and response actions in the event of a detection of Asian carp or eDNA in Ontario waters.

At its October 2012 meeting, GLFC's Council of Lake Committees (CLC) agreed to draft a position statement intended to shape the perspective of fishery managers throughout the Great Lakes regarding Asian carp. The position statement is under development and is expected to be brought forward for consideration by the CLC at its next regularly scheduled meeting in April 2013.

Other Great Lakes' Efforts

In 2012, USFWS approached the Council of Great Lakes Fisheries Agencies (Council) to discuss an overall management strategy of Asian carp and other AIS. It was decided that the Council would be the oversight authority for all monitoring and response efforts. In spring 2013, USFWS's FWCOs, in collaboration with its federal, state, tribal, and provincial partners, will implement Asian carp early detection and surveillance activities within each of the Great Lakes and selected tributaries. Sampling methodologies designed to capture various life stages of Asian carp will include eDNA, plankton sampling for early life history stages (eggs and larval fish), and traditional fish sampling gear (gill nets, fyke nets, trawls, electro-fishing for juvenile and adults). Results will be reviewed with state partners to further inform development of a comprehensive Asian carp early detection and surveillance plan for the Great Lakes.

Ichthyoplankton (eggs and larvae of fish found mainly in the near-surface waters) and traditional fish sampling gears for Asian carps will follow procedures recently developed by USFWS. Reportedly, Asian carps have been caught most easily in the egg and larval stages. Once water temperatures and flow regimes become suitable for Asian carp spawning and hatching in 2013, larval fish and fish eggs will be collected in areas likely to provide spawning and nursery habitat. Traditional fish sampling gear will be deployed in areas most likely to support age-0 Asian carps in 2013 using a probabilistic sampling design based on methodologies and approaches outlined in Trebitz el al. (2009) and Hoffman et al. (2011). Results of the 2012 sampling efforts in western Lake Erie and of the planned 2013 sampling activities will inform future monitoring plans.

3.3.3 eDNA Monitoring Throughout the Great Lakes Basin

Since 2010, USFWS and Illinois DNR have collected eDNA samples from the CAWS on a regular basis. USACE and USEPA filter the water samples to be processed at USACE's Engineer Research and Development Center (ERDC) laboratories. Processing efforts began with USACE in 2009 and will transition to USFWS in 2013. USFWS is on track for assuming responsibility for processing CAWS eDNA monitoring samples. Construction of the new Whitney Genetics Laboratory (WGL) was completed in November 2012 at the La Crosse Fish Health Center. This 5,800-square-foot building has 10 offices and 8 laboratories for Asian carp eDNA sample processing. Six clean rooms will be used for each step of the eDNA process. These clean rooms are about 120 square feet and have state-of-the art UV-sterilization designed to prevent contamination. WGL has hired six personnel to manage CAWS sampling, including provision of sterilized and labeled sampling kits

for the field offices. Personnel include a molecular geneticist, three fish biologists, and two biological science laboratory technicians. The WGL geneticist is evaluating the Quality Assurance Protection Plan (QAPP) and may suggest minor corrections or revisions to the eDNA technical working group. Once the document is finalized and approved, WGL eDNA staff will follow it strictly. The goal of the WGL is to become a fully functional eDNA lab and begin processing 2013 spring samples from the CAWS.

eDNA has been used as an early detection surveillance tool since 2009 and is specified for use by the ACRCC in the MRRP. It has yielded "presence/absence" data for the reaches of the waterway sampled. In 2010, 2011 and 2012, eDNA was used as a regular weekly monitoring tool to help inform response decisions, as specified in the MRRP. Results are posted regularly on the USACE Chicago District website: http://www.lrc.usace.army.mil/Missions/CivilWorksProjects/ANSPortal/eDNA.aspx. Between 2009 and 2012, over 7,000 water samples were analyzed for bighead and silver carp DNA.

eDNA sampling in the basin will follow the procedure developed by USFWS specifically for the Great Lakes. This standard operating procedure (SOP) was developed and modeled after the USACE eDNA QAAP for the CAWS. USFWS will work with the states, provinces, and other members of the Council of Great Lakes Fishery Agencies to identify where efforts should focus to ensure sampling occurs within areas with the highest probabilities of Asian carp spawning or presence (e.g., Maumee River/Bay, Sandusky River/Bay, and southern Lake Michigan). Sampling at these locations will follow a probabilistic design targeting areas of eDNA accumulation. Samples will be processed by any of the following ACRCC approved labs: the USFWS La Crosse Fish Health Center, the USGS Upper Midwest Environmental Sciences Center, the USACE – Vicksburg Lab, and the University of Notre Dame.

3.3.4 Other Monitoring Efforts

Asian carp gear development – USFWS Columbia FWCO is working in the Missouri River to develop various fishery gear to improve efficiency of catching Asian carp in areas where they are known to exist in large numbers. The purpose of this gear development is to transfer the technology to the CAWS to better monitor, collect, and remove Asian carp. Illinois DNR, Illinois Natural History Survey, the University of Illinois, and a panel of Asian carp experts are also working to develop fish collection gear to more efficiently capture Asian carp. Commercial fishermen from across the country have been brought together to provide valuable expertise. Gear developed in 2012 includes 30-foot deep gill nets, 6-foot hoop nets, and surface to bottom pound nets (similar to Great Lakes pound nets). Other nets and techniques are under review. Assessment of gear most effective for collection and sampling of Asian carp juveniles is also underway.

Fish behavior near the electric dispersal barriers as determined through Dual-Frequency Identification Sonar (DIDSON) and Telemetry studies – The Carterville FWCO of USFWS, with support from USACE, has a project that utilizes DIDSON to observe both feral and captive fish behavior in and around the barrier. Feral fish are viewed in timed (pre-determined) runs in and through the electrical dispersal barriers, and captive fish are being confined and transported through the electrical dispersal barriers in a boat-mounted cage to observe their reaction to the electric field. USACE is leading the effort, using ultrasonic telemetry, to directly assess efficacy of the electric dispersal barrier by determining if tagged fish are able to challenge and/or penetrate the electric dispersal barrier. Other purposes of the telemetry project are to determine if Asian carp are able to navigate through lock structures in the Illinois Waterway, to identify the leading edge of the Asian carp populations, and to directly test the response of smaller sizes of fish to the barrier. An acoustic array is established in the CAWS and the Illinois Waterway, spanning about 50 miles, which is also supplemented by monthly mobile tracking. USACE implanted 238 fish with transmitters, and their movements are tracked by the series of acoustic receivers throughout the waterway. Above the electrical dispersal barriers and immediately below in Brandon Road Pool, common carp, buffalo spp., grass carp, and freshwater drum are used to study fish movements, whereas in Dresden Island Pool, bighead and silver carp are used to study movement. Since 2010, over 5.5 million detections indicate no tagged fish have crossed the electrical dispersal barriers since the operating parameters were changed.

USACE is also using innovative technology to track fish movement at the electrical dispersal barriers. Preliminary analysis shows tagged fish moving upstream and turning back downstream as they approach the electrical dispersal barriers. This new technology will give us insight to fish aversion response near the electrical dispersal barriers.

Bighead Carp in Illinois Urban Fishing Ponds – Illinois DNR fields many public reports of observed or captured Asian carp. All reports are taken seriously and investigated through corresponding via phone/email with individuals making reports, requesting and viewing pictures of suspect fish, and visiting locations where fish are being held or reported to have been observed in the wild. Most reports of Asian carp prove to have been sightings of native gizzard shad or stocked non-natives such as trout, salmon, or grass carp. Reports of bighead or silver carp from valid sources and locations where these species are not known to have previously occurred elicit a sampling response with boat electrofishing gear and trammel or gill nets. Typically, no bighead or silver carp are captured during sampling responses. The "Bighead Carp in Illinois Urban

Fishing Ponds" report was published on www.asiancarp.us in December of 2011 to detail the bighead carp collected in ponds surrounding Chicago, Illinois. Historical accounts and targeted surveys of these ponds and lagoons cited detections of a few rare and large individuals. That all bighead carp collected from Chicago area ponds to date have been very large fish of similar size and age suggests stocking as a potential source. These demographics indicate that limited stocking probably occurred sometime before 2005, likely before the State of Illinois banned incoming transport of live bighead carp. During that time, bighead carp were commonly raised for market in ponds with channel catfish in certain regions of the U.S. Shipments of channel catfish may have been a vector of Asian carp in Illinois urban fishing ponds because catchable-sized catfish were stocked frequently and extensively in these waters throughout the State. Similar collections have been noted throughout the Midwest in states such as Nebraska and Kentucky, where the presence was associated with fish stocking; however, other pathways such as intentional release and bait bucket introduction cannot be ruled out.

Additional sampling and removal efforts through 2012 occurred at 24 ponds throughout the greater Chicago region. The majority of the ponds were found to lack bighead carp, and silver carp have never been detected at these locations. None of the locations where Asian carp have been collected is suspected to harbor threats to either the CAWS or Lake Michigan, as these areas are completely isolated from other water bodies. Several lagoons with connections to other water bodies have been recently rehabilitated (using rotenone and restocked), have undergone severe winterkill, or have otherwise been found devoid of any Asian carp via exhaustive sampling. Continued surveillance and/or removal is needed to prevent any further movement of these species in the Chicago area. Three exceptional specimens from Humboldt Park lagoon (42-62 pounds) were given to the John G. Shedd Aquarium in Chicago Illinois, for inclusion in the Shedd's AIS display.

3.4 Risk Assessment

Risk assessment is a process that incorporates existing biological information to assess risk and potential impacts of an invasive species. Risk is evaluated as the sum of the probability of introduction and the magnitude of consequences should a species successfully invade. Probability of introduction is based on four metrics: likelihood an invasive species will arrive in a system, likelihood that the species will survive in the system, likelihood that the species can

establish in the system, and likelihood that the species can spread within the system. Coupled with this evaluation of risk is the uncertainty of the conclusion, based on amount and quality of information available. An evaluation of potential ecological impacts of the invader occurs, often using ecosystem modeling. Based on the information derived from the biological assessment of risk, a socio-economic evaluation of risk also may occur. Risk assessment is part of a larger process called risk analysis that includes the risk assessment, risk management or mitigation, and risk communication.

3.4.1 Binational Risk Assessment

In 2012 the bi-national Canadian and United States risk assessment report regarding Asian carp in the Great Lakes[19] was released, indicating that Asian carp pose substantial environmental risk to the Great Lakes if they become established. The risk assessment report indicates that bighead and silver carp pose an environmental risk to the Great Lakes within 20 years, with the risk increasing over time. Lakes Michigan, Huron, and Erie face the highest risk relative to the other lakes.

The risk assessment was led by the DFO-Canada and included a team of scientists from Canada and the United States. The risk assessment examined, among other elements, the likelihood of survival and establishment of Asian carp in the Great Lakes. Because the risk assessment relied on prevention measures under way through November 2010, it did not consider the extensive preventive actions implemented since that time. The risk assessment report supports the notion that Asian carp could survive and successfully reproduce in the Great Lakes. The risk assessment report further identifies the most likely pathway for Asian carp to enter the Great Lakes as via the Chicago Area Waterway System.

The risk assessment report suggests that the major ecological consequence resulting from establishment and spread of Asian carp into the Great Lakes would likely be an overall decline in many native fish species, including commercially and recreationally important species. These declines could occur because Asian carp may outcompete native plankivorious fish, leading to reduced growth rates and declines in abundance. As these affected native fish may be an important food source, this effect may cascade upward, resulting in corresponding declines in native predatory fish

[19] Cudmore, B., N.E. Mandrak, J. Dettmers, D.C. Chapman, and C.S. Kolar. 2012. Binational Ecological Risk Assessment of Bigheaded Carps (*Hypophthalmichthys spp*.) for the Great Lakes Basin. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/114. Vi + 57 p.

populations. Asian carp could also reduce survival of open-water fish larvae, such as walleye and yellow perch, through competition for plankton or predation on the larvae.

Finally, the risk assessment report emphasizes that establishment of Asian carp in the Great Lakes and resulting ecosystem damage are not foregone conclusions. Preventing establishment of Asian carp in the Great Lakes is the best means of avoiding harmful ecological and economic effects.

3.4.2 Other Risk Assessments

Several risk assessment activities regarding Asian carp are also ongoing or planned by U.S. agencies through the 2011 and 2012 Frameworks, including current research activities to provide information for use in risk assessments. Some of these efforts are occurring outside of the ACRCC Framework; however, lead agencies and organizations are communicating and coordinating with the ACRCC to ensure that information is incorporated into the ACRCC's ongoing activities.

In 2010 and 2011, USGS undertook the project titled, *Great Lakes' Tributary Assessment for Asian Carp Habitat Suitability* (2.5.11) focusing on the Milwaukee River in Wisconsin and the St. Joseph River in Michigan. The outcomes of this project included the following:

- Determination of a more exact timeline for Asian carp to achieve required key developmental stages
- Determination of the minimum velocities needed to keep Asian carp in early, non-swimming life stages suspended in the water column
- Doppler current profile data, mean velocities, and longitudinal particle dispersion coefficients of rivers most likely to be used as spawning habitat by Asian carp
- Modeling of the transport of Asian carp eggs and larvae to assess spawning habitat suitability.

The hydraulic and water quality data obtained will be analyzed and documented to finish the ongoing risk assessment within the Milwaukee River in Wisconsin by the end of 2011. Additional testing of Asian carp species at the USGS Columbia Environmental Research Center will verify the development series and density data obtained. Spawning suitability models will be developed with the University of Illinois. In 2012, the Sandusky River, a tributary of Lake Erie in Ohio, was assessed.

USGS scientists conducted research in 2011 to examine the suitability of the Maumee River for spawning of bighead and silver carp. Findings indicate that the temperature regime and water flow characteristics of the Maumee River appear suitable for spawning. Additional research was undertaken in 2012 to identify potential spawning locations and to determine river locations suitable for development of mitigation options. A USGS report describing data acquistion and analysis from the Milwaukee, St. Joseph, Maumee, and Sandusky Rivers has been drafted, and publication is expected by July 2013.

In addition to the *Great Lakes' Tributary Assessment for Asian Carp Habitat Suitability*, USGS scientists conducted research on thermal and hydrologic suitability of Lake Erie and its major tributaries for spawning of Asian carp. The research manuscript describing these results was published in March 2012. These study methods were applied to seven major tributaries in Ohio: Maumee, Sandusky, Portage, Huron, Vermilion, Black, and Grand Rivers.

USFWS and NOAA are collaborating on a project titled *Ecological/Biological Risk Assessments* (2.4.4). This project will develop biological and/or ecological models for Lake Michigan, Lake Erie, and Lake Huron to more accurately predict potential for establishment and impacts of Asian carp within each water body. In 2012, rapid screening is identifying risks to the Great Lakes from Crucian carp, Prussian carp, and some other related species. Identified risks regarding these species are being shared with Great Lakes states and federal regulatory authorities.

NOAA is also leading an effort titled *Forecasting Spread and Bio-economic Impacts of AIS from Multiple Pathways* (2.4.5)—addressing establishment of AIS likely to be introduced into the Great Lakes via three major pathways: (1) shipping and recreational boating, (2) organisms in trade, and (3) canals, especially the CSSC. The effort will focus on forecasting:

- Probability of establishment
- Potential habitat of species within the Great Lakes
- Potential spread of invaders within the Great Lakes
- Regional economic impact.

These efforts collectively will furnish important information regarding risk of Asian carp introduction to the Great Lakes, and will provide direction for monitoring, response, and mitigation efforts if needed in the future.

3.5 Scientific Research and Development

The Framework science strategy focuses on development of approaches, methods, and tools for detection, prevention, attraction, and removal of invasive Asian carp. Numerous historical examples demonstrate the difficulty of eradicating or controlling populations of AIS (e.g., sea lamprey, zebra mussels, and common carp). Extirpation is rarely accomplished, and achieving persistent population control is challenging at best and expensive, requiring long-term, dedicated effort. This reality has oriented the major focus of Framework projects toward preventing introductions of Asian carp into the Great Lakes. However, fishery management tools are needed if failures of prevention occur, and to further reduce propagule pressure (i.e., lower population densities) where Asian carp are already established.

The focus on developing and determining effectiveness of control strategies will require continued information not just on effectiveness and efficiency of control methods, but also on (1) invasive species life history and types of habitats needed for growth, (2) best use of attractants and repellants to concentrate Asian carp within areas for control or removal, (3) hydrologic conditions for control application and monitoring activities, (4) effects of controls on native

organisms, and (5) other important factors. This information is also critical for identifying the most effective choke points for control of these species.

An Integrated Pest Management (IPM) approach will provide managers a range of options for addressing invasive species and controlling these. No single tool, technology, or method will suffice for all situations or species. Therefore, a suite of control options must be created—requiring the breadth of information gathered and knowledge gained from scientific activity under the Framework. While focused on Asian carp at this time, most detection, prevention, attraction, and removal methods are designed for application to a wide range of AIS.

In 2013, demonstration site(s) will be developed to test control strategies, train management agencies in use of these control methods, and promote awareness of these strategies among decision makers and the public.

Asian Carp Detection

Asian carp can exist at low population densities without detection because they are rarely caught by traditional angling methods; they are adept at avoiding static capture gear, and anecdotal evidence seems to indicate that silver carp rarely exhibit jumping behavior at low population densities. Early detection of Asian carp is critical for initiation of rapid response efforts that can prevent population establishment. eDNA is a new technology useful for detecting presence of carp DNA in a water sample, thus indicating nearby presence of fish. The current focus is on improving such genetic markers and sampling and analysis techniques. Other molecular surveillance techniques such as microbial source tracking (MST) also have promise for monitoring presence of Asian carp. MST targets bacteria unique to the digestive tract of Asian carp. This technique has been previously used to identify sources of fecal contamination and may complement eDNA analysis. Identifications of genetic markers and/or microbes are occurring, as well as sampling and analysis techniques to utilize MST for Asian carp detection. Methods by which Asian carp DNA and microbes can be introduced in the absence of live fish are also under investigation (e.g., birds and carcasses) to help address limitations of current eDNA monitoring methods. USACE, USFWS, and USGS are working to develop a model to determine how much DNA is given off by a fish and how quickly the DNA degrades under varying conditions so that sampling of eDNA can be used to develop a rough estimate of fish density or biomass. Additional information on these efforts appears in the following section.

3.5.1 eDNA Sampling and Analysis Optimization and Vector Analysis

eDNA is a surveillance tool used to indicate presence of genetic material of a particular species; in this study, bighead and silver carp were targeted. Fish, including Asian carp, naturally release cells containing DNA into the environment through mucoidal secretions, feces, and urine. DNA degrades in the environment, but the process is not instantaneous, and DNA can be held in suspension and transported. Genetic material of species can be detected by filtering water samples and then extracting and amplifying short fragments of the shed DNA. Unlike other

surveillance methods, eDNA does not rely on direct observation of Asian carp to indicate presence.

The eDNA method has undergone two review processes. The first was in 2009 when the University of Notre Dame laboratory was audited by an EPA team. That audit concluded that the eDNA method is sufficiently reliable and robust in reporting a pattern of detection, and that it should be considered actionable in a management context. The team expressed a high degree of confidence in the basic Polymerase Chain Reaction (PCR) method used to detect bighead and silver carp eDNA. The second was completed in December 2010, when the USACE contracted an independent external peer review of eDNA science and methodology, and findings were presented in the report, *Revised Final Independent External Review Report Environmental DNA (eDNA) Science and Methodology*. The review panel found some clear advantages and disadvantages of the eDNA methodology. In the panel's opinion, no other single method could provide the suite of advantages offered by eDNA sampling, which include the following: (1) sampling can occur over a large spatial area very rapidly at relatively low cost, and (2) the method is potentially more sensitive for detecting Asian carp in environments typical of the CSSC than are traditional fishery methods. Key limitations of the method, however, are that locations and condition (live or dead) of fish contributing eDNA to a water sample are not known. Additionally, eDNA detections do not provide information on the size, age, or gender of individuals present. Furthermore, the method cannot distinguish between pure silver or bighead carp or their hybrids, and detection is not immediate because of a time delay between water sample collection and processing for eDNA.

To date, USACE and the MRRWG have acknowledged that a positive eDNA sample indicates presence of Asian carp DNA and possible presence of live fish. Currently, the ACRCC cannot rely solely on eDNA as evidence to determine whether live Asian carp are present, whether the DNA may have come from a dead fish, the number of Asian carp in an area, or whether water containing Asian carp DNA may have been transported from other sources (e.g., translocation by vessels or birds). eDNA cannot presently provide exact, real-time information on locations of Asian carp because of the requisite 2-week sample processing time. However, the eDNA method can be used as a basis for precautionary and prudent actions. Moreover, for making critical management decisions, the eDNA method can be a useful complement to traditional fish sampling gears and can greatly improve efficiency of the monitoring program for detecting Asian carp.

To help resolve the issues identified above and manage these uncertainties, USACE is leading an ECALS with USGS and USFWS. The ECALS will investigate alternate sources of Asian carp DNA, improving existing genetic markers, and determining the relationship between (1) the number and distribution of positive eDNA samples and (2) the density of Asian carp. In addition, the ECALS will investigate ways to render the eDNA process more efficient (decrease processing time and cost). This would allow managers to better interpret what eDNA results mean and obtain results faster.

The following efforts are occurring or will be undertaken as part of the ECALS:

eDNA Vector Assessment

The assessment will investigate potential Asian carp vectors as a source of fish or eDNA movement in the CAWS (ACRCC Framework Item 2.5.3). The product will be a report and graphical representation of alternative avenues of eDNA transport, accompanied by some broad conclusions regarding risks of positive eDNA results from sources other than live fish having passed upstream of barriers. Specific objectives are:

- Objective 1.1: Develop a conceptual model of the possible pathways, aside from fish passage of barriers in the CAWS, for deposition of Asian carp eDNA upstream of barriers.
- Objective 1.2: Assess Asian carp eDNA prevalence in alternate pathways.
- Objective 1.3: Assess potential for transport/deposition of detectable Asian carp eDNA via piscivorous bird excrement.
- Objective 1.4: Assess likelihood of eDNA positive results resulting from trans-barrier transport of Asian carp carcasses on barges.
- Objective 1.5: Assess the role of sediments in eDNA transport.

eDNA Marker Development

Develop high-fidelity, sensitive genetic markers for detecting presence of Asian carp DNA in filtered water samples based on real-time polymerase chain reaction (RT PCR) or quantitative PCR (qPCR) (ACRCC Framework 2.6.5). The product will be a report describing a set of highly polymorphic mitochondrial DNA (mtDNA) markers that provide some degree of inference as to minimum numbers of individual Asian carp within a pooled eDNA sample. Specific objectives are:

- Objective 2.1: Sequence bighead and silver carp mitochondrial genomes.
- Objective 2.2: Test new markers.
- Objective 2.3: Detect multiple alleles.

eDNA Calibration

Determine the relationship between (1) the number and distribution of positive Asian carp eDNA detections and (2) the population density of Asian carp (ACRCC Framework 2.6.3). The products will include:

- A robust protocol for rapid extraction and analysis of eDNA samples
- Detailed conversion of the current PCR band-based (i.e., presence-absence) assay to a TaqMan real-time qPCR assay

- An optimized water sampling protocol
- A series of relationships among Asian carp biomass, number, and behavior and eDNA detection using PCR, including rate and extent of dispersion of Asian carp eDNA in both non-flowing and flowing waters
- Relationships between environmental factors (water temperature, light exposure, zooplankton and microbial biomass, pH) and eDNA degradation rates
- Description of demographic characteristics (size, biomass, sexual maturity)
- Hydrodynamic model of the CAWS for use as the basis of transport of eDNA within the system, including influence of barges and the electrical barrier
- A model to estimate probability that each potential source of eDNA in a water body is actually a source of eDNA—thus deriving the probability that an Asian carp population is present in that water body above the monitoring location.

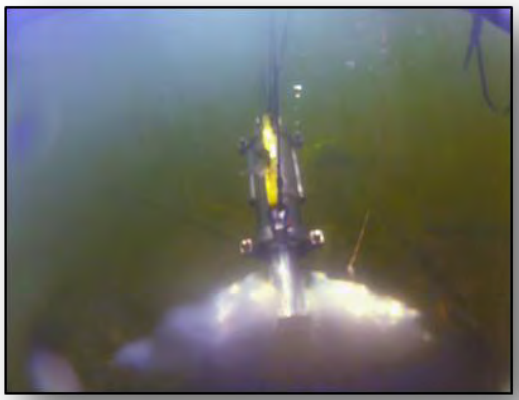
Specific objectives are:

- Increase efficiency and throughput of eDNA processing.
- Conduct eDNA calibration guidance studies.
- Develop a Hydrodynamic model.
- Develop a Probabilistic model.

Project managers of the ECALS will produce products including progress updates, team workshops, technical reporting, project management plan (PMP) development, and project communications.

3.5.2 Control Development

Control of invasive species involves both prevention of introductions and reduction of established populations. Current scientific research encompasses efforts to provide natural resource managers with the tools to (1) reduce the capacity of bighead carp and silver carp to establish in new locations and (2) decrease populations in areas where bighead carp and silver carp have become established. In addition, these efforts also include developments of (1) physical methods to create barriers to fish movement or reduce recruitment, and (2) other methods that incorporate a chemical or biological control agent to directly or indirectly reduce populations of bighead carp and silver carp.



Control – Physical Methods

Bighead carp and silver carp focus spawning efforts on riverine habitats with turbulent waters to provide their buoyant eggs the greatest opportunity to remain suspended in the water column during embryogenesis and early larval development. Identification of those areas coupled with physical systems to reduce survival of these sensitive life stages could reduce bighead carp and silver carp recruitment.

Electrical barriers operated by USACE in the CSSC are the primary physical barriers currently in place. USGS is examining the utility of pulsing sound (seismic) pressure in the water using water guns to affect distribution of Asian carp (Use of Seismic Technology to Divert or Eradicate Asian Carp – 2.5.6). Water guns have been shown to cause significant negative effects in caged fish of several species, including Asian carp, and will affect their behavior and movement. Some preliminary 2012 results have also shown that sound alone may be effective in herding or deterring Asian carp. In 2013, research will focus on refining the water guns and sound parameters necessary to repel and divert Asian carp, with the goal of determining the least amount of energy and force necessary. Additional studies on effects of water guns on the integrity of structures within a water body (e.g., canal walls) are also planned. In the future, this tool could be used in conjunction with netting or other control techniques to remove fish from targeted areas. Chemical barriers provide another opportunity to deter fish access to specific areas, and may be suitable for short-term rapid deployment during maintenance of longer term physical barriers (e.g., the electrical barriers operating in the CSSC). Chemical barriers may have an advantage over behavioral or physical barriers if the barrier is needed only for short time periods, especially if current methods for dissolution of carbon dioxide or ozone in water are sufficient to achieve concentrations above fish detection levels. Illinois DNR, USGS, and collaborators from the University of Illinois, Urbana-Champaign will evaluate the utility of chemical barriers to limit bighead carp and silver carp access to certain habitats.

Control – Biological/Chemical Methods

IPM programs often take advantage of combinations of biological, chemical, and physical controls in managing an invasive species. USGS research has principally focused on chemical controls of bighead carp and silver carp. A lack of registered piscicides (chemicals poisonous to fish) severely limits the tools that aquatic resources managers have available to control aquatic invasive fish. Identification and registration of new piscicides and development of biological control agents for incorporation into an oral delivery platform would increase the ability of managers to deal with aquatic invasive fish. Furthermore, increased scrutiny of rotenone due to human health implications could result in potential loss of this piscicide, creating a gap that would have to be filled. The USGS is analyzing structures and activities of chemicals with known piscicidal capabilities described in a variety of industrial, pesticide, and pharmaceutical libraries.

No current technology can specifically target bighead or silver carp for control within aquatic ecosystems. Current piscicidal chemicals are not selective for bighead or silver carp—current

methods to apply these in aquatic systems equally expose all animals present. Developing targeted delivery systems with high specificity for bighead and silver carp (e.g., systems that take advantage of these carps' particulate retention capacity) would increase the ability of management agencies to control or limit Asian carp while minimizing potential impacts on native species. USGS, in collaboration with private industry, is evaluating technologies to develop biological or chemical control agents in a microparticle delivery system that, when captured and ingested by a bighead or silver carp, would release its control agent payload within the digestive system, limiting exposure to non-target species. A microparticle incorporated with antimycin and targeted for uptake by Asian carp is in the final stages of production—a product of extensive research into the digestive system of bighead and silver carp, comparisons with relevant native fish species physiology and feeding habits, testing of the antimycin toxin, and acquisition of other critical information. Delivery of the microparticles to USGS is anticipated in spring 2013. Researchers will then begin lab trials on Asian carp to determine the effectiveness of this control tool.

In addition to antimycin, scientists are screening for potential chemicals with greater toxicity to Asian carp than to other native fishes. In 2013, researchers plan to begin cell toxicity assays of native fish, as well as Asian carp, using candidate chemicals. In the future, chemicals identified in this project could be incorporated into a microparticle application or developed for application in water to specifically control Asian carp.

A prospective biological control agent is a vaccine that could induce self-sterilization of Asian carp. Although similar vaccines have been developed in murine models, USGS is just beginning to determine whether this technology could be applied in fish. If successful, such a vaccine could substantially reduce recruitment by limiting the number of bighead carp and silver carp with viable gametes (reproductive cells).

Attractants and Repellants

Chemical stimuli play a critical role in the performance of essential life functions in many fishes, including Asian carp, by providing important information for locating favorable habitats, food resources, and conspecifics (other Asian carp) for schooling—as well as avoiding predators, synchronizing sexual readiness within the population, and inducing specific behaviors such as attraction and spawning behaviors. Sex pheromones can be induced through hormonal treatments. Repellant alarm pheromones offer carp protection from predation, and aggregating pheromones attract carp to schools. Selection and location of planktonic food sources are largely based on chemical cues.

Field studies are occurring to evaluate effectiveness of chemical stimuli as attractants and repellants to aid in capture of wild carp. These studies will include controlled pond mesocosms and restricted backwater or tributary habitats using caged fish as a source of stimulus, chemical stimulus release, or feeding station approaches. Technologies for observing responses of wild

carp to various control methods in the field are needed. Protocols are required to verify responses of Asian carp to attractive and repellant stimuli in the field.

This project is also investigating use of food as an attractant to aggregate and concentrate Asian carp. Laboratory and field studies in 2012 showed that fish are very responsive to certain algal mixtures. These "food stimuli" now are used in the field to condition Asian carp to feeding stations along tributaries of the Missouri River. These field tests will continue in 2013. This approach may be useful to aggregate Asian carp at these stations and then remove them by another control method or more effectively deliver control agents such as toxic microparticles.

Asian Carp Life-Cycle and Habitat

An understanding of the life cycle of Asian carp and the types of habitat they require for each phase of their development and reproductive success is essential for developing effective control strategies and tools. Asian carp recruitment success and year class strength are highly variable among years. Even given their extremely high fecundity (ability to produce offspring), survival of the early life stages appears to be the "Achilles heel" of Asian carps. In some years, most recently 2010 on the Illinois River, recruitment failed despite successful spawns. Asian carp larvae were briefly ubiquitous in off-channel habitats, but the larvae did not recruit (develop) to the fingerling stage. What combination of environmental conditions causes recruitment failure in some years is not clear, but a reasonable assumption is that with a more complete understanding of Asian carp larval and juvenile behavior and habitat selection, control mechanisms can be devised that take advantage of these strong drivers of recruitment success or failure.

That access to shallow lentic (still water) environments is important in the early life history of Asian carp seems highly likely, but beyond that, little is known. It is not understood how environmental parameters such as depth, presence and density of terrestrial or aquatic vegetation, turbidity, temperature, availability of planktonic or detrital food, degree of accessibility to the spawning river, and predator types and densities affect habitat selection and survival of young Asian carp. USGS research presumably will provide this knowledge, which should in turn offer opportunity to develop mechanisms for controlling this life stage that sets year class strength and thus controls population density of Asian carp. With knowledge of these requirements, future threats from Asian carp can be reduced. Also, habitats can be created that are highly attractive to young Asian carps, but where the fish could be easily harvested or targeted with directed toxicant formulations. Directed toxicant formulations would likely be much more effective in the shallow water habitats selected by juvenile bighead and silver carp than in the deep pelagic habitats selected by adult fish, because less water must be treated. Introductions of predators such as largemouth bass, catfish, or bowfin might be appropriate strategies, if the correct habitats can be identified and targeted.

USGS plans to conduct a number of projects that focus on determining the life cycle of and habitat uses by Asian carp. For example, despite some research and anecdotal information, locations of Asian carp nurseries in the Illinois, Mississippi, Missouri, and Wabash Rivers, and in

other rivers, are unknown. Some of these studies will occur necessarily where Asian carp are already established (e.g., sections of the Illinois, Missouri, and the Mississippi Rivers). Regardless of where this research occurs, all systems (Great Lakes, Ohio River, Mississippi River, etc.) will benefit because information expected to result from the effort is crucial for effectively and efficiently employing control technologies.

Hydrology, Hydraulics, and Water Quality

An understanding of the interaction between Asian carp and the hydrology and hydraulics of their river habitat is crucial in both risk assessment and application of control measures. Scientists have advanced the characterization of Asian carp egg transport in streams, rivers, and lakes to gain a greater understanding of what river velocities and lengths are needed to keep eggs suspended until they hatch. This information, along with identification of nursery habitat and spawning locations, will be helpful in understanding what makes a river a likely spawning and recruitment habitat. Hydraulic assessments of rivers will also be needed to support control measures. These assessments will allow us to identify possible "choke points" in rivers where control might be the most feasible.

Hydraulic data are also required for optimal application of other technologies such as attractant or repellent substances or oral-delivery toxins. To transition these technologies from the laboratory to field testing and application necessitates confidence in prediction of how far the introduced substance will travel and what flow conditions it will encounter. For example, areas of the Chicago Area Waterways occasionally reverse flow. Additionally, the Illinois River main channel has water velocities larger than those in the adjacent flood plain or side channels. Such conditions could cause false estimates of travel time and dispersal if an assumption of a simple flow condition is used. Hydraulic or geochemical analyses may also be needed to identify conditions when encapsulated toxins become isolated as "sediment" on stream bank areas or become re-suspended and are delivered during non-targeted times because of post-deployment changes in stream flow. USGS capabilities and experience in acquisition and assessment of water-quality data, from either fixed stations or field surveys, will be important to the success of these field applications to complement its biological expertise in Asian carp recruitment and control measures. USGS data regarding stream flow, water quality, and bathymetry, as well as USGS expertise in hydrologic simulation and climate change science, can help optimize the design of hydraulic separation measures and preserve prior hydraulic and ecologic functions of the proposed separated basins, as practicable.

Water quality is an important component of habitat, and understanding this is crucial for success of potential control measures. Asian carp sensitivity to conditions affecting water quality such as temperature and turbidity may impact spawning and recruitment. Similarly, performance of carp pheromone attractants to optimize other control measures may be affected by availability of other nutrients and food. Understanding effects on Asian carp of water-quality factors such as pH and dissolved oxygen may be important in devising successful attractant or repellent substances or oral-delivery toxins. Application of emerging types of water-quality data, such as from field-based

measurements of chlorophyll, organic matter, and other water quality characteristics (e.g., turbidity) could assist in identifying precursor conditions affecting field pheromone use as an attractant for Asian carp control.

Control Strategies

Other methods of controlling fish populations are numerous. Success of the Integrated Sea Lamprey Control Program, coordinated by GLFC, demonstrates the benefit of incorporating a variety of control tools into a comprehensive management plan. In addition to the previously described work, University of Illinois, Illinois DNR, and USGS researchers are examining the effectiveness of carbon dioxide and ozone to deter Asian carp. These potential deterrents will be tested in 2013 in the same USGS pond systems where continuing tests with the water guns and sound will occur, thus generating data that will enable comparisons among these potential options for deterring and aggregating Asian carp. The tests will be conducted to confirm the utility of a carbon dioxide gas barrier to exclude Asian carp from an area.

Any of previously cited methods to concentrate Asian carp into a specified area for targeted removal (such as use of pheromones, sonar, or seismic technology) would be improved by development of traps and nets designed to specifically target Asian carp once fish have been aggregated. Gear improvements are under examination in the project to Develop Alternate Traps and Net Designs to Enhance Asian Carp Capture Rates (2.5.15)—bringing together experts in various fields to develop and test alternative net and trap designs.

Finally, a project in 2013 will begin assembling a mobile electric array that will utilize state-of-the-art electrical technology to prevent fish passage. This array will be designed for deployment (at one location) relatively quickly—applicable to a variety of habitats and acting as a barrier within the CAWS or throughout the Great Lakes Basin where warranted. This can also be deployed as a moving electrical dispersal barrier to move, concentrate, or clear fish from an area.

3.6 Enforcement Activities

Asian carp are reared in aquaculture facilities in parts of the southern U.S., and are also commercially harvested in the wild. The fish are most highly valued alive at fish markets, which incentivizes non-compliant fish dealers to satisfy their customers. This illicit trade of live Asian carp threatens to circumvent the ACRCC's considerable effort to prevent movement through canals and waterways.

The Lacey Act prohibits interstate movement of live organisms that are on a list of injurious species. Currently, silver, bighead, and black carp are listed as injurious wildlife. Although the Lacey Act prohibits movement of live Asian carp across state lines, it does not prohibit Asian carp aquaculture or possession of live Asian carp. All the Great Lakes states and the province of Ontario have made it illegal to possess live Asian carp within their jurisdictions.

Despite the Lacey Act and state laws, movement of live Asian carp persists. Several recent arrests at the U.S./Canadian border illustrate this disconnect between the law and observed practice. In another instance, a shipper's dewatered tanks contained live Asian carp, but the individual made no effort to ensure all of the carp were in fact dead. In another case, a thin layer of ice was mortal to the fish on top, but the ice melt acted to slow the metabolism and prolong the lives of the fish underneath. Upon inspection, law enforcement officers observed moving Asian carp and placed these fish in water, where they quickly righted themselves and began swimming. In all instances, the Asian carp had originated from American fish farms outside of the Great Lakes Basin. These examples highlight the potential threat posed by the food-fish trade as a pathway for introduction of live Asian carp to the Great Lakes.

Enforcement of U.S. and Canadian laws regulating movement and/or possession of live fish is essential to prevent establishment of Asian carp in the Great Lakes Basin. GLFC's Lake Erie Committee believes that prevention efforts are the most important investment for protecting Lake Erie from potential effects of Asian carp. The Great Lakes Law Enforcement Committee has consistently advocated better enforcement and tougher laws governing interstate movement of live Asian carp, and has facilitated training of officers to identity Asian carp and other key invasive fishes.

The enforcement community needs the following additional tools and resources to enforce laws prohibiting interstate movement and possession of live Asian carp:

- **Directed enforcement efforts**. Additional enforcement efforts related to bait fish transfers and shipment of adult live fish are essential to reduce the threat from these two potential vectors for Asian carp introduction. Additional efforts should occur in the field, but may also be exerted to enforce permits or to develop a permitting system in states where permits are not required to ship live fish. In the field, checks of haulers at weigh stations or pick-up / drop-off locations would be beneficial.
- **Better coordination among the jurisdictions.** Improved information sharing and coordination among federal, state, provincial, and tribal law enforcement agencies are essential. Information sharing and coordination are necessary to stop transportation of live Asian carp before the fish enter the Great Lakes Basin. In the short term, developing and fostering strong relationships among state/provincial and federal law enforcement officers must continue. Providing funding or direction to support dedicated Asian carp liaison officers would be especially helpful to coordinate enforcement activities among state/provincial and federal agencies within and outside the Great Lakes region. Greater coordination and sharing of information would be especially helpful to track shippers as they take fish to markets, and also to track shippers back to fish farms. In the long term, an agreement among all appropriate federal, state, provincial, and tribal law enforcement agencies in both Canada and the United States would improve implementation of laws in place to stop transportation of live Asian carp.

- **Adoption of a clear definition of what constitutes a "dead" Asian carp.** Because all parts of the Asian carp supply chain have an incentive to provide the most freshly dead (or even still alive) bighead carp and grass carp to food markets, they would like to keep Asian carp alive as long as possible during shipment. Law enforcement needs an accepted (and appropriate) definition of "dead." The Great Lakes Law Enforcement Committee has developed a position statement endorsed by Great Lakes fishery managers, suggesting potential regulatory language for "dead" that would include "evisceration" of Asian carp prior to transport and sale. Ontario is now pursuing changes to provincial regulations that would require Asian carp to be dead and eviscerated prior to transport into the Province.
- **Continued and expanded training.** Two aspects of training are important for improved effectiveness of enforcement efforts related to laws governing movement of live Asian carp. First, conservation officers should be trained on how to identify Asian carp (both adults and young-of-the-year) and share information about the methods used by shippers to avoid enforcement. Second, conservation officers should work within their jurisdictions to reach out to fellow officers in the state patrol, commercial vehicle inspection, and similar bureaus to inform them about the problem and what they can do to assist conservation officers (essentially alert them when a live hauler is spotted) to stop illegal transport of live Asian carp. This strategy of having "more eyes watching" comes with a potential cost: if conservation officers do not respond to a contact, the highway officers may stop reporting incidents. Thus, conservation law enforcement agencies will need the resources to respond to contacts at any time of the day or night.
- **More effective enforcement outside of the Great Lakes Basin.** The most effective option to enforce the Lacey Act is at the source of the violation (e.g., the first location where a shipper crosses a state/provincial line) because this is where the greatest opportunity to intercept live fish exists. Strong coordination of state/provincial and federal law enforcement efforts would be necessary to accomplish such a strategy because, while USFWS officers have the authority to enforce the Lacey Act, they do not have inspection authority. Additionally, sharing of information about movements of live haulers would facilitate greater understanding of patterns of shipment. In both cases, sharing information between state and federal enforcement officers would improve efforts to stop interstate transport of live fish and minimize duplication of efforts to inspect lawful cargo.

The considerable resources spent to prevent Asian carp movement through the CAWS justify investment to prevent Asian carp movement through illegal movement of live fish. It would be unfortunate to spend hundreds of millions of dollars to stop Asian carp from swimming their way into the Great Lakes only to ignore the law enforcement efforts needed to close this vector for movement of Asian carp into the basin.

USFWS has expanded surveillance and enforcement of illegal transportation of federally listed invasive species. Wildlife inspectors have increased their efforts to target and interdict federally listed invasive species at border locations. In addition, USFWS has acquired an x-ray van that can be deployed at all international ports of entry. This van will improve effectiveness and efficiency of wildlife inspectors' search for invasive species. Moreover, USFWS is working with state partners to control the spread of invasive species, including Asian carp, through investigations here in the United States. In 2012, USFWS produced a video and an informational brochure to assist law enforcement officials in identifying Asian carp and transport vehicles used in moving these fish across state lines. These tools will be valuable assets to assist USFWS officers when partnering with other law enforcement entities in 2013.

While transport of live bighead and silver carp is listed under the Lacey Act as illegal, 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 has increased officer presence and friendly enforcement activities related to Asian carp. This has proven successful in promoting open dialogue among 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 preferring live fish for release or food preparation. Visits to dozens of live fish (for food) markets in Illinois during 2012 did not encounter any live bighead or silver carp.

Throughout 2013, Illinois 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 Ontario, Conservation officers' enforcement efforts include education and inspections at fish markets, as well as an increasing focus on inspections at various border crossings. Within less than 18 months, six transport trucks carrying live Asian carp across the U.S. border into Canada have been seized, resulting in five convictions and $160,000 in fines so far. Two instances of importing Asian carps are still before the courts with eight charges pending.

DFO-Canada is looking to develop national AIS regulations to prohibit import of high-risk AIS such as Asian carp. Coordinated efforts between DFO-Canada and provincial enforcement agencies will continue to prevent movement of live Asian carp through the live trade pathway.

3.7 Great Lakes State Aquatic Invasive Species Management

The Non-indigenous Aquatic Nuisance Prevention and Control Act (NANPACA) of 1990, as amended and expanded by the National Invasive Species Act (NISA) of 1996, calls for development of state and regional AIS Management Plans. Through a cost-share grant program, ANSTF, co-chaired by USFWS and NOAA, has been able to provide assistance to states for creation and implementation of AIS management plans and activities. This has included development of state-led response actions conducted under new response plans developed by

Great Lakes states. In 2009 and 2010, the Great Lakes states invested over $26.7 million toward prevention and control of AIS, of which almost $900,000 was committed to Asian carp control efforts.

With ongoing Great Lakes Restoration Initiative (GLRI) funds, the Great Lakes states will have fully developed, revised, and implemented AIS management plans. Additionally, these plans will include response capabilities, mock exercises, and possibly actual response actions. The plans will promote coordinated education and outreach that will prevent introduction and spread of AIS through recreational uses such as hunting, fishing, and boating. These activities will also support implementation of on-the-ground AIS management actions for each of the Great Lakes states.

This section highlights some of the Great Lakes' state actions planned or under way.

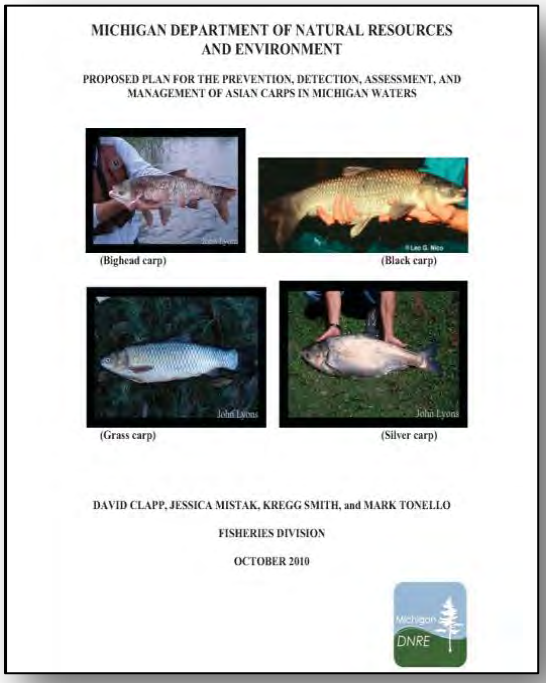
Illinois: Illinois completed extensive monitoring and removal efforts in support of collaborative Asian carp work in the CAWS. These efforts included sampling with traditional fishery gear, contracting commercial fishermen for targeted removal, sampling for larval Asian carp, supporting eDNA monitoring, conducting alternative barrier studies and fishery gear assessments, undertaking collaborative work on the Asian Carp MRRP, and outreaching to the public and bait shops in the Chicago area. A continued collaborative Asian carp monitoring and removal effort in the Illinois River and CAWS is expected during FY 2013 and beyond. In addition to Asian carp work, support of Illinois' statewide AIS management plan for 2013 includes (1) updating the plan; (2) conducting priority research into potential resource implications and environmental impacts of AIS introductions; (3) continuing to develop, assess, and improve AIS information, outreach, and education programs; (4) continuing to facilitate development of a collaborative AIS Rapid Response Plan; (5) developing a submersed aquatic vegetation (SAV) management plan; and (6) developing a pilot program to target and control AIS, including near-shore Lake Michigan habitats.

Indiana: The second year of the contract between Indiana DNR and Purdue University to determine Asian carp movement and spawning in the upper Wabash River has been completed. As in 2011, Asian carp did not demonstrate high dispersal into the Little River, which connects to the Eagle Marsh and the Maumee-Wabash areas. In fact, lower use of the upper Wabash by the Asian carp appears to correlate with the drought of 2012. Evidence of spawning was observed throughout summer 2012; however, eggs were not detected as far upstream as they had been in 2011. Eggs continued to be found during summer periods when no rise in the hydrograph occurred. Although eggs were found in 2012, it is highly unlikely that a successful year class was achieved because nearly all the backwater nursery areas were cut off from the Wabash River throughout the spawning period as a result of the drought. Additional research on Asian carp movement and spawning will be conducted through 2013.

Indiana hosted an Incident Command System (ICS) training and mock exercise event in 2012. The event sponsored by USEPA was a joint meeting of Indiana DNR and Ohio DNR staff.

The fence across Eagle Marsh remains in place. Evaluation of a permanent solution at Eagle Marsh continues, with anticipation that planning for a preferred alternative will begin early in 2013. In 2012, Indiana completed the distribution of new Asian carp signs for boat ramps and bait shops and pamphlets. Indiana is a member of the newly formed Ohio River Asian Carp Task Force. The group is tasked with developing further measures to prevent the colonization of Asian carp within the Ohio River basin.

Michigan: Michigan plans to complete its update of Michigan's AIS State Management Plan and develop coordinated monitoring, response, and education efforts. Michigan continues to build staff capacity for the AIS program and implement priority activities identified in the AIS state management plan with a focus on preventing entry and spread of AIS within the State. In addition, the State will continue to implement the statewide strategy for Asian carp prevention and management. Michigan DNR Law Enforcement conducted a statewide inspection of all wholesale fish dealers in an effort to prevent importation of live invasive fish species. Specific to Asian carp, rotenone was purchased to have on hand in the event of a needed treatment for eradication. Gear and vessels were also developed and enhanced for a deployment response involving surveillance or eradication. Finally, a response action occurred to address an inland water grass carp infestation.


MICHIGAN DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENT

PROPOSED PLAN FOR THE PREVENTION, DETECTION, ASSESSMENT, AND MANAGEMENT OF ASIAN CARPS IN MICHIGAN WATERS

(Bighead carp) (Black carp)

(Grass carp) (Silver carp)

DAVID CLAPP, JESSICA MISTAK, KREGG SMITH, and MARK TONELLO

FISHERIES DIVISION

OCTOBER 2010

Minnesota: Minnesota has developed a statewide AIS Rapid Response Plan. Individual regions across the State are developing regional AIS Rapid Response Plans based on the statewide plan. Minnesota plans to continue to conduct watercraft inspections, and has 23 hot water/high pressure washers used as part of the watercraft inspection program to prevent spread of AIS from infested areas. Minnesota has increased AIS outreach and enforcement efforts, continues to conduct enhanced AIS management and early detection monitoring actions, and provides grants for tribal and local AIS prevention.

New York: The New York State Department of Environmental Conservation staff participated in the Great Lakes Aquatic Invasive Species Tabletop Exercise in 2008, which led to development of an invasive species rapid response framework in 2010. This framework outlines a rapid response process and responsibilities for involved stakeholders. The New York State Invasive Species Management Strategy was prepared in 2011. State regulations restricting possession, transportation, and sale of Asian carp and other fish dangerous to indigenous fish populations were last updated in 2010, but at the present time are subject to an additional rule-making

proposal to eliminate an exemption for transport of live bighead carp in the five boroughs of the City of New York and two Towns in Westchester County. This exemption to allow limited movement of bighead carp became obsolete when preempted by the provisions of the federal Asian Carp Prevention and Control Act. New baitfish regulations were adopted in 2007, and then updated in 2011 to reduce introduction and transfer of disease organisms and spread of invasive species. In autumn 2012, an ad-hoc Task Force of New York State Department of Environmental Conservation staff was assembled and charged with developing a New York State Asian Carp Action Plan. In addition to New York's participation on the ACRCC and GLMRIS, New York State routinely coordinates with other agencies and jurisdictions via the Ohio River Basin Asian Carp planning effort, and regarding the Great Lakes through GLFC.

Ohio: USFWS collected 417 eDNA samples within western Lake Erie during August 2011. These samples were sent to the University of Notre Dame's eDNA laboratory for analysis. The eDNA results received in July 2012 indicted four samples collected in Ohio's Sandusky Bay were positive for bighead carp eDNA, and two samples collected in Ohio and Michigan waters of Maumee Bay were positive for silver carp eDNA. In response to the positive eDNA findings in western Lake Erie, the USFWS, Ohio DNR, and Michigan DNR developed a Command Team and initiated a rapid assessment in late July and early August 2012 that included collection of additional eDNA samples in both Sandusky River/Bay (150 samples) and Maumee River/Bay (350 samples), as well as extensive gear sampling within these areas using electrofishing and gill netting. The gear sampling revealed no bighead or silver carp. The eDNA results from Sandusky River/Bay, received in late August 2012, indicated that 20 of the 150 samples were positive for silver carp eDNA. In early September 2012, using a sampling strategy that employed electrofishing boats to drive fish into set gillnets, the Command Team conducted extensive follow-up gear sampling in areas of Sandusky River/Bay where positive eDNA results had been obtained. No bighead or silver carp were found during this sampling. The eDNA results for Maumee River/Bay, received in early September 2012, indicated that 3 of 350 samples were positive for silver carp eDNA in Maumee Bay. Additional follow-up sampling was not conducted in Maumee River/Bay during the 2012 field season. Bighead and silver carp monitoring and management activities for 2013 and beyond are currently coordinated through GLFC's Lake Erie Committee.

USACE's Draft 2012 GLMRIS Focus Area 2 Aquatic Pathways Assessment Summary Report identified the Long Lake connection in Akron, Ohio, and the Little Killbuck Creek connection in Medina County, Ohio, as medium-risk hydraulic pathways for AIS transfer between the Mississippi River and Great Lakes Basins. Ohio is working closely with USACE and the ACRCC to determine potential solutions to prevent AIS transfer at these connections.

Ohio revised its AIS State Management Plan in 2012 to address the quickly changing AIS landscape in Ohio. The plan was approved by ANSTF in November 2012 after undergoing both internal and external reviews. Assisted by USEPA, Ohio has developed a draft Rapid Response Plan that, when finalized in 2013, will be incorporated into the AIS State Management Plan. USEPA facilitated a rapid response exercise between Ohio and Indiana in Fort Wayne, Indiana, during August 2012. State and federal agencies, universities, and NGOs participated in this

exercise that included instruction on the ICS and a mock planning exercise at Eagle Marsh, Indiana.

Pennsylvania: The Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Fish and Boat Commission (PFBC), Penn State University, and the USGS Leetown Science Center are collaborating to monitor for presence of Asian carp eDNA via sampling, and are analyzing these samples using "next generation" metagenomic molecular techniques. In 2012, water samples were collected from Presque Isle Bay in Lake Erie, as well as from the Ohio, Monongahela, and Allegheny Rivers near Pittsburgh. These locations will be sampled again in 2013, and eDNA sampling will be expanded to include live bait dealers. PADEP is also conducting AIS monitoring of priority water bodies in and near Lake Erie using conventional monitoring techniques. No Asian carp have been detected in PA waters to date. PFBC is also coordinating lake-wide monitoring activities with the Lake Erie Committee.

PFBC has developed a draft Asian Carp Action Plan focusing on preventing spread of these species into Commonwealth waters. The Pennsylvania Invasive Species Council is updating its Rapid Response Plan, which can be used as a framework for a response to an Asian carp invasion. PA Sea Grant has developed Asian carp fact sheets, watch cards for Asian carp, and an AIS field guide that includes Asian carp; PA Sea Grant plans targeted education and outreach on Asian carp and other AIS. The Pennsylvania Invasive Species Council will begin reviewing and updating its AIS Management Plan in 2013.

Wisconsin: Wisconsin has a comprehensive AIS state management plan, approved by ANSTF, that focuses on prevention, containment, and control of AIS. Strong relations with federal, state, and local partners enable Wisconsin to focus on primary vectors for AIS movement: transient boaters, nurseries, and bait dealers at the local level. Wisconsin's AIS grant programs strongly support local involvement in prevention, containment, and control activities around the State. Boater education though signage at launches, informational materials, and one-on-one contacts at boat launches increase boater awareness of AIS. AIS statewide monitoring by volunteers and paid staff is evaluating the rate of spread of AIS in the State. This information will aid in assessing the effectiveness of the outreach programs. Enforcement of AIS laws is accomplished by dedicated AIS "Water Guards" and conservation officers. GLRI funding has significantly increased Wisconsin's ability to target prevention, containment, and control actions in the Great Lakes Basin.

Wisconsin began outreach to bait dealers and anglers within targeted areas, focusing on best practices and bait hygiene. The State has increased AIS monitoring and tracking, created websites for responsive reporting of findings, and hired a Watercraft Inspection Coordinator in cooperation with University of Wisconsin Sea Grant to enhance watercraft inspection and compliance with laws. The State has created educational media and signage at boat ramps to continue public outreach and education, and has provided counties within the Great Lakes Basin with funds to implement local AIS prevention, control, and education programs. Similar to the program established in Illinois, Wisconsin will soon (1) begin work with bait dealers, anglers, and

boaters to prevent introduction and spread of AIS within the waters of the State; (2) increase AIS monitoring efforts to include 500 water bodies annually; and (3) enhance watercraft inspection and regulatory compliance. To increase monitoring efforts on Lake Michigan and its Wisconsin tributaries, the State is coordinating with The Nature Conservancy and the University of Notre Dame to begin collecting and analyzing samples for presence of eDNA.

3.8 Canadian Federal and Provincial AIS Management and Control Efforts

In 2012, the Ontario Invasive Species Strategic Plan was released by the Ontario government. Objectives of the plan are to prevent introduction and spread of new invasive species such as Asian carp, and to reduce harmful impacts of existing invasive species (both terrestrial and aquatic). Prevention, early detection, response, and management/control are the primary goals of the Plan. Recent activities to address AIS include:

- A provincial review of existing legislation/policy to identify opportunities for improving capacity to address key AIS threats. For example, in 2013 Ontario, is pursuing changes to provincial regulations that would require Asian carp to be dead and eviscerated prior to transport into the province.
- Development of a provincial Asian Carp Response Plan that will guide provincial response efforts if Asian carp are detected in Ontario waters.
- Establishment of the Canada/Ontario Invasive Species Centre in partnership with the federal government to facilitate inter-agency coordination and collaboration in prevention and management of invasive species.
- Research and development into use of new surveillance techniques such as eDNA to enable early detection of priority AIS.
- Monitoring and surveillance programs for AIS within the Great Lakes basin, including Asian carp, in areas considered at high risk of invasion.
- Research and science to increase understanding of impacts and control and management of AIS.
- Enforcement of existing regulations addressing invasive fish such as Asian carp.
- Communications/outreach to the public and stakeholders involved in the key pathways for AIS introduction to engage them in prevention measures, and to encourage them to report new sightings of AIS within Ontario waters. Key partners in these efforts include the Ontario Federation of Anglers and Hunters, and the Ontario Commercial Fisheries Association.

DFO-Canada's Asian Carp Program focuses on prevention activities, rather than management and control activities, as Asian carp are not established in Canadian waters. The live trade pathway is a major pathway of concern for Canada and is therefore the focus of management

and control efforts in coordination with the province of Ontario. This work includes monitoring import records and inspecting live fish goods crossing the international border.

3.9 Rapid Response Training and Exercise Initiatives

USEPA Great Lakes National Program Office (GLNPO) has developed an ICS training course for invasive species response efforts. This 1- to 2-day course provides the knowledge required for service as lead response and/or support personnel in an invasive species response that may require multi-jurisdictional resources and agency coordination. The course is intended for agencies and groups that participate in an AIS-specific rapid response and may or may not have previous experience with ICS. The group exercise as part of the class promotes effective communication and collaboration, which are essential during rapid response incidents. Team training with multiple agencies is ideal to simulate the complexity of most incidents.

The goals of this course are to:

- Gain a general understanding of the ICS organizational and operational framework through a brief ICS instructional presentation.
- Demonstrate ability to effectively conduct internal notifications, coordinate across agencies, and use resources from multiple entities.
- Gain an understanding of the importance of jurisdictional authority based on agencies' missions/mandates and species/location.
- Organize and initiate a successful small-scale, on-water AIS assessment through group discussion and course exercises.
- Discuss the differences in operations and resources for various types of AIS rapid response efforts.

USEPA has combined this course with a tabletop exercise using an AIS scenario to introduce agencies to response-related situations and inter-agency coordination. This course offering will continue in 2013 on an as-requested basis. Additional, more in-depth ICS trainings are available if requested—depending on group size and trainer availability.

In January 2010, the State of New York published a statewide Rapid Response Framework for Invasive Species.[20] New York also participated in a Great Lakes rapid response training exercise in 2008 in Erie, Pennsylvania, sponsored by PADEP, USEPA, GLNPO, Pennsylvania Sea Grant, and Save Our Native Species (SONS).

[20] Eric J. Kasza. 2010. Rapid Response Framework for Invasive Species. New York State (NYS) Department of Environmental Control (DEC), Office of Invasive Species Coordination, Albany, New York 12233-1052. January.

Several state and provincial jurisdictions have Asian carp response plans at various stages of completion. For example, OMNR has developed a provincial Asian Carp Response Plan in partnership with DFO-Canada. The Plan outlines procedures for implementation of a rapid response if Asian carp are detected in Ontario waters—the province has undertaken several simulation exercises to test the plan and improve agency-wide preparedness. In 2013, the province will continue its efforts to improve the plan based on new science, and improved coordination with U.S. partners.

USEPA facilitated a rapid response exercise between Ohio and Indiana in Fort Wayne, Indiana, in August 2012. State and federal agencies, universities, and NGOs participated in this exercise that included instruction in ICS and a mock planning exercise at Eagle Marsh, Indiana.

Illinois DNR has supported all MRRWG rapid responses in the CAWS since 2010 under ICS. Illinois DNR has two complete ICS teams that train annually with Illinois State Emergency Management teams in conjunction with the National Incident Management Organization's (NIMO) national type III response team from Phoenix, Arizona. Team members have attended various USEPA training events, as well as ICS position-specific training. In addition, Illinois DNR staff have participated in statewide emergency management teams, and have supported wildfire teams in the western U.S.

DFO-Canada will begin development of in-agency capacity for rapid response activities to be implemented if Asian carp are discovered in Canadian waters. A national rapid response framework, and work conducted in collaboration with the province of Ontario, will form the basis of this preparedness. DFO-Canada will conduct business continuity planning and develop a database of available equipment that would be useful for a response action.

4.0 AGENCY COORDINATION AND MANAGEMENT ROLES

Federal agencies, the State of Illinois, provincial organizations, and local agencies with jurisdictional authority and/or vested interest in defending the Great Lakes against introduction and establishment of Asian carp came together to form the original ACRCC. In 2010, other Great Lakes State agencies were invited to join the ACRCC, and subsequently, in 2012, Canadian agencies were invited to join the ACRCC. The ACRCC represents a coordinated and collaborative effort among the involved organizations to prevent Asian carp from entering the Great Lakes, and to control and manage the invasion front of Asian carp in the CAWS. The ACRCC does not dictate management of fisheries issues to individual states or provincial authorities, and does not discourage or reject management principles, techniques, or actions.

4.1 ACRCC Coordination

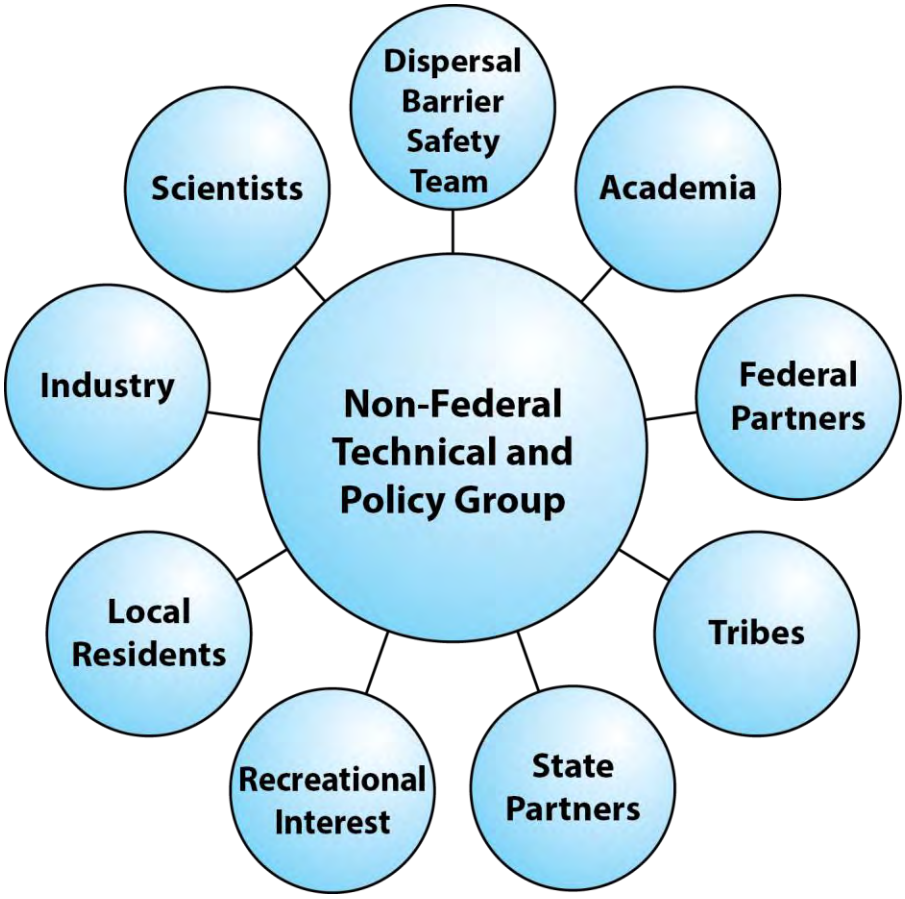
The ACRCC, with support from federal, state, and local agencies and other private stakeholder entities, will implement actions to protect and maintain the integrity and safety of the Great Lakes ecosystem from an Asian carp invasion via all incoming pathways. The Framework specifies the strategy and proposed action items to achieve this goal. Again and importantly, if Asian carp eDNA or live Asian carp are detected in the Great Lakes system, management and coordination likely will occur consistent with the GLFC lake committee process outlined in Section 2.3.

Exhibits 8 and 9 below depict relationships among the primary agencies or governmental groups involved in implementation of the Framework in the CAWS region. Relationships are non-linear because of need for harmonized input from each group in all facets of the Framework. The Executive Committee consists of senior managers from key U.S. federal agencies. The ACRCC is composed of agencies with operational and coordinating authority over work relevant to the CAWS. The two workgroups bracketing the ACRCC are tasked with specific responsibilities laid out in the Framework.

Exhibit 8. The ACRCC Organization

The third group, Non-Federal Technical and Policy Group (Exhibit 9 below), is a stand-alone entity providing input to the ACRCC workgroups. The stakeholder groups identified in Exhibit 9, led by representatives from their respective communities/agencies/organizations, compose and advise the Non-Federal Technical and Policy Group.

Exhibit 9. Non-Federal Technical and Policy Group



4.1.1 CAWS Monitoring and Rapid Response Workgroup (MRRWG)

This workgroup (MRRWG) of the ACRCC is tasked with monitoring and response efforts within the CAWS and at the leading edge of current Asian carp boundaries. This workgroup is generally composed of fisheries biologists and scientific experts from GLFC, Illinois DNR, Illinois Environmental Protection Agency (IEPA), Indiana DNR, USFWS, and USACE. In 2012, all of the Great Lakes states fisheries chiefs were also asked to participate in MRRWG. In 2010, MRRWG created an MRRP for the CAWS and revised this plan in 2011 with the overall goal of preventing Asian carp from establishing self-sustaining populations in the CAWS and subsequently in Lake Michigan. Five strategic objectives are specified in the plan to accomplish the overall goal:

- Determine the distribution and abundance of Asian carp in the CAWS and use this information to inform response removal actions.
- Remove Asian carp from the CAWS to the maximum extent practicable.
- Identify, assess, and react to any vulnerability in the current system of electrical dispersal barriers that exclude Asian carp from moving into the CAWS.

- Determine the leading edge of major Asian carp populations and reproductive success of those populations.
- Improve understanding of the likeliness of establishment of Asian carp in the Great Lakes.

MRRWG carries out these objectives through collective efforts by member agencies. The workgroup oversees eDNA collection, commercial fishing, netting, electrofishing, and other collection operations, and then interprets the data obtained to offer informed recommendations to the ACRCC.

4.1.2 Communications and Outreach Workgroup (CWG)

The purpose of CWG is to facilitate internal and external communication on Asian carp prevention and control efforts of the ACRCC. Audiences receiving this communication include elected officials and the public, with special attention to key constituents, media, internal ACRCC members, and ACRCC Work Groups, Framework Science Coordination groups, and other relevant groups outside the ACRCC.

Communication efforts support the ACRCC as it develops and executes short- and long-term strategies for preventing Asian carp movement above the electric barrier system in the CAWS, as well as other monitoring and control activities in other areas of the Great Lakes Basin. CWG does not intend to supplant or supersede actions of ACRCC members.

CWG has communication representatives from CEQ, USFWS, USEPA, USACE, USCG, USGS, the Great Lakes states, the province of Ontario, GLFC, DFO-Canada, and the Metropolitan Water Reclamation District. All members of the ACRCC are invited to establish representation on CWG.

CWG is currently co-chaired by two representatives—one each from USFWS and Illinois DNR. The chair has primary responsibility for the group's management, organization, and operation, but the work is shared among CWG members. One or both co-chair positions may be filled by a CWG member from another agency deemed appropriate by CWG.

CWG is divided into sub-committees consisting of appropriate agency communication representatives. Subcommittees include agency representatives from legislative affairs, media relations, and public/stakeholder outreach. At this time, CWG has two standing sub-committees: the Key Constituents Sub-committee and the Media Sub-committee.

Specific efforts of CWG include, but are not limited to the following:

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

4.2 Agency Roles, Responsibilities, and/or Authorities

This section generally describes the jurisdictions, authorities, and roles of the agencies and governmental units participating in the Framework. This is meant to be an informal description of these agencies with respect to the actions discussed in the Framework, and is not meant to restrict or assign responsibilities and authorities belonging to the agencies under their implementing statutes and regulations.

- **City of Chicago**

  Jurisdiction: Exercises home rule authority within municipal limits.
  Authority: Municipal.
  Role: Supports the work of other agencies, particularly those actions within the City of Chicago, and performs law enforcement, patrol, and emergency response duties along the lakefront and inland waterways within the City's jurisdiction.

- **Department of Fisheries and Oceans Canada (DFO-Canada)**

  Jurisdiction: Marine, estuarine, coastal, and freshwaters environments of Canada.
  Authority: Federal, national.

Role: Government of Canada lead agency for AIS; provides scientific and risk assessment leadership, technical expertise, and information needed to manage AIS.

- **Great Lakes Fishery Commission (GLFC)**

  Jurisdiction: Great Lakes Fishery Convention Act allowing implementation of the 1954 Convention of Great Lakes Fisheries between Canada and the United States.

  Authority: Bilateral treaty.

  Role: Conduct, support, and communicate fishery research; control the invasive sea lamprey; and facilitate multi-jurisdictional fishery management through A Joint Strategic Plan for Management of Great Lakes Fisheries.

- **Illinois Department of Natural Resources (IL DNR)**

  Jurisdiction: Investigations pertaining to the natural history, entomology, zoology, and botany of the State; geology and natural resources of the State; water and atmospheric resources of the State; and archeological and cultural history of the State of Illinois.

  Authority: State.

  Role: Lead agency for work relating to monitoring, sampling, fish removal actions, and rapid response activities within the State.

- **Illinois Environmental Protection Agency (IEPA)**

  Jurisdiction: IEPA's mission is to safeguard environmental quality, consistent with the social and economic needs of the State, so as to protect health, welfare, property, and quality of life.

  Authority: State.

  Role: Ensure that Illinois' rivers, streams, and lakes support all uses for which they are designated, including protection of aquatic life, recreation, and drinking water supplies.

- **Indiana Department of Natural Resources (IN DNR)**

  Jurisdiction: May investigate, compile, and disseminate information and make recommendations concerning the natural resources of Indiana and their conservation; and may cooperate with other governmental entities and public and private institutions in carrying out these powers.

  Authority: State.

  Role: Lead agency for work relating to monitoring, sampling, fish removal actions, and rapid response activities within the State of Indiana.

- **Office of the Great Lakes (OGL); Michigan Department of Environmental Quality**

  Jurisdiction: Within Michigan's waters of the Great Lakes, OGL collaborates with partners to support sustainable use of coastal resources, coordinate

restoration of severely degraded areas, manage water quality and quantity, prevent incursion of AIS, and engage in emerging issues.

Authority: State.

Role: OGL leads policy development and implements programs to protect, restore, and sustain the world's premier freshwater lakes.

- **Michigan Department of Natural Resources (MI DNR)**

  Jurisdiction: In the State's waters, Michigan DNR is responsible for management and protection of the Great Lakes fishery resources in regards to recreational, commercial, and tribal fisheries interests, and for the conservation and protection of biodiversity and aquatic habitats.

  Authority: State.

  Role: Provide leadership for strategic monitoring assessment, response, and public communication in Michigan as they pertain to Asian carp. Assist other states as requested in these activities.

- **Minnesota Department of Natural Resources (MN DNR)**

  Jurisdiction: Mission is to work with citizens to conserve and manage the State's natural resources, to provide recreational opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life.

  Authority: State.

  Role: Manage, protect, and regulate the State's fish and wildlife resources.

- **New York Department of Environmental Conservation**

  Jurisdiction: Mission is to conserve, improve, and protect New York's natural resources and environment, and to prevent, abate, and control water, land, and air pollution, in order to enhance the health, safety, and welfare of the people of the State and their overall economic and social well-being.

  Authority: State.

  Role: Responsible for conservation and enhancement of New York State's abundant and diverse populations of freshwater fishes while providing the public with quality recreational angling opportunities. New York Department of Environmental Conservation serves as the lead agency for prevention and control of invasive species in New York waters. Cooperation and coordination with other jurisdictions in the Great Lakes fisheries arena is routinely pursued through GLFC.

- **Ohio Department of Natural Resources (OH DNR)**

  Jurisdiction: The mission of Ohio DNR is to ensure a balance between wise use and protection of our natural resources for the benefit of all. Ohio DNR is responsible for protection, development, conservation, and management of Ohio's natural resources, including: managing the State's natural resources for sustainable productivity, protecting Ohio's native plant and animal species, developing industry and tourism opportunities and supporting

present and future economic health of the State, providing recreational opportunities for the public at all levels, and protecting health, safety, and biodiversity through fair and consistent law enforcement.

Authority: State.

Role: Lead agency in Ohio for fish research, fish sampling and monitoring, rapid response actions, as well as operation and maintenance of certain canal lands within the State.

- **Ontario Ministry of Natural Resources (OMNR)**

  Jurisdiction: OMNR is responsible for managing the fisheries of Ontario, and works with partners and agencies to protect, restore, and sustain Great Lakes and inland fish species and populations through planning, regulation, enforcement, scientific study, stocking, and stewardship.

  Authority: Provincial.

  Role: OMNR has the lead provincial role to prevent introduction, establishment, and spread of AIS. OMNR's responsibilities include leadership and coordination of inter-agency activities to prevent and manage the threat of AIS, development and enforcement of provincial legislation and policy, response planning, monitoring and science, development of management measures, and communications/outreach to the public.

- **Pennsylvania Department of Environmental Protection (PADEP)**

  Jurisdiction: Lead agency for enforcement of the Pennsylvania Clean Streams Law, Pennsylvania Water Quality Standards (25 PA Code Chapter 93), and delegated portions of the federal Clean Water Act (CWA). Water Quality Standards consist of Protected Water Uses (including Aquatic Life Uses), as well as the Water Quality Criteria necessary to protect them. PADEP's Coastal Resources Management Program has various policies to prevent the introduction and spread of AIS.

  Authority: State.

  Role: Permitting of pesticide applications needed for Asian carp response; monitoring and surveillance for Asian carp; supporting Asian carp rapid assessment and response; general scientific support as needed.

- **Pennsylvania Fish and Boat Commission (PFBC)**

  Jurisdiction: Responsible for all aquatic organisms in the Commonwealth of Pennsylvania, and shares enforcement responsibilities regarding aquatic resource issues with PADEP.

  Authority: State.

  Role: Primary responsibility for threat assessment and monitoring of all Pennsylvania AIS occurrences, including Asian carp, and lead responsibility for initiating the State's AIS rapid response plan when deemed necessary.

- **Wisconsin Department of Natural Resources (WI DNR)**

  Jurisdiction: Natural resources, conservation, outdoor recreation, and environmental quality in the State of Wisconsin.

  Authority: State.

  Role: Cooperate and support any activities which lead to the immediate and complete prevention of AIS between the Mississippi River and Great Lakes Basins in the Chicago area. Cooperate and support any activities which evaluate and eliminate other potential ecological pathways between the Mississippi River and Great Lakes Basins in Wisconsin.

- **Metropolitan Water Reclamation District of Greater Chicago**

  Jurisdiction: Surface water, municipal wastewater treatment for the metropolitan Chicago area (including almost all of Cook County), control of combined sewer overflows, dry and wet weather operation of the CAWS.

  Authority: Regional.

  Role: Supports work of other agencies and implements designated action items to the extent allowed by its statutory wastewater and stormwater authority.

- **National Oceanic and Atmospheric Administration (NOAA)**

  Jurisdiction: Implementation of technical assistance and management-oriented research programs that support coastal zone management.

  Authority: Coastal Zone Management Act of 1972 (16 *United States Code* [U.S.C.] § 1456c) and the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (P.L. 101-636).

  Role: Funding of research studies and activities. Co-chair of ANSTF. Represents the Department of Commerce as co-chair of the National Invasive Species Council (NISC). Additionally, NOAA's Great Lakes Environmental Research Laboratory (GLERL) shall provide technical assistance to appropriate entities to assist in the research conducted pursuant to this subsection.

- **United States Army Corps of Engineers (USACE)**

  Jurisdiction: Planning, construction, and operation of navigation and flood damage reduction projects; hydropower operations; environmental protection and restoration; water conservation, recreation, and disaster assistance.

  Authority: Federal.

Role: Operation of the CAWS Lock and Dam System and the electric barrier system.

- **United States Coast Guard (USCG)**

  Jurisdiction: Navigable waterways.

  Authority: Federal Authority; Port and Waterways Safety Act of 1972 and other legislation.

  Role: Ensure safety, security, and environmental protection of the Great Lakes and the Western Rivers. USCG manages waterways through Regulated Navigation Areas, and safety and security zones. Regulates the marine industry and supports the marine transportation system.

- **United States Department of Agriculture Natural Resources Conservation Service (NRCS)**

  Authority: Federal

  Role: The Food, Conservation, and Energy Act of 2008, authorizes NRCS to provide program participants technical and financial assistance to address resource concerns on agriculture, range and forest lands. Aquatic ecosystem restoration through the implementation of conservation practice standards can be accomplished though these programs.

- **United States Department of Transportation (US DOT)/Maritime Administration (MARAD)**

  Jurisdiction: Promotion of marine transportation and the supporting marine transportation industry.

  Authority: Federal.

  Role: Improve and strengthen the U.S. Marine Transportation System to meet the economic, environmental and security needs of the Nation.

- **United States Environmental Protection Agency (USEPA)**

  Jurisdiction: Coordination of federal Great Lakes funding, policy, and activities.

  Authority: Federal Great Lakes protection and restoration funding, policy, and other efforts specified in CWA 118, Executive Order 13340, and annual Great Lakes Restoration Initiative appropriation legislation.

  Role: Coordination and funding.

- **United States Fish and Wildlife Service (USFWS)**

  Jurisdiction: Implementation of activities in support and enforcement of the Lacey Act, Endangered Species Act, Fish and Wildlife Coordination Act, Great Lakes Fish and Wildlife Restoration Act, and the Non-indigenous Aquatic Nuisance Prevention and Control Act as amended; and supporting activities to include fish and AIS monitoring, risk assessment, and law enforcement.

  Authority: Federal.

Role: Coordination with federal, state, tribal, and non-governmental partners on actions to prevent the introduction and establishment of AIS or to mitigate resource impacts from introduced species.

- **United States Geological Survey (USGS)**

  Jurisdiction: Performance of surveys, investigations, and research covering topography, geology, hydrology, biology, and the mineral and water resources of the United States, its territories, and possessions.

  Authority: Federal.

  Role: Provide science leadership, technical expertise, and information needed to develop management tools to better predict ranges and effects of AIS; and to contain, reduce, or eradicate AIS populations.

- **White House Council on Environmental Quality (CEQ)**

  Authority: Federal – CEQ coordinates federal environmental efforts and works closely with agencies and other White House offices in development of environmental policies and initiatives.

  Authority: Federal.

  Role: CEQ closely monitors development and execution of the Framework.

5.0 STAKEHOLDER PARTICIPATION

Effectiveness of actions summarized in the Framework can be significantly enhanced through effective communication and increased participation by other agencies and stakeholders. To facilitate this, the ACRCC has developed a strategic communication plan that provides opportunities to inform the public and other stakeholders about key Asian carp control activities—including implementation of control actions, development of new control technologies, and progress toward Framework goals.

One of the primary efforts to garner public participation and involvement was the recent institution of regularly scheduled public forums across the Great Lakes Basin. At these meetings, the ACRCC invites stakeholders and user groups to provide input and comments on the Framework. Ongoing stakeholder input is necessary regarding both individual actions within this Framework and further development of the Framework itself.

The revamped ACRCC Asian carp website at **www.asiancarp.us** also provides opportunities for stakeholder involvement. This new website offers extensive information regarding all aspects of ACRCC actions, and includes links to other important federal, state, Canadian, and other relevant actions.

Specific communication outreach actions targeted in the 2012 Framework and proceeding concurrently with the programs in the Framework, include:

- Implementation of a Strategic Communication Plan as part of the Framework. The plan outlines communication tools, methods, and protocols that will provide timely and transparent information to multiple target audience groups including elected officials, states, tribes, key constituents, and the media.
- Development of opportunities for public comment including the regularly scheduled public forums occurring across the Great Lakes Basin.
- Maintenance of the primary online communication tool **www.asiancarp.us** to disseminate announcements and provide information on ACRCC activities; a new "How to Help" section is being established on the website.
- Release of both interim and final reports, findings, and studies as information becomes available.
- Coordination of on-site or telephonic media events, including press announcements regarding new Asian carp control efforts or other important related actions or findings, such as positive eDNA results and live fish detections.
- Outreach to municipal leaders, tribal leaders, and other interested parties.

- DFO-Canada will develop public, industry, and stakeholder partnerships with interested partners, such as with commercial and recreational fisheries and cottage associations. A website, fact sheet, and identification materials will be developed.

6.0 ASIAN CARP MONITORING AND CONTROL EFFORTS OUTSIDE THE GREAT LAKES

In 2007, the "Management and Control Plan for Bighead, Black, Grass and Silver Carps in the United States" was submitted by ANSTF. This Plan was developed by the Asian Carp Working Group, a committee made up of nearly 70 individuals representing state and federal agencies, and NGOs from the United States and Canada. This 20-year Plan includes 48 strategies and offers 133 recommendations to meet its ultimate goal of eradication of Asian carp across the nation.

In 2012, USFWS began working with partners to update the Plan, taking into account new technologies that have appeared within the past 5 years. Additionally, the 133 recommendations will be ranked according to some priority to accommodate a phased approach to funding the Plan.

6.1 Upper Mississippi River

Minnesota DNR is working with Barr Engineering and USACE on a preliminary design for a deterrent barrier at Lock and Dam 1. Electricity, sound, bubble, and light technologies are undergoing evaluation. Once a preferred technology is selected, Minnesota DNR needs approval from USACE before construction of a barrier could begin. If approval and sufficient funding can be obtained, the hope is that construction would begin in late fall 2013 and be completed by spring 2014.

Minnesota DNR is making improvements to the dam at Coon Rapids Minnesota, which is upstream of Lock and Dam 1. This physical barrier, in conjunction with a deterrent barrier at the lock, is expected to limit or slow the spread of Asian carp into the Upper Mississippi River watershed. Nevertheless, these barriers will not be 100% effective, and the best long-term strategy for preventing incursion of carp into the Upper Mississippi remains closure of the lock at Upper St. Anthony Falls.

Minnesota DNR is also continuing eDNA sampling with the University of Minnesota and USGS. MNDNR conducted eDNA sampling in 2011, but some of the results raised questions about the efficacy of the sampling. Sampling sites and times were replicated in 2012, using USFWS-developed protocols adopted for the Great Lakes. Results are expected in early March 2013.

Without dedicated funding to assist the states on the Upper Mississippi River, USFWS has been able to provide technical guidance only from lessons learned in the CAWS.

USGS is conducting some of its research efforts in the Upper Mississippi River Basin system and other river systems (e.g., the Missouri River), because these are locations where Asian carp are already established and can provide the life cycle and habitat information necessary to develop methods for efficient and effective use of Asian carp control procedures. Furthermore, control of Asian carp in the Upper Mississippi River System would reduce their pressure on the Great Lakes.

If Congressional funding for Asian carp research on the Upper Mississippi River is appropriated, USGS will conduct additional research directed at preventing incursion of reproducing Asian Carp populations into upstream areas such as the Mississippi River adjacent to Minnesota. Regardless of where the field research occurs, the information generated will benefit other locations threatened by Asian carp.

6.2 Ohio River Valley

In June 2012, over 60 representatives of the following organizations began to develop an interstate strategy for controlling spread and minimizing impacts of Asian carp in the Ohio River Watershed:

- Association of Fish and Wildlife Agencies
- Foundation for Pennsylvania Watersheds
- Illinois DNR
- Kentucky Department of Fish & Wildlife Resources
- Minnesota DNR
- Congressional offices of Congressman Doyle, Congressman Critz, and Congressman Kelly
- U.S. Senate offices of Senator Casey and Senator Toomey
- Ohio DNR
- Pennsylvania Department of Agriculture and PADEP
- PFBC
- Pennsylvania Sea Grant
- The Nature Conservancy
- USEPA
- USACE (Buffalo, Cincinnati, and Pittsburgh offices)
- USFWS
- USGS
- West Virginia DNR
- Western Pennsylvania Conservancy
- White House CEQ
- Indiana DNR
- New York State Department of Environmental Conservation
- North Carolina Wildlife Resources Commission
- Ohio River Valley Water Sanitation Commission
- Tennessee Wildlife Resource Agency.

At the conclusion of 2012, the Ohio River Fisheries Management Team was finalizing an Asian Carp Action Plan for the Ohio River Basin. Expectation is to share the Plan in late winter or early spring 2013 with agency, non-profit, and other partners who will have a role in refining and implementing the Plan.

The Strategic Response to Asian Carp Invasion Act calling for action on the Ohio River was introduced as H.R. 6385 and S. 3645 in fall 2012, and is expected to be reintroduced in 2013.

The States of Kentucky, Ohio, Pennsylvania, and West Virginia; USFWS; and the Association of Fish and Wildlife Agencies developed and submitted a grant request to support efforts to slow the leading edge; assess populations, movement, and habitat suitability; continue and expand education efforts; implement the Action Plan; and inform interstate law enforcement personnel.

Without dedicated funding to assist the states on the Ohio River, USFWS is currently providing technical guidance from lessons learned in the CAWS.

6.3 Other Asian Carp-related Efforts within the Great Lakes Basin

In 2012, USEPA GLNPO provided GLRI funding for numerous invasive species prevention and control projects. A number of these projects either directly or indirectly relate to ACRCC efforts. These projects include:

Grantee	Grant Amount	Project Title	Project Description
Michigan State University	$600,000	Development of a Portable Monitoring Device for High-Risk Invasive Species	This project will perform the laboratory and fieldwork necessary to develop a portable eDNA-based detection device which will be able to detect high-risk AIS of concern in the Great Lakes Basin. The device will be evaluated to assess sensitivity to small amounts of eDNA, species-specificity, speed, and ruggedness.
University of Notre Dame	$599,930	Improving eDNA-Based Surveillance Programs for High-Risk Potentially Invasive Species	This project will result in the ability to use eDNA to identify a greater number of high-risk invasive fish, mussels, and plants. The project will result in improved information on species population size; a better understanding of eDNA longevity under different environmental conditions; and increased speed and portability of invasive species detection methods. The project will enhance the early detection of invasive species and the effectiveness of rapid response programs.
University of Toledo	$598,922	Using DNA for Early Detection of High-Risk Invasive Fish Species	This project seeks to develop an accurate DNA-based diagnostic test on water samples that will enable the early detection of high-risk invasive fish species. The test is intended to be easy to use, rapid, and inexpensive. It is intended to be effective even in the presence of very small fish populations, and will be able to detect the presence of fish regardless of their life-stage (e.g., eggs, larvae, or adults).

Regents of University of Minnesota	$400,000	Reducing the Spread of Aquatic Invasive Species Via "Organisms in Trade"	The Great Lakes Sea Grant Network (GLSGN) will implement a research, education, and outreach initiative to reduce the spread of AIS via the sales of bait, aquarium fish, and other live organisms in trade. As part of this initiative, GLSGN will host a research symposium and will implement several outreach programs, including an expanded version of the "Nab the Aquatic Invader!" youth education program.
Great Lakes Commission	$400,000	Protecting the Great Lakes from Internet Trade of Aquatic Invasive Species	The project will develop software to assess the availability of invasive species via internet sales (i.e., Organisms in Trade or "OIT"), identify sellers of OIT, and assist regulators in developing and implementing targeted OIT management activities. This project will provide management tools to decision-makers and regulators, present information on the internet marketplace, better quantify the overall risks associated with internet sales of OIT, and present options for additional action to effectively prevent further releases of OIT into the environment.
Cornell University	$227,484	Working with Recreational Anglers and Boaters to Prevent the Spread of Invasive Species	This project supports the GLRI and the Great Lakes Water Quality Agreement, pursuant to Public Law 112-74. This project will increase efforts by government agencies and nongovernmental organizations in the Lake Ontario region to communicate with anglers and boaters about the risks that AIS pose to the Great Lakes and to discourage actions that contribute to their spread.
Central Michigan University	$356,154	Assessing Aquatic Invasive Species Risk in the Erie Canal Corridor	This project will assess the risks presented by AIS to the Erie Canal Corridor (ECC). The project will catalogue non-native species in the Mohawk-Hudson River and Lake Champlain basins and identify currently-restricted AIS that have the potential to spread into the ECC. By using eDNA surveys, the project will help identify the current range of priority AIS, potential invasion pathways, and future surveillance needs.
Board of Trustees University of Illinois	$398,009	Educating Aquaculture Suppliers and Hobbyists about Threats from Aquatic Invasive Species	This project will prevent the introduction of "aquatic organisms in trade" into the Great Lakes by educating hobbyists and suppliers in the aquarium, water garden, and biological supply trades about invasive species-related risks. An assessment of educational needs will be conducted and the results of that assessment will be used to create new outreach tools and to improve existing tools. These outreach tools will be distributed throughout the Great Lakes Basin by the Great Lakes Sea Grant Network.

7.0 ACRONYMS

ACRCC	Asian Carp Regional Coordinating Committee
AIS	Aquatic Invasive Species
ANS	Aquatic Nuisance Species
ANSTF	Aquatic Nuisance Species Task Force
Barrier	Electric Dispersal Barrier
CAWS	Chicago Area Waterway System
CEQ	Council on Environmental Quality
CLC	Council of Lake Committees
CSSC	Chicago Sanitary and Ship Canal
CWA	Clean Water Act
CWG	Communications and Outreach Workgroup
DC	Direct Current
DFO	Department of Fisheries and Oceans
DIDSON	Dual-frequency identification sonar
DNR	Department of Natural Resources
eDNA	Environmental deoxyribonucleic acid
ECALS	Environmental deoxyribonucleic acid calibration studies
ECC	Erie Canal Corridor
EDRR	Early Detection and Rapid Response
ERDC	USACE Engineering Research and Development Center
Framework	2011 Asian Carp Control Strategy Framework
FWCO	Fish and Wildlife Conservation Office
FY	Fiscal Year
GLC	Great Lakes Commission
GLERL	Great Lakes Environmental Research Laboratory
GLFC	Great Lakes Fishery Commission
GLMRIS	Great Lakes and Mississippi River Inter-Basin Study
GLNPO	Great Lakes National Program Office
GLRI	Great Lakes Restoration Initiative
GLSGN	Great Lakes Sea Grant Network
ICS	Incident Command System
IEPA	Illinois Environmental Protection Agency
IL DNR	Illinois Department of Natural Resources

IN DNR	Indiana Department of Natural Resources
IPM	Integrated pest management
I&M	Illinois and Michigan
MARAD	Maritime Administration
MI DNR	Michigan Department of Natural Resources
MN DNR	Minnesota Department of Natural Resources
MRRP	Monitoring and Rapid Response Plan
MRRWG	Monitoring and Rapid Response Workgroup
MST	Microbial source tracking
mtDNA	Mitochondrial DNA
NANPACA	Nonindigenous Aquatic Nuisance Prevention and Control Act
NGO	Non-governmental organization
NIMO	National Incident Management Organization
NISA	National Invasive Species Act
NISC	National Invasive Species Council
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service
OGL	Office of the Great Lakes
OH DNR	Ohio Department of Natural Resources
OIT	Organisms in Trade
OMNR	Ontario Ministry of Natural Resources
PADEP	Pennsylvania Department of Environmental Protection
PAFBC	Pennsylvania Fish and Boat Commission
PCR	Polymerase chain reaction
PED	Preconstruction, engineering, and design
PMP	Project Management Plan
QAPP	Quality Assurance Protection Plan
qPCR	Quantitative polymerase chain reaction
RT PCR	Real time polymerase chain reaction
SAV	Submerged aquatic vegetation
SONS	Save Our Native Species
SOP	Standard operating procedure
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
US DOT	United States Department of Transportation

USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WGL	Whitney Genetics Laboratory
WI DNR	Wisconsin Department of Natural Resources
WRDA	Water Resources Development Act

Appendix A
2013 Asian Carp Control Strategy Matrix – Funding by Agency

FY 2013 Asian Carp Control Strategy Matrix - Funding by Agency
July 2013

Action Item*	Title	NOAA		USACE		USCG		USDA-NRCS		USEPA**		USFWS		USGS	
		GLRI	Base	GLRI	Base	GLRI	Base	GLRI	Base	GLRI	Base	GLRI	Base	GLRI	Base
2.1.1	Enhanced Monitoring Efforts Above and Below the Electric Barrier System											$1,600,000	$0		
2.1.2	Monitoring (Electrofishing) and Rapid Response Team Support											$520,000	$300,000		
2.1.3	Support for Asian Carp Rapid Response in the Great Lakes Basin											$700,000	$0		
2.1.4	Great Lakes Asian Carp Monitoring Program											$350,000	$1,197,000		
2.1.5	Augmented Real-Time Detection of Bighead Carp													$0	$70,000
2.1.6	Wabash/Maumee Hydrologic Support to Prevent Interbasin Transfer of Asian Carp			$0	$50,000										$50,000
2.1.7	As Assessment of Silver and Bighead Carp Movement and Spawning Activities in the Wabash River Watershed														
2.2.1	Commercial Fishing for Removal											$1,200,000	$0		
2.2.2	Illinois River Stock Assessment/Management Alternatives											$400,000	$0		
2.2.3	Investigation of Certification Requirements for Asian Carp Usage											$0	$0		
2.3.1	Operations and Maintenance of Barriers			$0	$12,000,000										
2.3.2	Construction of Permanent Barrier I			$0	$12,451,000										
2.3.3	Telemetry - Barrier Efficacy Evaluation			$200,000	$0										
2.3.5	Eagle Marsh Temporary Barrier Fence Maintenance											$20,000	$0		
2.3.6	Eagle Marsh Invasive Species Barrier to Close Pathway			$338,000	$0			$1,200,000	$0						
2.3.7	CSSC Electric Fish Barrier Marine Safety Risk Assessment and Risk Mitigation Measures					$0	$0								
2.3.8	Waterway Traffic Management in Support of Asian Carp Control Activities					$0	$0								
2.3.9	Upper Wabash Asian Carp Telemetry and Spawning Study														
2.3.10	Development of Mobile Electric Barrier											TBD	$0		
2.3.11	Ohio Erie Canal Closure Assessment			$177,000	$0							$0	$0		
2.3.12	Little Killbuck Creek Closure Assessmen											$23,000	$0		
2.4.1	Efficacy Study			$0	$0										
2.4.2	GLMRIS Focus Area I: CAWS			$400,000	$4,740,500										
2.4.3	Feasibility Assessment of Inter-Basin Transfer of Aquatic Invasive Species Between the Des Plaines River and CAWS													$0	$0
2.4.5	Forecasting Spread and Bio-economic Impacts of AIS from Multiple Pathways	$292,800	$684,680												
2.4.11	Field Testing of Carbon Dioxide Barrier to Deter Asian Carp											$350,000	$0	$100,000	$0
2.5.1	Investigate Tow Boats and Barges as Potential Vectors					$0	$0								
2.5.2	Assessment Study of Potential Impacts of Steel-hulled Barges on Fish Movement Across Electric Barrier II			$0	$0										
2.5.4	Assessing Risks of Great Lakes Invasion by Understanding Asian Carp and Bluegreen Algae Dynamics													$0	$0
2.5.5	Risk Assessment of Asian Carp Establishment in the Great Lakes Based on Available Food Sources													$0	$0
2.5.6	Use of Seismic Technology to Divert or Eradicate Invasive Asian Carp													$775,000	$0
2.5.7	Field Evaluation of Chemical Attractants to Control Asian Carp and Development of Protocols for Field Verification of Response													$0	$200,000
2.5.8	Identify Potential Compounds for Inclusion in a Toxicant Screening Program													$0	$90,000
2.5.10	Developing Targeting Control Systems for Asian Carp Based on Species-Specific Digestive System Characteristics													$0	$70,000

2.5.11	Great Lakes' Tributary Assessment for Asian Carp Habitat Suitability													$0	$545,000
2.5.12	Technologies Using Oral Delivery Platforms for Species-Specific Control													$0	$400,000
2.5.15	Develop Alternate Traps and Net Designs to Enhance Asian Carp Capture Rates											$200,000	$0		
2.5.16	Development of a Rapid and Quantitative Genetic-Based Asian Carp Detection Method													$0	$140,000
2.5.17	Chicago Area Waterway System Monitoring Network Evaluation													$0	$40,000
2.5.22	Use of Acoustic Video and Side-scan Technology to Determine Behavior of Asian Carp - Net Avoidance Behavior													$0	$180,000
2.5.23	Movement, Habitat Selection and Behavior of Asian Carp and Native Planktivores in Newly Invaded River Segment: Implications for Control													$0	$110,000
2.5.24	Demonstration and Communication of New Technologies for the Control and Monitoring of Asian Carp													$50,000	$0
2.5.25	Hydraulic and Water-Quality Evaluation of Asian Carp Habitat in the Upper Illinois River													$0	$150,000
2.5.26	Feeding Habits of Asian Carp and Native Planktivores in Newly Invaded River Segment to Inform Chemical Control Strategies													$0	$90,000
2.5.27	Assessing Natural Recruitment Constraints on Asian Carp in River Reaches with Established and Emerging Populations: Implications for Control													$0	$225,000
2.6.1	eDNA Program Transition to USFWS (previously eDNA Monitoring of the CAWS)			$125,000	$0										
2.6.2	USFWS Fisheries Program Capacity for eDNA Sampling and Early Detection											$650,000	$400,000		
2.6.3	eDNA Calibration and Probabilistic Model			$1,300,000	$0										
2.6.4	USFWS Region 3 Fisheries Capacity for eDNA Processing											$500,000	$900,000		
2.6.5	Removing Uncertainty of eDNA Monitoring for Invasive Species in the Upper Mississippi River Basin													$0	$60,000
2.6.6	Environmental DNA Surveillance - Applied Early Detection											$0	$0		
2.6.7	eDNA Instructional Video Development											$10,000	$0		
2.6.8	Correlating Asian Carp eDNA or Microbial Tracking with Telemetry Data in the Wabash River													$0	$80,000
2.7.1	Outreach to Northeast Illinois' Bait Shops														
2.7.2	Increased Lacey Act Enforcement of Illegal Transport of Injurious Wildlife											$400,000	$0		
2.7.3	Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp											$300,000	$0		
2.7.4	Public Outreach through Website Development											$50,000	$0		
2.7.5	Asian Carp Education and Outreach	$0	$0												
2.7.9	Ecological Separation: Public Awareness and Education											$130,000			
2.8.1	USEPA Support for Asian Carp Activities			$1,060,000	$0					$1,340,000	$0	$550,000	$0	$700,000	$0
Agency Total: GLRI and Base Funding		$292,800	$684,680	$3,600,000	$29,241,500	$0	$0	$1,200,000	$0	$1,340,000	$0	$7,953,000	$2,797,000	$1,625,000	$2,500,000

Total FY 2013 Agency Base funding planned	$35,223,180
Total Fy 2013 GLRI funding requested	**$16,010,800**
Total Planned FY 2013 Funding: GLRI and Base	**$51,233,980**

Notes:

* Each Action Item reflects the 2012 Framework number assigned to it. New 2013 action items were numbered following the categorization used in the 2011 and 2012 framework.

** USEPA funding included monies alocated to CEQ for program support

Appendix B
2013 Asian Carp Control Strategy Framework Action Items

THE ASIAN CARP REGIONAL COORDINATING COMMITTEE

FY 2013 Asian Carp Control Strategy Framework Action Items

July 2013

Appendix B

Table of Contents

Note: The template numbers in this document reflect the action item numbers assigned to them in the 2011 and 2012 Asian Carp Control Strategy Frameworks. Newly proposed action items submitted for inclusion in the 2013 Asian Carp Control Strategy Framework have been categorized according to the 2011 and 2012 Framework and were assigned the next number in the series.

2.1. Targeted Monitoring and Assessment Activities

2.1.1 Enhanced Monitoring Above and Below Electric Barriers

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

Agency Collaboration: Illinois DNR, U.S. Army of Engineers (USACE), and U.S. Fish and Wildlife Service (USFWS) worked continually and extensively on the creation of the Monitoring and Response Plan (MRP; previously the Monitoring and Rapid Response Plan [MRRP]) and monitoring efforts and plans.

Fiscal Year (FY) 2013 Funding: $1,600,000 Great Lakes Restoration Initiative (GLRI) funds.

Project Explanation: Work will include a continuation of extensive monitoring efforts in elevated risk areas to detect presence of Asian carp and remove them, as necessary. Elevated areas are those previously identified through waterway characterization as preferable Asian carp habitat or where previous environmental deoxyribonucleic acid (eDNA) sampling indicated presence of Asian carp deoxyribonucleic acid (DNA) in the area at the time of sample collection.

FY 2012 Actions Undertaken

Illinois DNR in collaboration with USACE and USFWS have continued support of the 2012 MRRP through enhanced monitoring above and below the electric barrier system, as in prior years. Monitoring of these elevated areas included:

- Conventional monitoring, evaluation, coordination, and reporting for areas above and below the electric barrier.
- Five rapid response operations.
- Two barrier clearing events, multiple surveillance trips with remote sensing across electric barrier array.
- Deployment and support of gears developed under the FY2012 Alternate Traps and Net Design Project within the Chicago Area Waterway System (CAWS) to increase detection ability.
- Monitoring and managing of commercial gear deployment within the CAWS.

In addition, Illinois DNR began developing increased surveillance farther into CAWS and Lake Michigan near-shore waters. Efforts included:

- Sampling of larva, eggs, and small fish young-of-year fish (Young-of-Year—less than approximately 6 inches that are 0 years old) in CAWS and Upper Illinois Waterway. Illinois Natural History Survey (INHS) staff monitored the CAWS, and upper and middle Illinois Waterway for eggs and small fish, detecting none above Starved Rock Lock and Dam.
- Sharing of results by Monitoring and Response Workgroup (MRRWG; previously the Monitoring and Rapid Response Workgroup [MRRWG]) partners and agencies, which are

likely to modify strategy to further advance understanding in Asian carp work in and around the CAWS and at electric barriers, based on most recent data collection efforts.

- Serving as point of information and expert for other agencies regarding Asian carp control in other jurisdictions, states, and nations. Illinois DNR provided guidance based on scientific expertise and programmatic success as part of the Asian Carp Regional Coordinating Committee (ACRCC) and joint Asian carp efforts.

Bighead carp and silver carp were not collected in any of the CAWS scheduled sampling events or in any intense response actions. To date, after extraordinary sampling for nearly 3 years, only one live bighead carp has been collected in the CAWS (Lake Calumet 2010).

FY 2013 Actions Proposed

Monitoring of the elevated risk areas identified will include the following:

- Evaluation and updates to enhanced eDNA testing and monitoring in the CAWS
- Conventional monitoring, such as electrofishing and netting, at designated areas
- Continued deployment of experimental gears developed through FY 11-12 gear development project (augmenting MRP)
- Continued support of the 2013 MRP through enhanced monitoring above and below the Electric Barrier System (including deployment and scheduling of crews)
- Continued emphasis on larva and small fish 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
- Monitoring evaluation/efficacy (analysis of upstream commercial removal efforts and population front, and effort to seek independent review of efforts and identification of needs).
- Continuing to statistically evaluate monitoring program and evaluate for efficiencies in program, gears, and coordination of efforts
- Conducting weekly coordination and developing summaries of scheduled activities on the waterway
- Issuing weekly data summaries as available from MRP activities
- Coordinating with MRWG
- Continuing field support for efforts to remove any identified bighead carp in urban fishing ponds (a likely historical relic of fish rearing practices)
- Supporting ACRCC and MRWG efforts, outreach, and communication of results to partners and interested parties
- Assuming lead role in development of 2013 MRP based on 2012 results.

Expected Milestones

- Continued planned and intensive surveillance of the CAWS to assure that Asian carp populations have not changed. Evaluation of threat in CAWS.

- Modified surveillance, increased efficiency, and broadened spatial scope of planned and intensive surveillance in the upper Illinois River, the Des Plaines River, and the CAWS—further increasing our knowledge of Asian carp populations and populations just downstream of the electric barrier system.
- Monthly reporting of monitoring results to Asiancarp.us and to ACRCC partners.
- Adaptation to any needs identified through the MRWG, and communication of significant findings.
- Initiation of planning for 2014 MRP.

Outcomes/Output

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

Potential Hurdles

- Unidentified pathways for expansion of Asian carp
- Timeline of funding and prevention of timely allocation of resources.

2.1.2 USFWS Monitoring and Response Team Support in CAWS

Lead Agency: USFWS

Agency Collaboration: Illinois DNR, USACE

FY 2013 Funding: $820,000 Total ($300,000 base funds and $520,000 GLRI funds).

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 (rotenone, electrofishing, netting) and novel gear (eDNA, DIDSON) 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), 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.

FY 2012 Actions Undertaken: Illinois DNR, USFWS, and USACE continued extensive sampling efforts in search of Asian carp above and below the barriers following implementation of the updated 2012 MRP—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 September 2012, staff completed 416 electrofishing runs for a total of 105 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 eight response or barrier clearing exercises in 2012.

FY 2013 Actions Proposed: A USFWS team(s) will support Asian carp monitoring and response activities throughout the region as necessary, and help implement actions called for under the MRRP.

Expected end date: Unknown. Expected to continue until the threat of Asian carp range expansion via the CAWS no longer exists.

If not completed after 2013, explain follow-up activities: A USFWS team(s) will continue to support Asian carp monitoring and response activities throughout the region as necessary, and help implement actions called for under the MRP. The USFWS will work with agency partners to continue to refine monitoring techniques to increase sampling efficiencies, incorporate new and novel gears and technologies, and learn from data previously collected in the CAWS.

Expected Milestones:

- 2013: Approval and Implementation of the 2013 MRP
- Throughout 2013: Attainment of goals and objectives set by the MRP
- Completion of necessary monitoring with conventional and novel gears to determine the distribution and abundance of Asian carp in the CAWS
- Participation in response efforts, as needed
- Participation in necessary barrier clearing exercises, including measures to determine fish presence or absence between barriers.

Outcomes/Output:

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

Potential Hurdles:

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

2.1.3 Support for Asian Carp Rapid Response in the Great Lakes Basin

Lead Agency: USFWS

Agency Collaboration: Great Lakes States.

FY 2013 Funding: $700,000 GLRI funds.

Project Explanation: Current USFWS capacity for rapid response actions is largely restricted to the CAWS (via Task 2.1.2) or is limited in scope (Task 2.8.4). However, planned or ongoing early work to detect Asian carp will occur throughout the Great Lakes Basin (via Task 2.8.4) and near interbasin connection points specified in the Great Lakes Mississippi River Interbasin Study. Given possible need for multiple, high-cost, rapid response actions, additional response capacity is required. Rapid response activities may be implemented where specific evidence indicates presence of Asian carp within the Great Lakes basin or near interbasin connections.

FY 2012 Actions Undertaken: In 2012, USFWS participated in eight traditional gear/novel gear-based rapid response actions or barrier clearing exercises in the CAWS. In 2012, USFWS worked with the States of Michigan and Ohio to lead rapid assessment efforts in Maumee and Sandusky Bays of Lake Erie. From July-September 2012, the Service collected eDNA water samples, electrofished, and set large mesh gill nets to assess presence or absence of Asian carp based on positive eDNA results for bighead and silver carp announced by the University of Notre Dame. No Asian carp were captured, but positive eDNA results from USFWS sampling may signal a need for future actions in western lake Erie.

FY 2013 Actions Proposed: As requested, USFWS will support rapid response actions led by states or other jurisdictions around the Great Lakes basin. To supplement these efforts, USFWS will continue to store rotenone and be prepared to purchase other associated chemicals and materials. Additional staff will be trained in ICS as needed.

Expected end date: Unknown. Actions are expected to continue until threat of Asian carp range expansion into Great Lakes Basin no longer exists.

If not completed after 2013, explain follow-up activities: The USFWS will continue to stand ready to support rapid response actions led by states or other jurisdictions around the Great Lakes basin to control the spread of Asian carp.

Expected Milestones:

- Maintain capacity to conduct partner-driven rapid response actions(s), where appropriate, to control Asian carp
- Maintain staff proficiency and training to perform rapid response actions, where appropriate.

Outcomes/Output:

- Continued safe storage of rotenone and associated chemicals for use against Asian carp

- Provision by USFWS of support for any rapid response actions in the Great Lakes basin or associated interbasin connection points
- Satisfaction of needs of USFWS partners in addressing rapid response actions around the Great Lakes basin.

Potential Hurdles:

- Local coordination, staffing, and logistics of rapid response actions.

2.1.4 Great Lakes Asian Carp Monitoring Program

Lead Agency: USFWS

Other Agencies Involved: Great Lakes States, USGS, USACE, academic institutions

FY 2013 Funding: $1,547,000 Total ($1,197,000 base funds and $350,000 GLRI funds).

Project Description: Continue development and implementation of a comprehensive and complementary early detection and rapid assessment surveillance program for bighead and silver carps in and near the Great Lakes. This program would complement the eDNA sampling and analysis programs implemented by academia, USACE, and USFWS. Sampling would primarily target areas of high concern in the Great Lakes (e.g., southern Lake Michigan, western Lake Erie), and use a diverse array of traditional and novel gears to sample all potential life stages.

FY 2012 Actions Undertaken: In 2012, USFWS worked with partners to refine a Great Lakes basinwide early detection protocol for Asian carp and other AIS. USFWS and USEPA convened a workshop in March 2012 with Great Lakes Basin partners to further develop protocols, share information, and discuss ways to coordinate agency sampling efforts. In 2012, USFWS worked with the States of Michigan and Ohio to conduct provisional sampling efforts in Maumee and Sandusky Bays of Lake Erie. From July-September 2012, USFWS collected eDNA water samples, electrofished, and set large mesh gill nets to assess presence or absence of Asian carp based on positive eDNA results for bighead and silver carp announced by the University of Notre Dame. No Asian carp were captured, but positive eDNA results were obtained from USFWS sampling.

FY 2013 Actions Proposed: USFWS will work with partners to continue developing 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. By 2014, USFWS and partner agencies will fully implement a comprehensive Great Lakes basin wide early detection and monitoring program for Asian carp and other AIS.

Expected end date: Unknown.

If not completed after 2013, explain follow-up activities: USFWS will continue to refine protocols as more data are collected, and monitoring efforts will continue on an annual basis to detect new invasions of Asian carp.

Expected Milestones:

- 4th quarter 2013/1st quarter 2014: 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:

- Ongoing early detection, rapid assessment, and rapid response program for the Great Lakes
- Information that will build upon existing knowledge of habitat requirements for bighead and silver carp.

Potential Hurdles:

- Coordination among numerous agencies on a large landscape such as the Great Lakes basin
- Attainment of agreement regarding sampling gears and sampling design among diverse partners
- Possible issues regarding sampling site logistics (e.g., access and working in Canada without a Memorandum of Understanding [MOU] in place)
- Possible difficulty obtaining timely eDNA results
- Inefficiency of traditional sampling gear, particularly in large, voluminous water bodies.

2.1.5 Augmented Real-Time Detection of Bighead Carp

Lead Agency: U.S. Geological Survey (USGS) (Indiana Water Science Center)

Other Agencies Involved: Indiana DNR and Purdue University

FY 2013 Funding: $70,000 Base funding.

Project Description: USGS (Indiana Water Science Center) proposes to co-locate telemetry detectors and temperature sensors at existing USGS streamflow gage sites and use telemetry to provide early-warning, real-time data on movement of acoustically tagged bighead carp (Hypophthalmichthys spp.) up the Wabash River and selected tributaries toward the Adult BHC barrier at Eagle Marsh. A Purdue University network of tagged carp provides an opportunity to implement early-warning carp detection and control strategies already under development in an environment similar to those of concern in large streams in the Great Lakes and upper Mississippi basins. Data from the USGS real-time gages would accelerate Indiana and Ohio DNRs' responses to adult bighead carp migration events in the Wabash River watershed toward the Eagle Marsh

Adult BHC barrier to the Great Lakes. It would also speed up collection of quality assurance data on bighead carp presence for USGS validation testing of emerging rapid eDNA and microbial tracking methods of detecting bighead carp. The increased information related to bighead carp movements and spawning events and relation of this information to temperature and flooding conditions (Purdue University/Illinois DNR study) would improve understanding of how bighead carp may migrate in similar large rivers within the Great Lakes basin.

USGS will procure, install, and operate for 1 year: (1) four automated receivers at or near existing USGS stream gage sites to monitor and transmit real-time data on movements of acoustically tagged bighead carp, and (2) temperature sensors at these sites to indicate thermal conditions favorable to bighead carp migration. Installation of USGS real-time detectors of acoustically tagged bighead carp at USGS stream gages on mainstream Wabash and Little River USGS streamflow gages will enable evaluation of real-time streamflow data in connection with bighead carp detection. This project will enable relocation of several existing stationary receivers operated by Purdue University researchers to other Wabash River or tributary sites where more data are needed to describe bighead carp movements. Bighead carp detection data from the real-time sites will be reported on-line at approximately 1- to 4-hour intervals through the existing USGS National Water Information System NWIS-WEB system (http://waterdata.usgs.gov/in/nwis/rt), and will be archived in that system.

FY 2012 Actions Undertaken: USGS real-time telemetry activity was discussed with Indiana DNR (Keller), Purdue University (Goforth), and USGS stakeholders; this activity was proposed in August 2012. During FY 2012, the Purdue/Illinois DNR activity detected tagged bighead carp using stationary receivers and manual tracking (1) near the confluence of the Wabash and Little Rivers, (2) downstream to approximately Wabash River Mile 100, and (3) in one major tributary in the middle Wabash (Tippecanoe River). Manual tracking of bighead carp using portable receivers occurred monthly from May 1 to August 15 to accurately identify locations of fish and to record habitat information where tagged bighead carp were located. The Purdue/Indiana DNR work also coordinated egg netting with water quality and flow measurements for project 2.5.11 Great Lakes' Tributary Assessment for Asian Carp Habitat Suitability. An additional 50 or more fish will be tagged in fall 2012/spring 2013 during the Purdue/Illinois DNR activity.

FY 2013 Actions Proposed: During FY 2013, the following actions are proposed: After funds are allocated to the project, USGS will procure, install, and operate for 1 year: (1) three automated receivers at or near existing USGS streamgage sites to monitor and transmit real-time data on movements of acoustically tagged bighead carp, and (2) temperature sensors at these sites to indicate thermal conditions favorable to bighead carp migration. Installation of USGS real-time detectors of acoustically tagged bighead carp is proposed at the following USGS streamflow gages within the Wabash River watershed:

Description	USGS Streamflow Gage	Reason for site
On tributary leading to Eagle Marsh. Upstream at low-head dam in Little River or ~2 miles upstream from low-head dam	03324000 LITTLE RIVER NEAR HUNTINGTON, IN	Along tributary leading to Eagle Marsh; add USGS real-time tagged bighead carp detector and temperature sensor
On main stem of Wabash River—detection of real-time carp movement	03325000 WABASH RIVER AT WABASH, IN	Some bighead carp eggs detected on Wabash River near Wabash, Indiana, 2011; add USGS real-time tagged bighead carp detector and temperature sensor
On main stem of Wabash River—detection of real-time carp movement	03323500 WABASH RIVER AT HUNTINGTON, IN	Bighead carp migration detected in 2011; add USGS real-time tagged bighead carp detector

This project will enable relocation of several existing stationary receivers operated by Purdue University researchers to other Wabash River or tributary sites where more data are needed to describe bighead carp movements.

Bighead carp detection data will be reported on-line, starting in mid-July at approximately 1- to 4-hour intervals through the existing USGS National Water Information System NWIS-WEB system (and will be archived in that system).

Expected end date: The project is expected to end within no less than 12 months of the planned beginning of data collection in July 2013.

If not completed after 2013, explain follow-up activities: At the end of this project, depending on lifespans of the transmitter-equipped bighead carp and timing of installation of a long-term AIS/bighead carp barrier at Eagle Marsh, USGS will discuss with Indiana DNR and Ohio DNR need and funds for continued monitoring and reporting of real-time bighead carp detection data.

Expected Milestones:

- 1-4 months from project start. Procure stationary receivers and necessary cables, data loggers, and cellular modems. Data loggers, many cables, and temperature probes can be procured through existing USGS contracts. Stationary receivers and dedicated cables will require dedicated purchases.
- 4-5 months from start (about July 2013). Install access points from bridges. Deploy passive monitors and temperature probes. Transmit data real-time to USGS NWIS system. Post temperature data on-line. Have bighead carp detections retrievable to researchers from dedicated IP addresses at their duty stations.
- 6-12 months from project start. Monitor data through duration of planned USGS and Purdue collaborations. For example, the USGS part of this project to correlate Asian carp

eDNA and/or microbial tracking technologies with telemetry data in the Wabash River also begins in USGS funding year FY 2013.

Outcomes: The USGS real-time data on bighead carp detections will result in several outcomes beneficial to bighead carp early-warning detection, control, and migration prevention:

- Results from the USGS real-time monitoring will accelerate emergency response by the Illinois DNR and others to bighead carp migration toward the Eagle Marsh barrier at the time of a flood. Not until weeks after the event would currently deployed, downloadable, stationary and manual receivers operated by Purdue University provide information about whether tagged bighead carp decide to rapidly migrate upstream in the Wabash River toward the boundary at Eagle Marsh.
- The USGS project will also provide necessary real-time quality assurance data on tagged bighead carp in reaches where USGS enhanced eDNA and microbial tracking methods to detect bighead carp will be tested. The outcome will speed up USGS validation testing and establish confidence in emerging rapid eDNA and microbial tracking methods of detecting bighead carp.
- The USGS real-time monitoring will assist response by Purdue University to spawning events in the Wabash River watershed.
- The cumulative benefit of the real-time bighead carp detection, streamflow, and temperature data will be indication as to where bighead carp may migrate in similar large river environments within the Great Lakes basin.

Potential Hurdles:

- Delays in funding availability beyond about January 1, 2013, could delay acquisition and installation of the real-time bighead carp detection equipment beyond the April 15-May 15 date range (when data collection should start).
- Early allocation to the project of up to about $38,000 would permit acquisition of project equipment and installation and commencement of operation by the time the rest of funds would be released.

2.1.6 Wabash/Maumee Hydrologic Support to Prevent Interbasin Transfer of Asian Carp

Lead Agency: USGS (Indiana Water Science Center)

Agency Collaboration: USACE (Great Lakes Mississippi River Interbasin Study [GLMRIS]—Other Pathways), Indiana DNR, Little River Wetlands Project (LRWP)

FY 2013 Funding: $100,000 Base funding ($50,000 USACE and $50,000 USGS).

Project Explanation: Presence of adult bighead carp has been confirmed within the Wabash River basin for at least 15 years. The Wabash River basin intermittently connects with the Maumee Basin (Lake Erie) during flood stage through a former glacial channel at Eagle Marsh in northeast Indiana. This proposed effort would support flow modeling by the USACE to develop feasible

plans for separating the basins to prevent migration of ANS while maintaining the marsh as viable flood relief for Fort Wayne, Indiana.

Existing stage gage operation is needed to validate periods when Eagle Marsh floods sufficiently for the adult carp barrier fence to operate, and to indicate needs of maintenance and cleaning. Links to these gages are as follows:

- 03323583 EAGLE MARSH EAST NEAR FORT WAYNE, Indiana
- 03323584 EAGLE MARSH WEST NEAR FORT WAYNE, Indiana

Funding requested will cover: (1) operation of the existing water-level gages at the Eagle Marsh carp fence, (2) enhancement of the existing water-level gages at the Eagle Marsh carp fence to include a webcam to validate flooding conditions when observers must mobilize to classify fish at the barrier fence, and (3) oper**a**tion of two hydro-acoustic streamflow and temperature gages in the area for a planned second year to establish flow properties during temperature conditions favorable to carp migration. The data from this project will directly help prevent ANS migration into the Great Lakes by providing the basis for a design that separates the two basins and limits possible flooding.

FY 2012 Actions Undertaken: USGS continued support of adult carp barrier fence function by continued reporting of real-time water-level data from barrier fence from October 1, 2011, through September 30, 2012. High water level conditions were also observed at the fence from November 9, 2011, to November 30, 2011, during a period not favorable to fish movement.

In May-June 2012, streamflow and temperature gages were installed at stream sites east and west of Eagle Marsh to provide calibration data for simulating and limiting induced flooding from measures to prevent interbasin transfer of adult bighead carp, round goby, and other aquatic invasive species. Acoustic streamflow gages and temperature probes were installed on Graham McCulloch Ditch (Wabash River basin) and Junk Ditch (Maumee River basin) to measure flows and temperatures during episodes of high water after rainfall, and to reveal periods when flow conditions on Junk Ditch reverse direction westward from the St. Mary's River toward Eagle Marsh. Operation of these gages continues today.

FY 2013 Actions Proposed

- Continue USGS support of adult carp barrier fence function by operating and maintaining two existing water-level (stage) gages on east and west sides of fence. The water-level gages indicate when water levels are sufficiently high for fish to reach the fence, and provide warning to Indiana DNR staff to verify presence of adult carp.
- Install and operate a webcam as a secondary observation point where the carp barrier fence connects to the Graham McCulloch Ditch berm to observe fish conditions at the barrier and water height relative to the berm separating Graham McCulloch Ditch from Eagle Marsh. The webcam observations are also needed to observe conditions affecting berm integrity.

- Operate the streamflow gages and report real-time streamflow and temperature data for sites on Graham-McCulloch and Junk Ditch to provide a second year of data. About 6-8 visits by USGS will occur to measure quality assurance flow data and use these data to report accurate flows, flow directions, and temperatures. The second year of data are needed to maximize the chance of observing extreme water-level and flow conditions during temperature conditions favorable to migration of adult bighead carp. The data will be used by the USACE to calibrate its hydraulic model of flows in both Ditches, and simulate possible flooding of the Marsh and nearby parts of Fort Wayne and Allen County during extreme events after construction of basin separation measures. The model is an essential part of designing basin separation structures that prevent ANS migration, minimize incidental flooding, and meet state and federal standards.

Expected end date: If FY2013 funds are provided through GLRI, the end of USGS data collection is expected by February 28, 2014 (end of GLRI FY 2013) or 1 to 4 months later as these funds and construction schedules permit.

If not completed after 2013, explain follow-up activities: The USACE and partners may need to apply these data to the model and separation design after the expected data collection is complete. The USGS plans to identify local stakeholders to operate whatever sites are needed to validate barrier operation, as indicated by the USACE design.

Expected Milestones:

- Provide provisional streamflow and temperature information online, through second year after installation (March 2013 through February 2014 or later as funds permit) from following locations.
  - Graham McCullough Ditch near where it empties into Little River (http://waterdata.usgs.gov/in/nwis/uv/?site_no=03323587)
  - Site on Junk Ditch above St. Mary's River (http://waterdata.usgs.gov/in/nwis/uv/?site_no=04182755)
- June 2013: Finalize streamflow data from year 1 through review of quality assurance measurements, and develop rating of streamflow from water level, velocity, and flow direction measurements.
- June 2013 (or earlier as funds permit): Procure and install webcam. Display image through USGS (Indiana Water Science Center) RiverCams website (http://in.water.usgs.gov/rivercam.shtml).

Outcomes:

- Publication of provisional data on USGS NWIS-Web, and provision of information to USACE and Illinois DNR partners for effective use in hydraulic simulation of ANS separation alternatives.
- Operation of water-level gages and webcam to activate response of USACE, Indiana DNR, and Little River Wetland Project to possible carp presence at barrier fence.

- Enhancement via webcam of public access to Asian carp control strategies, and enhancement of response by technical staff to potential Wabash-Maumee interbasin connection events.

Potential Hurdles:

- Landowner access for stream-flow gages—will attempt to locate at existing road crossings to use government-controlled right-of-ways.

2.1.7 An Assessment of Silver and Bighead Carp Movement and Spawning Activities in the Wabash River Watershed

Lead Agency: Indiana DNR

Agency Collaboration: Purdue University

FY 2013 Funding: No additional FY 2013 funds necessary.

Project Explanation: Potential trajectories and rates of movement by silver and bighead carp throughout the Wabash River, and especially into the Little River and Eagle Marsh, are under evaluation. To date, approximately 160 Asian carp have undergone implantation of acoustic tags, and by spring 2013, a total of 300 fish will have been tagged. A network of passive receivers is in place in the upper and middle Wabash River and in some tributaries to determine Asian carp use and their approach toward the watershed connection at Eagle Marsh. Bongo net tows will be employed for Asian carp eggs to determine the upstream extent and duration of Asian carp spawning in the Wabash River.

FY 2012 Actions Undertaken: A total of 160 Asian carp (nearly all silver carp) were tracked through 2012. Due to the extreme drought of 2012 and at times record low river levels, Asian carp showed much less use of the upper Wabash River than during 2011. Despite low river levels and very few spikes in the hydrograph, Asian carp spawning was verified beginning in early May and continuing through early September. Again because of low river levels, Asian carp eggs were not found as far upstream in the Wabash River as they had been in 2011.

FY 2013 Actions Proposed: If conditions allow, another 140 Asian carp will undergo insertions of acoustic tags by spring 2013. This would bring the total of at-large tagged fish to 300. Stationary receivers will be maintained throughout the upper and middle Wabash River and in some tributaries to detect movements. Manual tracking will occur as well to determine habitat preference of Asian carp. Bongo nets will again be utilized to determine the upstream extent and duration of spawning.

Expected Milestones:

- By the end of 2013 and after 3 years of research, we should have a complete understanding of Asian carp use of the upper Wabash River, extent of spawning in the upper Wabash River, their preferred habitat, and water level/temperature triggers for movement and spawning.

Outcomes/Output:

- October 30, 2013: Phase II project report submitted by Purdue to Indiana DNR.

Potential Hurdles:

- Inclement weather and flood or drought conditions may delay some project activities.

2.2. Commercial Harvesting and Removal Actions below the Electric Barrier System

2.2.1 Contract Fishing for Asian Carp Removal

Lead Agency: Illinois DNR

FY 2013 Funding: $1,200,000 GLRI funds.

Project Explanation: This program was established to reduce the number 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 number of carp testing the barrier, and therefore decrease the possibility of Asian carp moving across the barrier and gaining access to waters upstream of the barrier. This program removed over 60 tons of Asian carp in 2010, and over 300 tons in 2011. This program also allows for monitoring population densities of Asian carp over time within the four pools immediately below the electric barrier system.

FY 2012 Actions Undertaken: Contracted commercial fishers and Illinois DNR biologists caught and removed over 44,000 bighead carp and 47,000 silver carp (nearly 700 tons in all) from Starved Rock, Marseilles, and Dresden Island pools of the Illinois River from 2010-2012. Combined, over 284 tons of Asian carp was removed from the river in 2012. Consistent removal has reduced catch rates across the areas fished. The catchable leading edge of carp apparently has not moved farther upstream toward the CAWS and Lake Michigan.

FY 2013 Actions Proposed: Ten commercial fishing crews will be employed to continue to detect, harvest, and reduce population of Asian carp approximately bi-weekly within the area between the Starved Rock Lock and Dam and the electric barrier system, as well as within the CAWS. Harvested fish will be picked up and utilized by private industry under contract to Illinois DNR. The harvest will inform managers of changes in population/harvest rates and fish condition, further informing us of Asian carp population changes—information important for controlling these species. Length/weight and catch rates will be reported bi-weekly and monitored continuously. Scheduling of fishing effort will be targeted when fish are in high access areas, based on prior years' experience, allowing for similar effort to remove more fish. Other monitoring will take advantage of removal efforts to gain valuable insight into movement of Asian carp responding to the density changes due to harvest up and down the waterway, as a supplement to fixed site monitoring. Efficacy of reduction efforts will be gauged by monitoring by other components and Framework responses. Results of these removal efforts will support the MRRP and combine with results of peer review and recommendations upon conclusion of annual analyses and assessments. This method above the electric barrier is an important detection tool, allowing account of the only Asian carp collected above the electric barrier.

Rapid response efforts include these contracted commercial fishers that can deploy exceptional amounts of nets in a fashion consistent with that used to catch Asian carp within other areas of the waterway.

Expected Milestones:

- March 1, 2013: Implementation of winter sampling protocols (trammel, gill nets, and seine hauls) will further reduce overall biomass of Asian carp in river reaches below the electric barrier system.
- September 30, 2013: Overall reduction of biomass of Asian carp in river reaches below the electric barrier system will reduce the threat of challenges to electric barrier system and lower the threat to the Great Lakes.

Outcomes:

- Ability to assess these populations by spring 2012 and adjust efforts to optimize impacts
- Population reduction yields reducing opportunity for Asian carp to challenge electric barrier system
- Monitoring of leading front of Asian carp, determining length, weight, and general biological condition
- Significant personnel with experience fishing multiple gears in riverine conditions to respond rapidly for early detection and rapid responses
- Assessment of efficacy of removal efforts by reference to added telemetry data (other projects)—expected to indicate success of removal efforts on a pool by pool basis and thus success in prohibiting upstream movement of Asian carp.

Potential Hurdles:

- Increased immigration from out-populations could outpace removal efforts.

2.2.2 Illinois River Stock Assessment/Management Alternatives

Lead Agency: Illinois DNR

Agency Collaboration: Southern Illinois University, Feeding Illinois

FY 2013 Funding: $400,000 GLRI funds.

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 provide 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 2007 *Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States*. 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 of (1) prevention of spread toward the CAWS, and (2) further reduction of Asian carp populations

FY 2012 Actions Undertaken: Using the best science and understanding of the fishing industry and stock/recruitment variables, we are developing dynamic models to forecast and predict effects of harvest and breadth of Asian carp populations. This provides science-based direction for harvest strategy, and presumably will lead to success of industry and regional regulatory oversight in achieving goals to prevent spread and further reduce Asian carp populations. The 2012 activities maintained counts and assessment of fishing efforts to maximize reduction.

Counts. A baseline density and weight estimate now exists regarding Asian carp in the Illinois River; continued comparisons are necessary to account for immigration/emigration and year-to-year variation and hydrological changes. Intensification of monitoring and assessments activities within the upper Illinois Waterway will provide information on efficacy of removal and movement (upstream or downstream of population front)

Fishing estimate. The amount of fishing necessary to reduce population size and reproductive output of the two Asian carp species is unknown. Removal of approximately 3 million pounds of Asian carp was completed in 2012. Ongoing analyses will evaluate the success of the removal and detection in these downriver portions of the Illinois River. Concurrent analyses will focus on upstream contracted removal efforts.

Environmental impact. We will further study the impact of Asian carp on native species in the Illinois River. Changes in native species and their food are being quantified to assess the risk of an Asian carp invasion in the Great Lakes. This dynamic relationship will be monitored annually, up and down the Illinois River, venturing into the Great Lakes where practicable to render research predictions accurate. Currently, differences in plankton populations show upstream to downstream gradients, similar to the abundance of Asian Carp. Change in this relationship may also indicate change in population fronts.

Movement. Asian carp populations in the Illinois River are not isolated, and ongoing monitoring will evaluate annual differences.

FY 2013 Actions Proposed:

Surveillance work has identified fishable populations of Asian carp for removal by 2.2.1 Contract fishing (prior project) that may have gone undetected using traditional fishing alone. These combined efforts and communications among projects have increased efficiency of removal and have provided opportunities for calibration via remote sensing techniques. The following actions for proposed for FY 2013:

- Provide interactive information system with biological monitoring and harvest data to inform managers on success of on-the-ground efforts of industry and of agency control efforts.
- Determine source of upstream population and formulate strategy to reduce this front further. If immigration from outside the Illinois River occurs, a different strategy is necessary than one assuming population of the upper Illinois River from the downstream Illinois River Pools.
- Determine natal environments for Asian carp that have moved up into the upper Illinois River.
- Provide state-of-the-art hydroacoustic surveillance of Asian carp locations to maximize removal efforts.

- Provide hydro-acoustic expertise to evaluate risk surrounding the electric barrier clearing activities.
- Maintain estimates of carp populations and habitats used to maximize removal. Determine if any refuges from control exist.
- Collect additional data as necessary to complete and fine-tune models developed in prior years, and increase accuracy to reduce error.
- Determine annual changes in population and recruitment—necessary for accurate assessments.
- Assess biological impacts on native Illinois River fishes and fauna.
- Establish plankton abundances over various Asian carp populations, and predict abundances and potential impacts on new ecosystems.
- Conduct workshop in on Asian carp population model (review and improvements) with national experts.

Expected Milestones:

- Population estimate for all Illinois populations of Asian carp for use by program to maximize efficiency in reducing numbers and retracting range of Asian carp.
- Dynamic movement and multi-pool models for entire Illinois River.

Outcomes:

- 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 Asian carp invade the Great Lakes.

Potential Hurdles:

- Variation in feral carp populations due to reproduction and/or movements that may exceed ability of harvest/control efforts to detect changes
- Hydrological effects on removal efforts and implementation of surveillance.

2.2.3 Investigation of Certification Requirements for Asian Carp Usage

Lead Agency: Illinois DNR

Agency Collaboration: U.S. Agency for International Development (USAID)

FY 2013 Funding: None (State Funded).

Project Explanation: Asian carp could be used as a human food source, but certification procedures that would document suitability of Asian carp from the Illinois River and Mississippi River for human consumption have not yet been assessed.

FY 2012 Actions Undertaken:

- Information communicated to national and global organizations with compositional and contaminant information in hand
- Close collaboration with Illinois River Stock Assessment/Management Alternatives project
- Enhancement of state, local, regional promotions of Asian carp as high-quality food to garner support for USAID investigation
- Numerous discussions with leaders in national and international Agency for International Development (AID) organizations.

FY 2013 Actions Proposed:

- Continue to communicate with key people in U.S. Department of Agriculture (USDA) and share information on ability of Asian carp to provide healthy and high-quality food items.
- Investigate private or not-for-profit agencies and organizations to utilize these entities in a fashion similar to use of governmental aid organizations.

Expected Milestones:

- Contaminant analysis and report is complete.
- Additional letter may allow further listing of Asian carp for global use.
- Obtaining supply and health certifications will promote good use of this protein for humanitarian uses.

Outcomes:

- Identify partners and workable pathways to get packaged product into the international aid pipeline

Potential Hurdles:

- Ability to supply fish in quantities desired
- Ability to support both domestic and international needs
- Identification and provision of proper and suitable packaging for fish to be welcomed and used in USAID
- Increased costs of logistics/transportation of high-quality protein.

2.3. Barrier Actions and Waterway Separation Measures

2.3.1 Operations and Maintenance of Barriers

Lead Agency: USACE

FY 2013 Funding: $12,000,000 Base funding.

Project Explanation: USACE applies three different types of fish deterrent measures throughout the CAWS. Each is designed to prevent a distinct migration pathway of Asian carp toward the Great Lakes.

- The Bypass Barrier physically blocks known bypasses around the electric barriers that occur during periods of flooding from the Des Plaines River and the Illinois and Michigan (I&M) Canal, and halts possible fish movement through this area. The barriers placed in these locations are intended to stop juvenile and adult Asian carp. Additional and/or more permanent separation measures will be assessed in the Efficacy Study Report.
- The Electric Barriers create a waterborne, pulsed, direct current, electric field in the Chicago Sanitary and Ship Canal (CSSC) that exposes fish penetrating the electric field to electrical stimuli that act as a deterrent. As fish swim into the field, they feel increasingly uncomfortable. When the sensation is too intense, the fish are either immobilized or deterred from progressing farther into the field. Three barriers (Demo, IIA, and IIB) have been constructed so that two can operate fully at any given time and the third is available for emergencies or planned maintenance shutdown.

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 these structures must be maintained as authorized by law.

FY 2013 Actions Proposed: USACE will continue to operate and maintain these structures with base agency funds. These actions include periodic inspections to keep structures free from debris, and regular maintenance to ensure the electric barriers are functioning properly.

Expected Milestones:

- 3rd Quarter FY2013 – Complete electric barrier maintenance.

Outcomes/Output: The barriers will perform as designed, thereby minimizing risks of movement of fish toward Lake Michigan via the CSSC, and bypass around the electric barriers via the I&M Canal and the Des Plaines River.

Potential Hurdles: None.

2.3.2 Construction of Permanent Barrier I

Lead Agency: USACE

FY 2013 Funding: $12,451,000 base funding.

Project Explanation: The Electric Barriers operate by creating a waterborne, pulsed, direct current, electric field in the 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 are either immobilized or are deterred from progressing farther into the field. Three barriers (Demo, IIA, and IIB) have been constructed, but only two are fully operational at any given time.

Additionally, 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 migration of Asian carp within the CAWS.

FY 2012 Actions Undertaken: The first construction contract for Barrier I was awarded in September 2012.

FY 2013 Actions Proposed: USACE will begin site work at Barrier I. Two additional construction contracts are anticipated for work at the site.

Expected Milestones:

- 4th Quarter 2013: Award contracts for placement of barrier electrodes and parasitics, and to supply barrier electronics.

Potential Hurdles: None.

2.3.3 Telemetry – Barrier Efficacy Evaluation (Barrier Efficacy Evaluation)

Lead Agency: USACE

Agency Collaboration: USFWS, Southern Illinois University at Carbondale (SIUC)

FY 2013 Funding: $200,000 GLRI funds.

Project Explanation: Continued validation and enhanced understanding of electric barrier effectiveness is one of the highest priorities in the immediate strategy to prevent Asian carp from reaching the Great Lakes. Proposed actions have included tagged fish/telemetry, installation and operation of hydro-acoustics at the barrier, and pursuit of further research regarding barrier effectiveness; however, for FY 2013, only telemetry studies will occur.

Telemetry: The telemetry plan includes tagging fish with individually coded ultrasonic transmitters in the Upper Illinois Waterway (IWW) and CAWS. Telemetry is used to assess effectiveness of the electric barriers by monitoring movement of fish in the immediate vicinity of the barriers in order to determine if the fish can challenge and/or penetrate the Barrier. Additionally, telemetry is used to identify the leading edge of the Asian carp population and whether Asian carp can navigate through lock structures in the IWW system. Surrogate species (i.e., common carp, buffalo spp.) will be tagged at and near the Barrier for monitoring (Lockport Pool); Asian carp will be tagged in the Dresden Island and Brandon Road Pools. The acoustic network proposed is composed of stationary acoustic receivers supplemented by a mobile hydrophone unit.

FY 2012 Actions Undertaken:

Telemetry: USACE tagged additional surrogate species to replace tags implanted in 2010 whose battery life had been exceeded or fish that died or moved out of system. The focus of study was at and around the Barrier, utilizing the 5-year life of the receivers deployed at the Barrier system.

Split beam hydro-acoustic monitoring:

- Design of a pilot study for hydro-acoustic fish monitoring at the CSSC Electric Barrier System
- Installation of the hydro-acoustic fish monitoring system
- Monitoring of fish movements with adjustments as necessary. If fish move upstream through the barrier, river managers are to be alerted.

FY 2013 Actions Proposed:

Telemetry: USACE will continue to assess efficacy of Barriers IIA and IIB, as well as add an array at the site of the new permanent Barrier I. By combining the array established by USACE with the new arrays established by SIUC and USFWS, we are also able to monitor long-term movement of Asian carp within the entire IWW, including localized movements through lock structures and at

the area of the population's leading edge. Additionally, USACE will continue to coordinate efforts with SIUC and USFWS, with objectives of (1) integrating information among related acoustic telemetry studies; (2) downloading and analyzing post-telemetry data for information sharing; and (3) expanding the existing acoustic network in Dresden Island and Marseilles pools to support USFWS telemetry network, and to maintain capability to rapidly deploy to areas of interest in response to new information.

Further barrier research: In 2013, USACE will assemble an expert interagency team to review and develop new research recommendations for barrier effectiveness. The team will identify, prioritize, and recommend work for further research.

Expected Milestones:

- February: Publication of 2012 Summary of findings in MRRP Summary Report
- April: Acoustic network inspection; installation and testing of new receivers
- July: Initiation of tagging efforts:
  - Dresden Island and Marseilles pools: Asian carp
  - Lockport and Brandon Road pools: surrogate species
  - Barrier: small non-Asian carp species
- Spring-Fall (ongoing): Acoustic network maintenance, downloads, and mobile tracking (monthly)
- December: Winterization of acoustic network; compilation of yearly summary.

Outcomes:

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

- Monitor movements of tagged fish (large and small) in the vicinity of the Barrier using receivers placed immediately upstream, within, and immediately downstream of the Barrier, in addition to conducting mobile tracking.
- Determine if detection coverage is adequate to effectively assess efficacy of Barrier.
- Assess the possibility of barge traffic shadowing acoustic transmissions.

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

- Monitor movements of tagged fish at Marseilles, Dresden Island, Brandon Road, and Lockport Locks and Dams using stationary receivers placed above and below each dam.
- Determine if there is adequate detection coverage to effectively assess fish passage through lock structures

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

- Determine if the leading edge of Asian carp invasion, currently, RM 281.5, is the upstream location of Asian carp population.

- Describe habitat use and movement in the areas of the Upper IWW and tributaries where Asian carp have been captured, and compare to areas in the CAWS where Asian carp are not currently present.

Potential Hurdles:

- Availability of fish for implantation (especially for small fish study)
- Weather impacts on fish mortality rate
- Movement of tagged fish out of detection range (open system).

2.3.5 Eagle Marsh Temporary Barrier Fence Maintenance

Lead Agency: Indiana DNR

Other Agencies Involved: LRWP

FY 2013 Funding: $20,000 GLRI (funded through GLRI to implement the state ANS management plan)

Project Explanation: Routine maintenance along the Eagle Marsh Asian carp barrier fence to assure that water flow during flooding is not impeded until a permanent barrier is put into place. Assure that no holes are in the fence or gaps greater than 2 inches are present that would allow adult Asian carp to move through the fence. Engage in activities to prepare for construction of a permanent solution at Eagle Marsh, likely to occur in summer and fall of 2014.

FY 2012 Actions Undertaken: LRWP has been under contract by Indiana DNR to perform routine maintenance along the fence erected in fall 2010. Maintenance includes regular mowing and weed control along the fence, assurance that all gates close properly and remain closed, and inspection of the fence following flooding to assure no damage has occurred at the fence that would allow adult Asian carp to pass.

FY 2013 Actions Proposed: Same as above. The contract with LRWP was renewed in fall 2012 for another 2-year period, so maintenance will continue through September 30, 2014. LRWP will be extensively involved with events leading up to and during construction of Phase 1 of the permanent barrier at Eagle Marsh

Expected end date: Current maintenance contract with LRWP expires September 30, 2014.

If not completed after 2013, explain follow-up activities: Continued maintenance to assure that vegetation does not block water flow during flooding and that no gaps greater than 2 inches are present along any portion of the fence. Completion of Phase 1 of the permanent barrier is anticipated during fall 2014.

Expected Milestones:

Throughout 2013: Multi-weekly inspections along the fence to confirm that no gaps exceed 2 inches (which would allow adult Asian carp to pass).

Throughout 2013: Regular mowing, burning, and debris removal to prevent blockage of the fence when flooding occurs.

Outcomes:

- The fence remains fully intact, and to date, no damage has occurred to the structure. Only very minor flood events have occurred since the fence was erected.
- The fence will continue to block fish as designed, and flow will not be impeded during flood events.
- Through 2013, Phase 1 of the permanent barrier is designed and permitted, and construction planning begins. Construction is expected to begin in summer 2014, and be completed by the end of the year.

Potential Hurdles:

- Flood debris or vandalism could cause damage to the fence, which could allow adult Asian carp to move through the fence should they find their way up Little River during a flood event.
- The Graham-McCulloch left bank berm continues to be the weak link in the barrier system, and could fail prior to construction of Phase 1 of the permanent barrier.
- If a breach of the berm occurs east of the fence, Asian carp would move unimpeded to the Maumee basin.

2.3.6 Eagle Marsh Invasive Species Barrier to Close Pathway

Lead Agency: USDA Natural Resources Conservation Service (NRCS) and USACE

Other Agencies Involved: USACE, Indiana DNR, LRWP, Allen County Drainage Board, Maumee River Basin Commission, and The Nature Conservancy of Indiana

FY 2013 Funding: $1,538,000 GLRI ($338,000 – USACE to complete Hydrology and Hydraulic [H&H] and Gross Appraisal) ($1,200,000 - NRCS for Initial Design and Construction)

Project Description: The GLMRIS interim controls report by USACE rated Eagle Marsh as a high risk for invasive species transfer and a medium risk for Asian carp transfer. The proposed project will reconstruct an existing ditch berm, raising the height to 2 feet above the 100 year flood level and increasing the structural integrity of the berm to reduce potential for failure. The existing ditch wall is not structurally sound and is predicted to fail at some future time without correction. This partnership of USACE and NRCS will design and construct this earthen berm to provide a complete separation of the basins. This separation will proceed in two phases.

Phase 1 is a berm with a spillway elevation low enough that there would be no off-site impacts, but high enough to provide a watershed separation for the 25 year flood. Phase 1 will provide a structurally sound barrier that eliminates the serious concern that the existing ditch wall could

fail, opening a pathway for Asian carp to advance to the Maumee basin. The temporary Asian carp fence installed by Indiana DNR will remain in place until Phase 2 is completed.

Phase 2 will elevate the spillway to the 100 year flood level after USACE completes its refined study and the off-site properties are properly mitigated.

FY 2012 Actions: USACE completed the GLMRIS interim controls report for Eagle Marsh. A public hearing was held in Fort Wayne to present the alternatives, and the public comments supported rebuilding the Graham McCulloch Ditch to create a permanent barrier to stop invasive species transfer at Eagle Marsh. The property is jointly owned by LRWP and the Indiana DNR. Eagle Marsh was restored by NRCS utilizing Wetland Reserve funds. The Indiana Nature Conservancy was a supporting partner in the land acquisition. The ditch is a legal drain managed by the Allen County Drainage Board. The above-cited organizations met as the primary stakeholders in the property and reached a consensus to rebuild the ditch berm in two phases as the most cost-effective construction with the lowest long-term operation and maintenance costs that would provide a complete separation of the two basins. Indiana DNR Division of Water has also concluded that the current ditch wall is constructed of sediment removed from the ditch and is destined to fail at some time in the future if not rebuilt with soil that would provide structural integrity to withstand extreme flood events. The no action alternative is unacceptable to the stakeholder groups due to the threat of a breach in the ditch wall that could allow Asian carp and other invasive species to pass between the basins.

FY 2013 Actions Proposed: Final design will be completed by a partnership of USACE and USDA-NRCS Engineers. USACE will complete H&H modeling in support of NRCS's final design of the berm and documentation for permitting and real estate efforts. This effort will include additional surveys of channels and topography at select areas along Junk Ditch and Graham-McCulloch Ditch to refine the modeling and further improve understanding of expected impacts. A study of the Graham-McCulloch watershed will be conducted to develop more accurate flow values for modeling purposes.

First-floor elevations will be obtained to inform a Gross (Mass) Appraisal Report for the induced flooding impacts. The report will rely on forthcoming survey data to include first-floor elevations, current assessed land and improvement data, comparable land sales, and actual market conditions. Preparation of the report will include site visits and cursory inspections by the Appraiser as appropriate; however, landowner contact will not occur. A tract-by-tract analysis may or may not be warranted. The report will adhere to the Uniform Standards of Professional Appraisal Practice (USPAP) and ER 405-1-12. USDA-NRCS has a preliminary estimate of design and construction costs for Phase 1 at $3,200,000. USDA-NRCS is considering construction funding from the Wetlands Reserve Program. The Maumee Basin Commission could be a partner in implementation of the mitigation plan for acquisition or flood easements of impacted properties within the St. Mary's/Maumee River Basin.

Expected Milestones:

Phase 1:

- Graham-McCulloch Watershed modeling complete April 2013
- Channel Surveys complete May 2013
- Hydraulic Engineering Centers (HEC)-River Analysis System (RAS) Modeling complete July 2013
- USDA-NRCS Design complete October 2013

Phase 2:

- First-floor elevation survey complete July 2013
- Inundation mapping update complete August 2013
- Gross (Mass) Appraisal Report complete September 2013.

Outcomes:

- Closure of the Eagle Marsh pathway for invasive species. Eagle Marsh was rated the second highest risk site for Asian carp and other invasive species by GLMRIS. The Chicago Area Waterway System is considered the top area at risk.

Potential Hurdles:

- Funding for completion of the mitigation plan prior to Phase 2 construction.

2.3.7 Chicago Sanitary & Ship Canal (CSSC) Electric Fish Barrier Marine Safety Risk Assessment and Risk Mitigation Measures

Lead Agency: USCG

Other Agencies Involved: USACE, U.S. Environmental Protection Agency (USEPA)

FY 2013 Funding: USCG base funding, no additional funding necessary.

Project Explanation: The Electric Barrier System on the CSSC presents multiple potential hazards to marine safety. Various regulatory actions prescribe operating rules and guidance to promote: (1) navigation safety for commercial and recreational mariners transiting the CSSC in the vicinity of the barrier, and (2) safe work practices and operating standards for commercial facility operations that operate or moor vessels in the vicinity of the barrier. The USCG operational commander desires a comprehensive review of marine safety risks associated with the fish barrier, adequacy of present risk mitigation strategies, and recommendations for alternatives to these strategies.

FY 2013 Actions Proposed: This project conducted measurements to examine shore-worker risk exposure in October 2012. Vessel transit data collection continued through November 2012. The preliminary risk assessment report was delivered to the USCG Research and Development Center (RDC) in December 2012. Following review of supplemental inputs, RDC will schedule a

waterway-user validation meeting during the second quarter of FY2013, and deliver the final report in the third quarter of FY2013.

Expected end date: 3rd Quarter of FY2013.

If not completed after 2013, explain follow-up activities: Address issues or concerns that are causing delays, and finish report after appropriate revision.

Expected Milestones:

- December 2012: Deliver preliminary risk assessment report.
- May 2013: Deliver final report.

Outcomes/Output:

- A summary of the marine safety risks associated with the fish barrier, adequacy of present risk mitigation strategies, and recommendations for alternatives to these strategies.

Potential Hurdles:

- RDC request for "conference hosting" permission (i.e., to rent a conference space large enough to comfortably hold approximately 40 stakeholders) pends—this has delayed schedule for obtaining stakeholder validation of baseline assumptions.
- Stakeholders' opinions differ as to need for or effectiveness of current risk mitigation measures.
- Risk mitigation measures without effective compliance may not yield any overall improvement in marine safety.

2.3.8 Management of Waterway Traffic in Support of Asian Carp Control Activities

Lead Agency: USCG

Other Agencies Involved: Illinois DNR, USEPA

FY 2013 Funding: USACG Base funding, no additional funds necessary.

Project Explanation: USCG manages federally navigable waterways through establishment and enforcement of Regulated Navigation Areas (RNA), safety zones, and security zones. Many waterways in the Chicago Area are designated as federally navigable waterways, including the Illinois River, the Des Plaines River, the CSSC, branches of the Chicago River, and the Calumet-Saganashkee Channel.

When operations associated with the electric fish barrier, rapid response actions, research projects, or any other Asian carp activity impact the flow of traffic on a navigable waterway, USCG creates a 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 closure of a navigable waterway is required, USCG may deploy assets on scene to enforce the closure. For extended

closures, USCG may also establish a temporary vessel traffic service that tracks delayed vessels and facilitates orderly resumption of traffic after the closure is lifted.

To create a RNA or safety zone, USCG must complete a rulemaking project, including public notice in the *Federal Register*. To streamline this process, USCG created a safety zone in 2010 that covers 77 miles of the CAWS and allows USCG to restrict or stop traffic for Asian carp activities. However, USCG still strives to provide at least a 30-day notice to waterway users prior to a waterway closure.

FY 2012 Actions Undertaken: USCG issued and enforced a series of full waterway closures to support Electric Fish Barrier maintenance and ANS control activities throughout FY 12. On December 12, 2011, USCG issued a Final Rule to make permanent the safety zone and RNA created under the Temporary Interim Rule issued in December 2010.

FY 2013 Actions Proposed: USCG will issue and enforce a series of full and partial waterway closures to support Electric Fish Barrier maintenance, barrier construction, and AIS control activities throughout FY 2013.

Expected Milestones: None. Activities are carried out as needed.

Outcomes:

- Appropriate control of vessel traffic to protect vessels and persons from the hazards associated with any federal and state efforts to control AIS.

Potential Hurdles:

Waterway closure requests received by USCG less than 35 days prior to the event do not provide enough time for USCG to carry out the rulemaking process or provide public notice. Waterway restrictions and closures should be planned ahead and coordinated among agencies whenever possible to facilitate the regulatory process and minimize impact on waterway users.

2.3.9 Upper Wabash Asian Carp Telemetry and Spawning Study

Lead Agency: Indiana DNR

Agency Collaboration: Purdue University

FY 2013 Funding: Funded through Indiana DNR state ANS management plan.

Project Explanation: Determine Asian carp use of the upper Wabash River and determine their desire to utilize Little River, the route Asian carp would use to reach Eagle Marsh. Evaluate Asian carp spawning in the upper Wabash River to determine how close to Eagle Marsh the fish are spawning.

FY 2012 Actions Undertaken: Approximately 70 silver carp were inserted with transmitters in fall 2011 and spring 2012. Intentions were to insert 100 tags during the period; however, extremely low river levels in spring 2012 made conditions difficult to find congregations of Asian carp, and

low water persisted through the entire summer. Asian carp spawning was evaluated weekly at Lafayette once water temperature exceeded approximately 55 degrees. Once egg release was confirmed, upper reaches were frequently monitored for spawning as well. Spawning evaluations continued into the late summer until water temperatures dropped below 55 degrees. Data collected so far indicate that moderate-density Asian carp populations begin at Logansport and increase farther downstream. No Asian carp containing transmitters have entered Little River, so these Asian carp have posed no threat to Eagle Marsh. Eggs have been found regularly from Logansport and downstream when water temperature exceeded approximately 65 degrees, and only a few eggs have been found as far upstream as the town of Wabash. Egg laying seems closely correlated to Asian carp abundance in the extreme upper Wabash River

FY 2013 Actions Proposed: The approximately 30 transmitters remaining from the 2012 work and an additional 100 transmitters were to be implanted into Asian carp in fall 2012 and spring 2013. Asian carp spawning will be evaluated weekly at Lafayette once water temperature exceeds approximately 55 degrees. Once egg release is confirmed, upper reaches will be monitored for spawning as well. Spawning evaluations will continue into the late summer until water temperatures drop below 55 degrees.

Expected end date: The current contract with Purdue expires October 31, 2013

Expected Milestones: None.

Outcomes/Output:

- Following 3 years of evaluating movement and spawning of Asian carp in the Wabash River, a more thorough knowledge of how Asian carp are using the upper Wabash River and whether they show any interest in utilizing Little River will be obtained.
- This evaluation will result in a clear picture of where Asian carp spawning occurs.

Potential Hurdles:

- Water levels may make collection of fish for transmitter insertion difficult.
- Transmitters inserted in 2010 may lose battery life in 2013.

2.3.10 Development of Mobile Electric Barrier

Lead Agency: Illinois DNR

Agency Collaboration: Ohio DNR, Michigan DNR

FY 2013 Funding: TBD

Project Explanation: Electricity has been used for fisheries management for a considerable period of time. Physical effects and science of using electricity on fish behavior have been studied and understood to a greater extent than have resulting effects and science of many emerging technologies. Holliman et al. (2011) has well documented the effects of an electric field/barrier on Asian carp specifically and use of such tools in the CAWS. This project will implement one of our

most effective tools to stop carp within the CAWS, the electric dispersal barrier, in a way that is mobile and flexible. Building upon prior work and engineering, Illinois DNR will solicit designs and construction of a mobile electric barrier that can be deployed in the CAWS to move and/or clear fish when needed over the existing barrier arrays, but may also be moved throughout the CAWS, upper Illinois River, or other regions where fish containment/movement is desired—even acting as a temporary barrier for experimental or emergency situations. This tool will be available for use throughout the Great Lakes Basin and will serve as a model for other areas needing to slow or stop Asian carp migrations.

Even with our existing barriers running at 100 percent efficiency, there is desire to slow the spread of carp across the range (Ohio, Upper Mississippi, and in Upper Illinois rivers) and other places where Asian carp are suspected; therefore, designs for this tool will consider the following:

- **Flexibility** – knowing that electrifying or sweeping lock chambers would significantly hamper movement of fish, especially at places like Lockport or Brandon road where dam passage is minimal to nil.
- **Focused applications** – attempting to minimize spurious electronic or environmental emissions.
- **Ease and safety** – allow for mobilizing quickly and with minimal amounts of training with high degree of safety.

Expected Milestones:

- Proposals for multiple designs within 6 to 9 months of receipt of funding
- Selection of proper technology and awarding of contract to develop and construct electric array.

Outcomes:

- Once on the water, valuable for "clearing" exercises for fish over and around existing electric barrier arrays, and possibly increasing fishing/removal in areas where either few fish are present or canal habitat renders traditional gears hard to deploy
- Tool that can be deployed rapidly for responses/containment to determine risk of fish in an area
- A deployable gear that can act as a temporary barrier anyplace in the canal or other water body without fouling or clogging resulting from debris in the water
- Goal to have tool on the water within 12 months of receiving funds, knowing that logistics, procurement, and contracting concerns beyond our control may influence timeline
- A model for other watersheds to limit spread of Asian carp and other invasives.

Potential Hurdles:

- Procuring available technology and components may increase time span necessary to complete implementation.

- Review and assessment of proposed technologies will take time.
- Contractual procurement could slow progress.

2.3.11 Ohio Erie Canal Closure Assessment

Lead Agency: Ohio DNR Division of Wildlife (DOW) is working with USACE.

Other Agencies Involved: Ohio DNR Division of Soil and Water Resources (DSWR), Ohio DNR Division of Engineering, City of Akron, and USACE

FY 2013 Funding: $177,000 GLRI funds.

Project Description: As part of USACE's GLMRIS, the Ohio Erie Canal was assessed and determined to pose risk as a pathway for transfer of AIS from the Mississippi basin to the Great Lakes basin. The connection was rated a medium for silver, bighead, and black carp, as well as northern snakehead. To ensure no risk, Ohio DNR is proposing to close this pathway.

FY 2012 Actions Undertaken: No template was in place. Prior to release of the GLMRIS Aquatic Pathway Assessment Report, Ohio DNR DOW met with the City of Akron to discuss the upcoming report and the two primary areas of concern:

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

FY 2013 Actions Proposed: Using the Aquatic Pathway Assessment Report for the Ohio Erie Canal, Ohio DNR is working with USACE to determine the best path forward in development of alternatives for basin separation at this connection. The work will include design of separation options at the connection, including:

- Closure options at the feeder gate that include (1) closing the connection and discontinuing transfer of water, and (2) modifying the feeder gate to eliminate transfer of AIS. Closure at this area of the connection is complicated by multiple water lease issues currently under evaluation. Closure via these options is anticipated to result from collaboration between Ohio DNR and USACE, with USACE providing engineering design options at this site.
- Closure of the connection at some other point other than the feeder gate so existing water leases are maintained.
- Development of options at the tow path to eliminate movement of water over this connection. This option will likely include design of an elevated tow path that prevents water movement.

Expected end date: June, 2014.

If not completed after 2013, explain follow-up activities: Continue to develop basin separation options until a viable option is developed. The chosen option will then be implemented.

Expected Milestones:

- April 2013: Preliminary assessment of separation options (Complete)
- February 2014: Presentation of option to the City of Akron
- March 2014: Choice of the option that separates the basin and is acceptable to involved stakeholders
- June 2014: Finalization of design for basin separation.

Outcomes:

- Completion of assessment of methods for separation of at-risk pathway.

Potential Hurdles:

- Ability to develop a separation option that prevents movement of AIS across the basin divide while allowing the City of Akron to fulfill obligations related to interbasin transfer of water, as dictated by the Great Lakes Compact.

2.3.12 Little Killbuck Creek Closure Assessment

Lead Agency: Ohio DNR DOW

Other Agencies Involved: USACE, Medina County SWCD, and NRCS.

FY 2013 Funding: $23,000 GLRI funds.

Project Description: As part of USACE's GLMRIS, the Little Killbuck Creek connection was assessed, with resulting determination that a risk is posed from transfer of AIS from the Mississippi basin to the Great Lakes basin through this pathway. The connection was rated a medium for silver, bighead, and black carp, as well as northern snakehead. To ensure no risk, Ohio DNR is proposing to close this pathway.

FY 2012 Actions Undertaken: No template was in place. The Ohio DNR DOW met with the landowner of the Little Killbuck connection to discuss the Aquatic Pathway Assessment Report. The Ohio DNR DOW, USDA-NRCS, and Medina County SWCD (group) then met to discuss the project and options for preventing movement of AIS. The group met with the landowner to discuss the project and gage his comfort level with three options:

- *Other land uses:* Conversion of the agricultural lands to wetlands using federal programs that assist landowners developing wetlands (e.g., Wetland Reserve Program)
- *Non-structural alternatives:* Chemical control measures, biological monitoring, and physical removal of fish

- *Structural alternatives:* Berm supplementation, new berm construction, and drainage reconfiguration.

The group indicated that their preferences were options 1 and 3 (or a combination of these options) because these options would provide a permanent solution and not require continued monitoring and control efforts as option 2 would necessitate. The landowner was comfortable with further discussion of options 1 and 3; consequently, Ohio DNR DOW will work with the USACE, Medina SWCD, and USDA-NRCS to come up with several alternatives for presentation to the landowner.

FY 2013 Actions Proposed: Using the Aquatic Pathway Assessment Report for Little Killbuck Creek, the group will develop alternatives for basin separation using options 1 and 3. The work will include design of separation options to be presented to the landowner. USACE and USDA-NRCS will provide services regarding engineering design of these options that will ensure basin separation while allowing the landowner to continue to farm this property.

Expected end date: September, 2014.

If not completed after 2013, explain follow-up activities: Continue to develop basin separation options until a viable option results. The chosen option will then be implemented.

Expected Milestones:

- April 2014: Preliminary assessment of separation options
- June 2014: Choice of the option that separates the basin and is acceptable to involved stakeholders
- September 2014: Finalization of design for basin separation.

Outcomes:

- Completion of assessment of methods for separation of at-risk pathway.

Potential Hurdles:

- Ability to develop a separation option that prevents movement of AIS across the basin while allowing the landowner to continue farming options.

2.4. CAWS Barrier System and Great Lakes Mississippi River Study Activities

2.4.1 Efficacy Study

Lead Agency: USACE

FY 2013 Funding: No new funding needed in 2013.

Project Explanation: The study investigates hazards that could reduce the efficacy of the Electric Barrier System in Romeoville, Illinois. The project includes an analysis of potential bypasses, optimal operating parameters, deterrent systems, modified structures and operations, fish monitoring and reduction, and potential for migration via other pathways.

FY 2013 Actions Proposed: The Comprehensive Efficacy Study report will be completed and will undergo an independent external peer review. The study report will be released to the public in 2013.

Expected Milestones:

- 3rd Quarter 2013: Initiate independent external peer review. .
- 4th Quarter 2013: Complete Comprehensive Efficacy Report.

Potential Hurdles:

- Future extension of emergency authority for recommended actions/measures
- Determination of relative risks and tradeoffs of pursuing identified actions.

2.4.2 GLMRIS Focus Area I: Chicago Area Waterway System

Lead Agency: USACE

Agency Collaboration: USFWS, USGS, USEPA, National Oceanic and Atmospheric Administration (NOAA), USCG, U.S. Department of Transportation (USDOT), USDA, Illinois DNR, Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)

FY 2013 Funding: $4,740,500 Base funding, $400,000 GLRI funds.

Project Explanation: GLMRIS is a congressionally authorized feasibility study directing USACE to consult with appropriate federal, state, local, and nongovernmental organizations in order to investigate the range of options and technologies available to prevent spread of AIS between the Great Lakes and the Mississippi River Basins through the CAWS and other aquatic pathways. GLMRIS includes identification of aquatic pathways that may exist between the basins, an inventory of current and future potential aquatic nuisance species, evaluation of possible AIS controls to prevent AIS transfer (including but not limited to hydrologic separation), and assessment of the impacts that each ANS control may exert on existing waterway uses. The study

is proceeding within two focus areas: Focus Area I is the CAWS, and Focus Area II consists of all aquatic pathways outside the CAWS, commonly referred to as the Other Aquatic Pathways.

GLRI dollars will help complete the GLMRIS Report via five initiatives:

- Technology Evaluation ($150K) – Funding is essential for evaluating risk reduction associated with implementation of alternatives. Additional funding is needed to fully support the GLMRIS Team in its development of conceptual design of alternatives for inclusion in the GLMRIS report.
- Environmental Compliance Documentation ($100K) – Regulatory and environmental compliance documentation will be included in the GLMRIS report to provide a basis for future National Environmental Protection Act (NEPA) documentation. This information will assist with agency planning and decision making regarding any alternative that may be recommended for implementation.
- Risk Management Support ($50K) – This will assist the GLMRIS Team in evaluating and assigning criteria to alternatives that support future decision making.
- Final Documentation of Conceptual Engineering Analyses and Costs ($50K) – This will support compilation and integration of numerous datasets, information, and reports. Due to the volumes of data accumulated in GLMRIS, it will be essential to review the report for completeness, consistency, and accuracy.
- Continue Stakeholder Engagement and GLMRIS Website Support ($50K) – This will be essential for keeping the lines of communication open with our stakeholders; funding will support final packaging and future roll-out of GLMRIS report.

FY 2013 Actions Proposed:

In July 2012, Congress passed the Moving Ahead for Progress in the 21st Century Act (MAP-21). Section 1538 of MAP-21 directs the Secretary to expedite completion of the report for GLMRIS and, if the Secretary determines a project is justified in the completed report, to proceed directly to project preconstruction engineering and design (PED). MAP-21 also directs the Secretary to complete the GLMRIS report within 18 months of enactment, and to submit an interim report to Congress within 90 days.

This new GLMRIS Report will provide Congress and other stakeholders an analysis of potential alternatives and additional pertinent information. USACE anticipates that the GLMRIS Report will identify additional requirements that must be completed after January 2014, but prior to initiating PED, including detailed design analyses, completion of the environmental compliance analysis, required internal reviews, and public and state/agency reviews.

Expected Milestones:

- January and April 2013: Executive Steering Committee Meetings/Updates

Outcomes/Output:

- December 2013: GLMRIS Report

Potential Hurdles:

Congressional action has accelerated the schedule, impacting scope of activities and necessary resources.

2.4.3 Feasibility Assessment of Inter-Basin Transfer of Aquatic Invasive Species (AIS) between the Des Plaines River and CAWS

Lead Agency: USGS

Agency Collaboration: USACE

FY 2013 Funding: No additional FY 2013 funds necessary.

Project Explanation: Transfer of AIS or eDNA via surface and subsurface fractures or solution features may be occurring. These additional hydraulic connections between Des Plaines River and CAWS could allow transfer of AIS and/or eDNA and should be addressed.

FY 2012 Actions: Efforts focused on project completion. Complete analysis of the 2011 tracer study is expected, along with the draft report that will (1) summarize all research conducted in conjunction with the project, and (2) offer preliminary conclusions regarding potential for inter-basin transfer between the two waterways.

FY 2013 Actions Undertaken and Proposed: Report through colleague review. Text will be submitted for Director's approval and publication. Write and publish Fact Sheet providing overview of the project and results.

Expected Milestones:

- May 2013: Publication of final project report
- July 2013: Publication of Fact Sheet.

Outcomes/Output:

- January 2013: Report and conclusions regarding potential for inter-basin transfer of invasive species between the Des Plaines River and CAWS.

Potential Hurdles: None.

2.4.5 Forecasting Spread and Bio-economic Impacts of AIS from Multiple Pathways to Improve Management and Policy in the Great Lakes

Lead Agency: NOAA Center for Sponsored Coastal Ocean Research

Agency Collaboration: USFS; USFWS, USGS, USEPA, USACE, USDOT, USCG, United States Park Service (USPS), Illinois DNR, Illinois/Indiana Sea Grant, Indiana DNR, Michigan DNR, Michigan Department of Environmental Quality (DEQ), Ohio DNR, New York DNR, Wisconsin DNR

FY 2013 Funding: $1,172,860 Total funding ($292,800 GLRI ACRCC Framework funds/ $684,680 Base funds/ $195,200 (source to be determined [funding shortfall for non-Asian carp activities of the project]).

Project Explanation: Without accurate forecasts of arrival and bio-economic impact of non-indigenous species, natural resource management cannot cost effectively respond to current invasions or prevent future invasions. This project draws on scientific, economic, risk analysis, and management expertise to (1) forecast probability of establishment, spread, and ecological and economic impacts from invasion to the Great Lakes; (2) determine habitat availability, and (3) identify actions to improve cost-effective management of invasive species in the Great Lakes. To forecast probability of establishment, the project draws on the literature and ongoing studies to identify which non-indigenous species are likely to be introduced into the Great Lakes via three major pathways (1) shipping, (2) organisms in trade (pet, horticulture, aquaculture, biological supplies, live food, and live bait industries), and (c) canals, especially the CAWS. To forecast the potential habitat of species within the Great Lakes, the project is using multiple ecological niche models, based on new Geographic Information System (GIS) layers (also produced by the project) of habitat and species distributions. To forecast potential spread of invaders within the Great Lakes, the project compares natural background dispersal (predicted by water current models) to that predicted by oceanic ships, lake ships, and recreational boaters. To forecast ecological impacts, the project is using food web modeling to develop quantitative scenarios of ecological impacts, with uncertainties specified via structured expert judgment. To forecast regional economic impact, the project is linking the food web models to a Great Lakes' regional economic model (a computable general equilibrium model) to account for feedbacks between ecological and economic systems, and quantitatively value ecosystem goods and services affected by invasive species. The ecological and economic impact models will be used to evaluate alternative management strategies focused on preventing species introduction, early detection and rapid response (EDRR) efforts, slow-the-spread strategies, and integrated control options through cost-benefit analyses.

FY 2012 Actions Undertaken: During FY 2012, work focused on completion of model development activities to begin the assessment of dispersal, potential habitat, and ecological and economic impacts of the selected invasive species. In addition, continuing its direct collaboration with relevant federal and state management agencies, the project began a consultation process with its management partners to develop and evaluate alternative management responses to circumstances within each of the key Great Lakes pathways. The process is expected to continue through the remaining life of the project.

FY 2013 Actions Proposed: In FY13, the project will use the GLRI Asian Carp funds requested to finalize its activities focused specifically on Asian carp. These activities comprise 60 percent of the overall project effort in FY13. Proposed activities are as follows:

- Produce environmental niche models for Asian carp. We will publicly provide the first-ever set of standard habitat data layers (N = 15) for all Great Lakes, and will combine these

layers with biologically relevant data to determine Great Lakes suitable habitat for Asian carp. Niche models and models of dispersal by currents will be used to identify areas of greatest concern as potential habitat from which ships' ballast water could disperse Asian carp eggs or larvae to other parts of the Great Lakes. Ballast water discharge sites will also be added to those areas at high risk for Asian carp introduction, directing subsequent Great Lakes surveillance areas to prevent spread.

- Assess ecological impacts of Asian carp, including uncertainty around parameter values provided by a structured expert judgment (SEJ) effort, for Lakes Michigan, Erie, and Huron using whole lake good web models. Other components of the SEJ effort will also provide additional assessment (independent of the food web model) of impacts of an Asian carp invasion to Lake Erie, as well as likely efficacy of various Asian carp dispersal deterrents.
- Continue to develop two economic models: one specific to Lake Erie and another more general model incorporating the entire Great Lakes Basin—both assessing impacts of Asian carp establishment, dispersal, and management on the Great Lakes economy. The Lake Erie economic model is linked to the Lake Erie food web model to assess costs of Asian carp establishment borne by commercial and recreational fisheries, and subsequent effects on the Lake Erie regional economy.
- In collaboration with the project's Management Transition Board, use the results of these economic models to forecast the benefits of alternative approaches to management of Asian carp in the Great Lakes.
- Assist state and federal agencies in refinement of a basin-wide surveillance program for Asian carp, drawing on data from eDNA, bait shop surveillance, Asian carp-specific risk assessments, and cost estimates for surveillance programs provided by state and federal partners on the Management Transition Board.

Expected end date: August 31, 2014.

Expected Milestones:

- Throughout 2013: Delivery of forecasts of potential for introduction and establishment of Asian carp by lake ship traffic and other pathways
- Throughout 2013: Published GIS data layers regarding Asian carp in Great Lakes
- Throughout 2013: Published data layers regarding current distribution of Asian carp in their native and introduced ranges
- Throughout 2013: Published maps of habitat suitable for Asian carp in Great Lakes
- Throughout 2013: Completed forecast of natural background dispersal of Asian carp in Great Lakes
- Throughout 2013: Completed forecast of dispersal of Asian carp in Great Lakes via key pathways
- Throughout 2013: Completed scenarios of effectiveness and costs of alternate management responses to Asian carp in Great Lakes

- Throughout 2013: Provision of results to external advisory panels that will allow development of management recommendations regarding Asian carp in Great Lakes
- Throughout 2013: Communication of results to decision makers via advisory panels.

Outcomes:

- Improved ability to prioritize potential activities for prevention, early detection, and other management efforts in response to Asian carp
- Improved understanding of invasion risk among managers and policy-makers responsible for shipping, organisms in trade, and canal pathways
- Improved understanding among managers of locations and habitats to target for efforts at early detection of and monitoring for Asian carp
- Increased basic information regarding benefits and costs of alternative management and policy responses to Asian carp.

Potential Hurdles:

- Costs and limited effectiveness of management alternatives could lead to uncertainties about results of implementing recommendations.
- A new invasion or invasions could supersede ongoing analyses and rapidly change research and management priorities.

2.4.11 Field Testing of Carbon Dioxide Barrier to Deter Asian Carp

Lead Agency: Illinois DNR/USGS

Other Collaborators Involved: University of Illinois, Upper Midwest Environmental Sciences Center (UMESC), USACE, USEPA, and Illinois EPA

FY 2013 Funding: $450,000 GLRI funds ($350,000 Illinois DNR and $100,000 USGS).

Project Explanation: Previous work has demonstrated that carbon dioxide gas, when applied to water, can cause significant behavioral, physical, and physiological disturbances of Asian carp, and induce their efforts at active avoidance. These results have significant benefits and application to act as a novel fish barrier, supplementing existing electric barriers with a redundant barrier technology. To date, evidence used to derive these conclusions has come largely from controlled, laboratory experiments performed under stable, "ideal" circumstances. Therefore, despite the promise of carbon dioxide to act as a novel barrier for controlling movement of Asian carp, a number of questions and uncertainties remain regarding its use in real-world scenarios, especially related to efficacy, feasibility, costs, and potential impacts on non-target organisms.

FY 2013 Actions Proposed: The overall goal of this project is to quantify effectiveness and feasibility of using carbon dioxide gas as a novel Asian carp deterrent at ecologically relevant scales in real-world scenarios. For this, the ecologically relevant scale to be used would be an actual, full-scale deployment on a water body currently used for commercial shipping, likely using a lock chamber. A full-scale carbon dioxide barrier at a location such as this would be developed,

implemented, and tested. Quantification of barrier effectiveness would be carried out through use of a telemetry array or remote monitoring (sonar, side-scan technology, etc.) of fishes currently residing downstream of the lock chamber. In addition, collaborations with agencies such as USACE, Illinois EPA, USGS, and others would occur to quantify impacts of target carbon dioxide concentrations on non-target organisms, as well as existing infrastructure.

USGS will conduct a combination of controlled mesocosm experiments in the UMESC research pond complex to confirm the utility of a carbon dioxide gas barrier to exclude Asian carp from an area. Work in FY2013 will also focus on identifying potential changes in water chemistry that might affect barrier application in navigational structures.

Collaboration with University of Illinois at Urbana-Champaign (UIUC) and Illinois DNR also will occur to complete field evaluations of the utility of a carbon dioxide gas barrier to exclude Asian carp from an area.

Assistance also will ensue in determining regulatory issues associated with emplacement of a carbon dioxide gas barrier to exclude Asian carp from an area.

Expected end date: September 2014.

If not completed after 2013, explain follow-up activities: If successful trials are completed in FY2013, additional work may be required to address any regulatory issues that may limit deployment of this barrier system.

Expected Milestones:

- Improved understanding of the efficacy of carbon dioxide to act as a novel fish deterrent to prevent passage
- Improved understanding of potential effectiveness of carbon dioxide to help facilitate directed movement of Asian carp to help with harvest efforts
- Knowledge of the cost, feasibility, and logistics challenges associated with use of carbon dioxide as a fish deterrent in a real-world scenario
- Assessment of the non-target impacts of carbon dioxide on biota, abiotic parameters, and existing infrastructure (i.e., existing cement locks)
- Journal publications and conference presentations on these findings to disseminate results and share outcomes with broader scientific community.

Expected Outcomes

- Improved understanding of the efficacy of carbon dioxide to act as a novel fish deterrent to prevent passage (significant advantage over using carbon dioxide as a piscicide)
- Improved understanding of the potential effectiveness of carbon dioxide to help facilitate directed movement of Asian carp to help with harvest efforts
- Knowledge of the cost, feasibility, and logistic challenges associated with use of carbon dioxide as a fish deterrent in a real-world scenario
- Assessment of the non-target impacts of carbon dioxide on biota, abiotic parameters, and existing infrastructure (i.e., existing cement locks)

- Journal publications and conference presentations on these findings to disseminate results and share outcomes with broader scientific community.

Potential Hurdles:

- Timely permitting and permissions to allow use of carbon dioxide as a deterrent at an ecologically important location (trial)
- Potential or unknown effect of carbon dioxide on lock structures that may slow permission to work at these locations
- Extreme drought or flooding that may limit ability to complete field evaluations of a carbon dioxide gas barrier to exclude Asian carp from an area.

2.5. Research and Technology Development

2.5.1 Investigate Tow Boats and Barges as Potential Vectors

Lead Agency: USCG (Research and Development Center [RDC])

Agency Collaboration: USEPA, USACE, Members of the planning workgroup including personnel from USGS, Sea Grant (University of Wisconsin), and USCG District 9. In addition to developing the experimental plan, personnel will also review draft reports.

FY 2013 Funding: No additional 2013 funding necessary.

Project Explanation: The purpose of this study is to investigate potential for entrainment and survival of Asian carp early life stages in barge ballast tanks that might allow these fish to bypass the USACE electrical dispersal barriers in the CSSC.

FY 2012 Actions Undertaken: A draft report of the survival experiments was delivered to EPA by the USCG RDC in late 2011, and a draft final report was produced in March 2012. Upon review, it was determined that additional research was needed to assess the number of barges locally transiting the electric dispersal barrier with water in their voids. A barge tank survey was completed in August 2012, and information from the survey was incorporated into the original water transport report of January 2011.

FY 2013 Actions Proposed: The updated survey report will be incorporated into the final report about survivability delivered to sponsor in March 2012. Completion of the consolidated report is expected in November 2012.

Expected end date: Second quarter, FY 2013.

If not completed after 2013, explain follow-up activities: Additional follow-up research may be desired after completion of the final report**.**

Expected Milestones:

- November 2012: Draft report of experiment results delivered to USEPA.
- March - April 2013: Final report of experiment results.

Outcomes/Output:

- Summary of potential for transport of Asian carp across the electric barrier by towing vessels and barges.

Potential Hurdles: None.

2.5.2 Assessment Study of Potential Impacts of Steel-hulled Barges on Fish Movement across Electric Barrier II

Lead Agency: USACE

FY 2013 Funding: No additional funding needed.

Project Explanation: Studies of the Demonstration Barrier (Barrier I), operating at parameters lower than the current operation of Barrier II, indicated that immobilization of fish (due to the electric barrier) swimming alongside barges took about three times longer than if the fish were swimming through the electric field without any substantial steel hull present. As the steel hull approaches the barrier, the steel warps the electric field toward the hull, thus providing a shielded area where fish would feel reduced or completely eliminated effects from the barrier. Therefore, steel-hulled barges may increase the possibility that fish are not affected by the electric barrier. Results of the studies at the Demonstration Barrier were used to design Barriers IIA and IIB so that steel-hulled effects on the electric field would be eliminated or minimized. However, continued field testing of potential steel-hull effects over Barriers IIA and IIB is needed because fish could be stunned and swept through the barriers with the barge and revived once again upstream of the barriers.

FY 2012 and 2013 Actions: Design and conduct experiments to test effectiveness of Electric Barriers IIA and IIB in the presence of steel-hulled barges and other vessels.

Expected Milestones:

- September 2012: Obtain data.
- September 2013: Publish report.

Potential Hurdles: None.

2.5.4 Assessing Risks of Great Lakes Invasion by Understanding Asian Carp and Bluegreen Algae Dynamics

Lead Agency: USGS

Agency Collaboration: None

FY 2013 Funding: No additional FY 2013 funds necessary.

Project Explanation: Bluegreen algae (primarily Microcystis sp.) blooms resulting from the mussel invasion may provide an excellent food source for bighead carp, enhancing their invasion. Noxious bluegreen algal blooms, under some circumstances, can be enhanced by interaction with silver and bighead carp, and presence of these carp may enhance toxin production by noxious algae. This project focuses on assessing the risk of Asian carp survival in the Great Lakes based on Asian carp feeding habits.

FY 2012 Actions Undertaken: Draft manuscripts were produced for improved and validated bioenergetic models of bighead and silver carp. These are required for both this study and for the alternative foods project (2.5.5). Trials of bighead and silver carp consumption of microcystis algae were completed to determine microcystin toxins uptake by bighead and silver carp and changes in toxin production when carp were introduced to tanks with microcystis.

Also, remote sensing data from which both green and bluegreen algae can be determined were acquired for Lake Erie, St. Clair, and most of Lake Michigan. These were used, along with the improved bioenergetic model, to map where and when in Lake Erie and St. Clair adequate concentrations of chlorophyll (as an estimate of algae) exist for bighead carp weight maintenance, and also when and where multiples of this minimum value occurs. Remote sensing data were also used to map when and where concentrations of bluegreen algae at least double the minimum concentration for bighead carp weight maintenance would be available. Remote sensing data were inadequately sensitive to determine concentrations as low as the minimum value of bluegreen algae for bighead carp weight maintenance and bluegreen algae has a lower energetic content than green algae. Nevertheless, because the noxious algae microcystis dominates the plankton for much of the summer in Lake Erie, modeled area with double the amount of bluegreen algae required for weight maintenance generally exceeded the areas modeled as adequate for weight maintenance using the algorhythm for chlorophyll containing algae. These results indicate that large areas of Lake Erie and St. Clair will be adequate for growth of bighead and silver carp.

Lake Michigan data were also analyzed, but results are hampered by probably artifactually high algal concentrations near the coast. We have undertaken to acquire different, higher resolution data from Lake Michigan which we hope will supersede those artifacts.

FY 2013 Actions Undertaken: A test of the relationship between bighead carp and transfer of nutrients from desirable green algae to undesirable microcystis (using radiolabeled phosphorus) was completed in December 2012. Final chemical analytical results of this undertaking were received on February 6, 2013.

A draft manuscript has been prepared describing results of the remote sensing study.

FY 2013 Actions proposed: Submission of the final analysis of the microcystis data.

Expected Milestones:

- February 2013 – Submit to manuscript on adequacy of Lake Erie and St. Clair for growth of bighead carp citing remotely sensed algae concentrations.
- March 2013 – Receive enhanced Lake Michigan data, and determine if these data will remove coastline artifacts. If so, produce maps similar to those produced for Lake Erie.
- Spring 2013 – Prepare manuscript on results of microcystin analysis and on phosphorus transfer from beneficial to undesirable algae.

Outcomes/Output:

- Final publication of research findings (publication date dependent on journal).

Potential Hurdles: None.

2.5.5 Risk Assessment of Asian Carp Establishment in the Great Lakes Based on Available Food Sources

Lead Agency: USGS

Agency Collaboration: None

FY 2013 Funding: No additional 2013 funds necessary.

Project Explanation: Bighead carp have been observed to diversify their diets beyond preferred pelagic plankton sources, feeding on organic matter ("detritus") under certain conditions and on the basis of availability of food resources. Silver carp are also thought to derive substantial nutrition from bacteria, both consumed and cultured in the gut. However, whether these food sources are adequate for growth and survival of Asian carp is unknown. Scientists are testing an established model that indicates Asian carp cannot survive in Lake Michigan based on available food types. Alteration of his model occurs as documentation of new findings on what the carp will eat (e.g., types of algae) appears.

FY 2012 Actions Undertaken: Draft manuscripts were produced for improved and validated bioenergetic models of bighead and silver carp. These are required for both this study and for the bluegreen algae project. In 2012, laboratory studies of bighead and silver carp consumption of Cladophora (juvenile and subadult fish) were completed. Juvenile fish ate only a little of the Cladophora, and this did not seem to be an adequate food source for small fish, probably because of the toughness of the algae. When larger fish were restricted to Cladophora as a sole diet, some, but not all, of the fish ate the Cladophora and did not lose weight when Cladophora was presented as a sole food source. Cladophora would not likely be a preferred food source for bighead carp of the tested sizes. However, Cladophora would be an alternative food that would provide nutrition for bighead carps at times when planktonic algae is inadequate. Also, the toughness of the Cladophora might be less of a problem for adult bighead or silver carp, and thus it may be more attractive to fish larger than those we tested. Our analysis does indicate that Cladophora should be bioenergetically somewhat superior to planktonic algae for bighead carps.

Also in 2012, Dreissenid mussel feces and pseudofeces, which accumulate in very large quantities wherever dreissenids have invaded the Great Lakes, were collected to determine if bighead carp would consume them and be able to use them as an adequate alternative food source. Caloric analysis of this alternative food found that mussel feces and pseudofeces were lower in caloric density than plankton, but still probably adequate for survival and growth of bighead carp if the carp consume these.

Also in 2012, using published data regarding dreissenid mussel veliger densities in the Great lakes and caloric content of veligers, we developed a bioenergetics model of bighead carp feeding on these veligers. Results indicate that only in areas of high veliger abundance would veligers alone be an adequate food source for bighead carp, but that veliger abundance near dreissenid mussel beds was sometimes several times higher than that required for carp weight maintenance.

The above results were presented at the American Fisheries Society meeting in Minneapolis

FY 2013 Actions Undertaken: Final testing of bighead and silver carp consumption of driessenid mussel pseudofeces was completed, as was testing of growth and before/after fish calorie content. All final data for this project are now in hand, and most of analysis has been completed. Determination of calorie content of fish from the pseudofeces, the last data required for this study, was completed in January 2013.

In December 2012, a presentation on the results of this study occurred at the Midwest Fish and Wildlife Conference in Wichita, Kansas**.**

FY 2013 Actions Proposed: Complete final analysis of fish calorie content gain/loss, make final determinations of adequacy of dreissenid mussel pseudofeces as a food source for bighead carp, and produce final publications of these results. Present on these results at the International Conference on Aquatic Invasive Species in Niagara Falls, Ontario, and at the American Fisheries Society Conference in Little Rock, Arkansas.

Expected Milestones:

- Spring 2013: Submit two manuscripts on bioenergetic model improvement (one regarding silver carp, one regarding bighead carp).
- Spring or Summer 2013: Submit to a journal the final manuscript detailing all work regarding alternative foods.

Outcomes/Output:

- Final publication of research findings (publication date dependent on journal).

Potential Hurdles: None.

2.5.6 Use of Seismic Technology to Divert and Eradicate Asian Carp

Lead Agency: USGS

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

FY 2013 Funding: $775,000 GLRI funds.

Project Explanation: Silver carp and bighead carp, two invasive Asian carp species, have become established in the Mississippi River watershed, and these fish could invade Great Lakes waters in the near future. Currently, prevention of movement of Asian carp from the Mississippi

watershed into the Great Lakes rests on a set of electric barriers installed in the CSSC. Additional barriers and/or supplements to the electric barrier would improve the efficacy of deterring Asian carp movement into the Great Lakes and elsewhere. Seismic technologies used in oil exploration create high-pressure, underwater sound energy waves that may deter movement of Asian carp. These sound energy waves may be produced by a variety of means ranging from chemical explosives to high-pressure air. Two pneumatic techniques, both involving high-pressure air, are air guns and water guns. Air guns release on command a specified volume of high-pressure air that produces a steep-fronted shock wave with several oscillations caused by repeated collapse and expansion of the air bubble. Water guns use high-pressure air to drive a shuttle through the lower chamber of the water gun. Rapid expulsion of the water in the lower chamber by the shuttle creates a void that is rapidly filled by collapse of water back into the void—collapse of water into this void creates a pulsed sound energy or pressure wave whose frequencies range from 20 to 1,500 Hertz (Hz). Seismic technologies employed as a barrier could deter movement of or drive Asian carp from an area—effectively supplementing existing barriers or providing a standalone deterrent at other locations (e.g., locks, connecting waterways, etc.).

Prior to deploying seismic water guns in the CSSC to prevent movement of Asian carp past critical points, it is crucial that the effectiveness of this technology to either repel or damage carp in the field be demonstrated conclusively. Behavioral responses of several fish species to seismic surveys in marine environments suggest that seismic survey gear (e.g., air guns) causes increased fish movement (as evidenced by greater catch rates of marine fishes in gillnets [a gear that required fish to encounter it]) and decreased feeding (as evidenced by decreased catch using long line sets [a gear that requires active feeding] and decreased stomach contents). Movement response appears to vary with the habitat preference of the species—marine species using essentially featureless habitats were reported to have greater dispersal responses to seismic survey technologies than species that inhabit more specific "rough" bottom habitats. If freshwater pelagic species like bighead carp and silver carp respond similarly to marine pelagic fishes, the water gun discharge may cause them to disperse in response to the sound/pressure pulse generated from that water gun discharge.

FY 2012 Actions Undertaken: Use of water guns to control, divert, and/or eradicate Asian carp was evaluated in experiments completed at Hansen Material Services, Morris, Illinois, and in deployment to the electrical barrier on the CSSC. Experiments were intended to utilize metrics of fish movement to determine the feasibility of water guns for barrier applications and increased capture efficacy. Additional efforts were directed at water gun usage during electric barrier maintenance in conjunction with USACE, USCG, and Illinois DNR.

FY 2013 Actions Proposed: USGS will conduct a combination of controlled mesocosm experiments in the UMESC research pond complex and in field locations to evaluate the efficacy of pulse-pressure stimuli from 1 or 120 cubic inch (in^3) water guns to exclude Asian carp from an area. Work in FY2013 will focus on identifying the minimum gun size, operating pressure, and gun discharge frequency needed to alter behavior of Asian carp. Proposed behavior research will address current unknowns: (1) What is the optimal operating sequence and pulse pressure

configuration to establish an acoustic barrier for both large and small carp? (2) For how long and at what distance will carp remain out of the area during and after cessation of pulse pressure application? (3) How will carp respond in different environments such as in the CSSC or around lock structures that would be considerably noisy due to anthropogenic activities, "masking" the acoustic noise created by the pulse pressure technologies? (4) What are the minimum gun size, operating pressure, and gun discharge frequency needed to alter behavior of carp under field conditions? Work completed in FY 2013 will evaluate responses of multiple sizes of Asian carp. Water gun operation will support electrical barrier maintenance in the CSSC in conjunction with activities and fulfillments of requests by the USACE, USCG, and Illinois DNR.

Expected end date: September 2014.

If not completed after 2013, explain follow-up activities: Work would continue in 2014 to finalize preparation of reports of studies completed in 2013, and to transition use of the water guns to management applications as dictated by behavioral results of research in 2013. USGS would coordinate with management agencies that seek to implement water gun barriers to provide advice, guidance, and training on barrier implementation and equipment operation.

Expected Milestones:

- Recommendations on minimum gun size, operating pressure, and gun discharge frequency needed to create a static barrier to deter Asian carp
- Recommendations on minimum gun size, operating pressure, and gun discharge frequency needed to create a mobile barrier/herding system to deter Asian carp
- Recommendations on minimum gun size, operating pressure, and gun discharge frequency and implementation of those parameters during operations to support electrical barrier maintenance operations on the CSSC.

Outcomes/Output:

- Understanding of minimum gun size, operating pressure, and gun discharge frequency needed to alter behavior of Asian carp.

Potential Hurdles:

- The current configuration of the air compressor restricts operation to temperatures above 41 degrees Fahrenheit (°F) (5 degrees Celsius [°C]). A mobile compressor configuration capable of placement onto a barge/boat is needed to allow operation under all weather conditions.
- A limited number of water guns are available, and replacement parts are similarly in limited supply.

2.5.7 Field Evaluation of Chemical Attractants to Control Asian Carp and Development of Protocols for Field Verification of Response

Lead Agency: USGS

Agency Collaboration: State agencies, USFWS

FY 2013 Funding: $200,000 Base funding.

Project Explanation: Chemical stimuli play a critical role in essential life functions of many fishes, including Asian carp. Chemical stimuli can lead to acquisition of important information regarding favorable habitats, location of food, other Asian carp for schooling, avoidance of predators, synchronization of sexual readiness within the population, and inducement of specific behaviors such as attraction and spawning behaviors. Sex pheromones can be induced through hormonal treatments. Repellant alarm pheromones offer carp protection from predation, and aggregating pheromones attract carp to schools. Selection and location of planktonic food sources are largely based on chemical cues.

Field studies are required to evaluate the effectiveness of hormonally induced sex pheromone production in caged female carp as an attractant to aid in capturing wild carp. Technologies must be identified for observing the response of wild carp to attractive and repellant stimuli in the field.

FY 2012 Actions Undertaken: Proof-of-concept studies were initiated with the aim of using caged treated females as a source of attractive pheromone to aid in the capture of wild carp. These studies attempted to document the response of Asian carp to caged female carp that had been hormonally induced to produce attractive pheromones as a potential lure to assist in the capture and removal of Asian carp. Hormonal manipulations required to synchronize reproductive readiness proved difficult and unpredictable; however, slight attraction (about 15% relative attraction) of males to hormonally induced females was observed in laboratory studies. This low-level attraction may not justify further investigation at this time, considering that only a small percentage of the population would be responsive to sexual attractants. An algal food stimulus used in the culture of early life stage bighead carp was used as a positive stimulus during tests with the induced females, and was found to be highly stimulatory, inducing prolonged attraction in the area of release. The algal stimulus induced similar responses in silver carp. Laboratory tests indicate several components of the algal stimulus were highly attractive. Evaluations of attraction to natural algal cultures and potential inhibition by natural algae were initiated, and chemical profiles for amino acids were initiated. Protocols for use of attractants as lures were developed from the mesocosm studies. This assessment considers responsiveness of free-ranging fish relative to species, sex, and stage of sexual maturation. The studies will also attempt to determine the effective range over which fish are responsive to focal attractive stimuli and the persistence with which they respond. We initiated studies for conditioning wild fish response to feeding stations. This should provide a means of inducing aggregations of carp to facilitate harvest.

Accurate documentation of the response of wild fish is critical to development of chemical lures in carp control. Several imaging technologies were evaluated, including sidescan and DIDSON sonar imagery, visual video, and pit tag detection to observe wild fish and confirm their attraction to these stimuli. A pond mesocosm was instrumented with an array of pit tag antennas enabling continuous monitoring of individual carp movements through a maze-like arena. An expanded research effort is evaluating the attractiveness of pure algal cultures of different species (e.g., selenastrum, microcystis) and will determine if the ambient algal community diminishes the responsiveness of Asian carp to the algal attractants so as to identify season and environmental conditions most optimal for application of the algal stimulus. Expanded studies that combine behavioral and physiological methodologies will enable evaluation of chemical components identified in the algal stimulus such as amino acids (serine, alanine, methionine, gamma amino butyric acid, among others) and potentially flavenoids associated with the algae. Physiological measures of the carp taste system response to these stimuli will be used to screen for chemicals that the carp are most sensitive to, and behavioral studies will evaluate the extent to which carp are attracted to physiologically stimulatory components.

FY 2013 Actions Proposed: Field testing of chemical stimulants based on algae and pheromones will seek to identify efficacious mixtures based on persistence and duration of attraction. These studies will include consideration of component chemicals such as amino acids produced by algae or sex hormone metabolites that enhance the attractiveness of the stimulus, based on screening physiological assays of carp smell and taste senses. Means of providing a sustained release of the stimulant will be explored through tests of various media. Tests will be conducted to confirm the possibility that carp can be conditioned to feeding stations that can be used to facilitate their capture.

Demonstration projects of integrated control technologies will be conducted at two or more field locations reflecting increasing environmental complexity in order to enable development of protocols for luring carp into a specific area to facilitate treatment by micro particle toxins or destruction by pulse pressure technology (water gun). Site selection will be based on hydrological characteristics, monitoring information, and habitat preferences shown by early life stage. An array of detection technologies including DIDSON sidescan sonar, pit tag surveillance, and telemetry will be used to document fish response to treatment.

Expected end date: December 31, 2013.

If not completed after 2013, explain follow-up activities: Complete reports.

Expected Milestones:

- October 1-March 31: Conduct comparison of technologies for detecting positions and movements of fish in the field relative to an attractive or aversive fixed-point stimulus—considering range and accuracy of detection, as well as handling stress imposed on the fish as required by the different approaches.

- March 31-September 31: Conduct replicated studies to assess attraction of free-ranging carp to feeding and pheromonal stimuli. Proof of concept studies will evaluate the possibility of attracting wild carp to feeding stations to facilitate harvest.
- March 31-September 31: Participate in multiple agency interdisciplinary demonstration projects to evaluate the effectiveness of proposed control strategies, and to confirm accuracy of monitoring technologies in the field.

Outcomes:

- Protocols for conducting behavioral observation of free-ranging fish to focal stimuli
- Draft protocols for use of chemical stimuli as lures to assist in capture of free-ranging fish
- USGS report on feasibility of chemical attractants and repellants to capture and harvest Asian carp.

Potential Hurdles:

- Selection of study site that allows sufficient control of free-ranging carp to conduct replicated field trials.

2.5.8 Identify Potential Compounds for Inclusion in a Toxicant Screening Program for Control of Asian Carp

Lead Agency: USGS

Agency Collaboration: Viterbo University, USFWS, USEPA

FY 2013 Funding: $90,000 Base funding.

Project Explanation: A lack of registered piscicides severely limits the tools that aquatic resources managers have available to control aquatic invasive fish. Identification and registration of new piscicides would increase the ability of managers to deal with aquatic invasive fish. Furthermore, increased scrutiny of rotenone due to human health implications could result in potential loss of this piscicide, creating a gap that would have to be filled. This project will analyze structures and activities of chemicals with known piscicidal capabilities described in a variety of industrial, pesticide, and pharmaceutical libraries. Chemicals similar in structure or activities to known piscicides will be evaluated for potential use in controlling aquatic invasive fish such as bighead or silver carp.

FY 2012 Actions Undertaken:

- Continued the comprehensive literature review to catalogue chemicals with known piscicidal activity. Results of the literature search are being compiled in a database for review to identify common structural features and correlate those features with modes of action. The database, in progress, now includes over 200 compounds.
- Continued the review of pharmaceutical and pesticide databases, in progress, to identify candidate fish toxicants. The SAR review will incorporate results of the literature search and information provided from incorporation of the enzymatic and molecular profiles in

order to narrow the search criteria. Preliminary contacts have been made with two agrichemical/chemical companies to gain access to chemical databases. Access to databases of additional agrichemical/chemical/pharmaceutical companies will be pursued. In addition, a webinar on SAR/chemical database review will occur in May.

- Identify, in collaboration with the USFWS La Crosse Fish Health Center, sources of native fish cell lines suitable for use in cytotoxicity (cell toxicity) assays. Cell lines of native fish species have been identified, and culture of those cell lines has been initiated.
- Develop, in collaboration with the USFWS La Crosse Fish Health Center, bighead and silver carp cell lines suitable for use in cytotoxicity assays. Because silver and bighead carp cell lines are not currently available, development of cell lines of these species likely must occur before screening can proceed. Development of cell lines of bighead and silver carp has begun. Additionally, contacts have been established to acquire cell lines from research agencies in China.

FY 2013 Actions Proposed:

- Complete cytotoxicity screening assays with candidate fish toxicants identified in SAR review. Cytotoxicity screening will be completed using cell lines of bighead and silver carp and at least two representative non-target fish.
- Confirm, using in vivo bioassays with fish, the acute toxicity of chemicals that selectively cause cytotoxicity in Asian carp cell lines. In vivo bioassays will include non-target native fishes; the number of species included will depend on fish availability.
- Continue development of Asian carp cell lines to support in vitro cytotoxicity assays in order to identify candidates for further testing.
- Initiate in vivo assays based on results of the in vitro cytotoxicity assays, and identify candidate chemicals for evaluation as new piscicides.

Expected end date: September 2015.

If not completed after 2013, explain follow-up activities: Work in 2014 and 2015 would transition to evaluate the possibility of developing vaccines to cause the fish immune system to target its own cells.

Expected Milestones:

- Continue in vitro cytotoxicity assays and initiate in vivo fish assays.

Outcomes/Output:

- Approximately one dozen candidate fish toxicants identified for further testing.

Potential Hurdles:

- Access to candidate fish toxicants from private chemical libraries.

2.5.10 Developing Targeted Control Systems for Asian Carp Based on Species-Specific Digestive System Characteristics

Lead Agency: USGS

Agency Collaboration: INHS, Purdue University, and South Dakota State University.

FY 2012 Funding: $70,000 Base funding.

Project Explanation: Current toxicants used to control AIS are non-selective and applied throughout the entire water column, resulting in equal exposures of native and invasive species to the toxicant. Development of a delivery system selectively consumed by or active in an invasive species could reduce non-target species exposure to the toxicant and may enhance selectivity and reduce effects on non-target species. Development of such delivery methodologies will require full understanding of native and invasive species gill and gut enzyme activity and physiology, because a targeted delivery system will likely require selective or non-selective uptake via oral or gill adhesion delivery routes, with ultimate delivery in/through the gastrointestinal tract. A complete understanding of the differences between the gastrointestinal system of native planktivores (fish that eat plankton) and that of Asian carp is critical to development of any targeted delivery system.

Focus thus far has been on minimizing impacts of a new control tool on native fishes that may directly consume microparticles from the water column much as do Asian carp. Even though these particles are designed to be neutrally buoyant, particles may eventually settle and accumulate in the sediment with other debris. Thus, particles may be incidentally consumed by fishes that feed in the benthos on detritus like common carp, smallmouth buffalo, white sucker, and some sturgeon species. A complete understanding of the digestive processes of detritivores is critically important to understand potential impacts on native fishes of a microparticle delivery system of control agents to bighead and silver carp.

FY 2012 Actions Undertaken:

- Established collaborations with South Dakota State University to collect digestive tract samples (enzymes and bacterial flora) of native planktivores from the James River, SD, in order to determine if geographic differences in the digestive tract enzymes or bacterial flora of native planktivore populations exist.
- Collected digestive tract samples during winter (October through February). Overwintering feeding habits of Asian carp and native planktivores in northern rivers is essentially unknown. Gut content samples collected in March 2011 indicated that silver carp may be feeding at temperatures and times that native planktivores are not. This information will determine the optimal time for applying an oral toxicant that will decrease its impacts on native fishes while maximizing its impacts on Asian carp.
- Completed assays to compare the enzyme kinetics and activity between silver carp and gizzard shad. Silver carp were determined to have substantially more trypsin and much greater trypsin activity than gizzard shad.

FY 2013 Actions Proposed:

- Establish collaborations and agreements with Purdue University and South Dakota State University.
- Initiate collection of gastrointestinal tracts of detritivous fishes.
- Produce final report.

Expected end date: July 2014.

If not completed after 2013, explain follow-up activities: A small amount of funds will be requested for FY 2014 to collect samples in October/November 2013, and to complete processing along with analysis of these samples.

Expected Milestones:

- February 2012: Develop collaborations and agreements with Purdue University and South Dakota State University.
- March 2012: Initiate detritivore sampling in the Illinois River, Wabash River, and James River. Collect fecal samples from detritivores to support validation of microbial source tracking monitoring study (Framework project 2.5.16). Initiate semi-quantitative analysis of digestive enzymes.
- March 2013: Initiate processing and analysis.

Outcomes/Output:

- Synthesis of differences in digestive physiology (enzymatic and symbiotic flora) among planktivorous fish and comparison of those in Asian carp (work on Asian carp enzymes is part of Framework project 2.5.12). Incorporation of these identified differences into development of a targeted piscicide delivery system that minimizes impact of an oral toxicant on native planktivores.

Potential Hurdles:

- Possible difficulties collecting digestive tract samples during winter months
- Possible inaccessibility of sampling sites during winter months.

2.5.11 Great Lakes' Tributary Assessment for Asian Carp Habitat Suitability

Lead Agency: USGS (Illinois Water Science Center)

FY 2012 Funding: $545,000 Base funding.

Project Explanation: This project focuses on determination of minimum river length, water velocity, and water temperature characteristics required for spawning and growth of bighead and silver carp, in order to determine which, if any, Great Lakes tributaries have the required characteristics for bighead and silver carp reproduction, and to inform placement of barriers or

creation of egg settling zones that would be effective in preventing carp reproduction. Hydraulic and water-quality data have been collected on the Milwaukee, St. Joseph, Maumee, and Sandusky Rivers to (1) allow for preliminary assessments of the ability of the rivers to keep eggs suspended, and (2) develop estimates of egg transport times. The first phase of the project also determined the densities of the eggs as they develop, and how much time the bighead and silver carp require to begin swimming and migrating laterally from flowing water into nursery habitat. This information about river hydraulics and water-quality and egg transport requirements has been used by a graduate student at the University of Illinois working with USGS scientists to create a Fluvial Egg Transport (FluEgg) model. This model takes into account the hydraulics of a river (water velocity and dispersion rates) and the water temperature (affects egg and larvae development rates) in order to determine if a river is sufficiently long and the velocities high enough for the eggs to remain in suspension to develop into larvae. Resource managers will be able to use the Fluvial Egg Transport model to efficiently identify Great Lakes tributaries that pose elevated risk for reproduction of bighead and silver carp by simulating egg travel times and the likelihood that eggs remain in suspension in a given river.

Given the importance of accurately estimating egg suspension and travel time in potential control efforts in the Great Lakes, validation of FluEgg and other drift models is required. Phase 2 of this study is validation of these models and investigation of assumptions about mortality of eggs settled on the river bottom. This assumption will be tested with laboratory experiments designed to examine the interaction between the eggs and sediment in order to learn more about the mechanisms of egg mortality. Model validation will be tested in rivers with known populations of Asian carp. Reproductive populations of bighead carp are known to be established in at least one Midwestern reservoir (Grand Lake [personal communication, Jim Long, USGS Coop Unit, Univ. of Oklahoma]), and fertile grass carp are present in many others, in some cases reproducing. Grass carp are an Asian carp with reproductive requirements essentially similar to those of bighead and silver carp. These smaller bodies of water containing Asian carp are mesocosms for validation of the Great Lakes tributary models. This phase will evaluate which reservoir tributaries are successfully used by Asian carp for reproduction, and the FluEgg model developed in Phase 1 of this project for Great Lakes tributaries will be applied. This work will validate, or inform correction or modification of FluEgg and other drift models. Reservoir tributary research will also provide information on the minimum size of a tributary reach for spawning, a key element of uncertainty in incorporating these models into control methodologies and risk assessments.

FY 2012 Actions Undertaken:

- Submittal of manuscript on early development and behavior of bighead and silver carp to journal.
- Publication of Deters, J.E., D.C. Chapman, and B. McElroy. 2012. Location and timing of Asian carp spawning in the Lower Missouri River. Environmental Biology of Fishes. On-line address: http://www.springerlink.com/content/jok253x50l68n655/?MUD=MP

- Presentation at the Annual Meeting of the American Fisheries Society in Minneapolis, MN on "Use of Drift Models to Understand Asian Carp Spawning and Early Life History" in August 2012.
- Hydraulic and water-quality data collected on the Wabash River in Indiana concurrently with Asian Carp egg collection by biologists at Purdue University. The Wabash River data will be compared with FluEgg model results as a measure of model performance.
- Hydraulic and water-quality data collected on the Sandusky River in Ohio in September 2012.
- Development of first-order egg transport assessments of the Milwaukee, St. Joseph, and Maumee Rivers based on the hydraulic data collected.
- Development of the FluEgg model.

FY 2013 Actions Proposed:

Phase 1:

- Process hydraulic and water-quality data for the Sandusky River, and analyze results for likelihood of egg transport.
- Prepare a USGS Scientific Investigation Report presenting the methodology and data from the hydraulic and water-quality data collection on the Milwaukee, St. Joseph, and Maumee Rivers. The Sandusky River may also be included in this publication.
- Continue collaboration with Purdue University by sharing data collected on the Wabash River.
- Presentation by the University of Illinois on Fluvial Egg Transport at the Midwest Fish and Wildlife Conference occurred in December 2012; publication of a journal article documenting the model (FluEgg) development.

Phase 2:

- Beta-test the FluEgg model, including acquisition of user feedback and application of the model to river data.
- Design and carry out laboratory experiments to increase knowledge about mortality mechanisms for Asian Carp eggs that have settled to the bottom of a river.
- Develop early life history information on grass carp, similar to that completed for bighead and silver carp, to ensure that models encompass grass carp accurately.
- Evaluate reservoir tributaries for presence of Asian carp eggs and larvae during the peak spawning season, and evaluate presence of young-of-year Asian carp in reservoir wetlands.
- Determine approximate spawning locations of carp eggs or larvae collected, using drift models.

Expected end date: Phase 1 will conclude in FY13 with publication of a USGS report documenting data collection and processing methods, and offering conclusions about egg transport on a number of Great Lakes tributaries; and with a journal article documenting development of the FluEgg model.

If not completed after 2013, explain follow-up activities: Due to the positive eDNA results at several locations in the Great Lakes Basin, demand for information about spawning suitability of a number of rivers is expected to continue, especially around Lake Erie.

Phase 2 includes experiments on mechanisms of mortality for settled eggs, field verification of the FluEgg model, and 2 years of field work (2013 and 2014), with final dissemination of results in 2015.

Expected Milestones:

Phase 1:

- Manuscript submitted to journal describing sinking rate of eggs and relationships among velocity, shear velocity, and egg transport (December 2012)
- USGS Scientific Investigations Report on hydraulic and water-quality data and analysis to be published (summer 2013)
- Documentation of the FluEgg model in a journal (spring 2013)
- Dissemination of FluEgg model to scientists and managers through conference presentations and/or WebEx (throughout FY 13)
- Laboratory experiments designed and carried out to observe how eggs interact with sediment (fall 2013).

Phase 2:

- Data collection complete regarding egg size and buoyancy, and regarding developmental rate and behavior of grass carp early life stages (July 2013)
- Publication submitted regarding egg size and buoyancy, and developmental rate and behavior of grass carp early life stages (fall 2013)
- Final field data collection complete for Phase 2 (fall 2014)
- Publication of Phase 2 results with recommendations regarding Great Lakes tributary models (spring 2015).

Outcomes:

Phase 1:

- USGS Scientific Investigations Report to be published regarding hydraulic and water-quality data collected on Great Lakes tributaries, along with information about potential spawning locations and egg settling zones in reaches along the rivers. These data will help managers target locations in rivers where eggs may settle or Asian carp may spawn to assist in control measures. The data analysis from this project may also lead to control strategies such as determining placement of low-head dams to create settling zones that disrupt egg development but cause fewer ecological impacts than other control strategies such as poisons.
- Scientists will be able to use the FluEgg model to efficiently identify Great Lakes tributaries that pose elevated risk for reproduction of bighead and silver carp—by referencing hydraulic characteristics to simulate egg travel times and to determine likelihood of eggs remaining in suspension until development.

Phase 2:

- To understand mortality mechanisms of settled eggs, investigators will design and carry out laboratory experiments to determine how eggs interact with turbulence and sediment. This work is important to validate or discredit the assumption that eggs must be carried in the drift to continue to develop, and will contribute to understanding of stream conditions needed for successful egg development.
- Model validation will greatly reduce uncertainty about whether application of these models will result in effective controls, and will allow for more accurate and effective deployment of control methodologies based on the early life history requirements of Asian carp.

Potential Hurdles:

- If field data are required, acquisition depends on weather conditions (sufficient flow during periods of warm weather) and availability of spawning Asian carp (if applicable).
- Publication schedule is affected by length of time various reviewers need, which is beyond the control of project personnel.
- Beta testing results may lead to model changes and improvements that will delay wide distribution of the FluEgg model.

2.5.12 Technologies Using Oral Delivery Platforms for Species-Specific Control

Lead Agency: USGS

Agency Collaboration: Advanced BioNutrition Corporation, INHS, Purdue University, University of Wisconsin – LaCrosse, UIUC, Viterbo University, USEPA, USFWS

FY 2013 Funding: $400,000 Base funding.

Project Explanation: No current technology can specifically target bighead or silver carp for control within aquatic ecosystems. Current piscicidal chemicals are not selective for bighead or silver carp, and current methods to apply these in aquatic systems equally expose all animals present. 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. Similarly, developing new chemical tools specifically toxic to bighead or silver carp would lead to more success in management efforts to control Asian carp. Indeed, developing new selective chemical control tools appears essential to successful management of Asian carp.

FY 2012 Actions Undertaken:

Identify potential field trial locations to evaluate a selective targeted delivery system of rotenone. The evaluation was initially to occur in 2011 but was delayed due to unavailability of the number of fish needed for the studies

STATUS: Partner discussions regarding field testing location(s) have been initiated and will continue pending results of laboratory and controlled mesocosm trials.

Submit Experimental Use Permit application to USEPA to allow field trials of a selective targeted delivery system of rotenone. This also was to occur in 2011 but was delayed due to unavailability of the number of fish needed for the studies

STATUS: Submission of an Experimental Use Permit has been postponed pending completion of laboratory and controlled mesocosm trials. This work was postponed to accommodate need to develop target (bighead and silver carp) and non-target toxicity data that would inform the parameters of the permit

Establish collaborations with South Dakota State University to collect digestive tract samples (enzymes and bacterial flora) of bighead and silver carp from the James River, South Dakota. This will help identify any geographic differences in the digestive tract enzymes or bacterial flora of bighead and silver carp populations

STATUS: Digestive enzymes were analyzed from fish captured from the Illinois (IL), Wabash (IN) and James Rivers (SD), and a manuscript describing these data is under development for publication in a peer-review journal. Additionally, mean pore sizes of gill rakers of silver carp and interraker spacing of gill rakers of gizzard shad have been compared seasonally in the Illinois River and among the Illinois, Wabash, and James Rivers. Drafts of two manuscripts are nearing completion.

Complete work to evaluate toxicity of a selective targeted delivery system of rotenone in order to determine field exposure rates for controlling bighead and silver carp

STATUS: Initial research comparing the oral toxicity of rotenone and antimycin to microparticle ingestion by bighead and silver carps resulted in an active ingredient formulation specification change from rotenone to antimycin. Antimycin-incorporated microparticles are being prepared for evaluation in laboratory trials. Studies were performed to determine gastric evacuation rates and apparent digestibilities of food (and thus microparticles) of bighead and silver carp at three temperatures (12, 19, and 25°C). Studies to evaluate effects of temperature on enzyme kinetics are in progress, and completion is expected in December 2012.

Initiate work to evaluate inclusion of palatability enhancers (e.g., algal constituents, amino acids, etc.) to increase consumption of rotenone by bighead and silver carp via a selective targeted delivery system.

STATUS: Protocols are being developed for the assay and fractionation of attractive substances of algal diets that may enhance bighead and silver carp microparticle consumption. Antimycin will replace rotenone in microparticle formulations.

Develop application techniques for delivering a selective targeted delivery system of rotenone to bighead and silver carp. This work will include optimization of toxicant loading rates, treatment concentration rates, and treatment duration to achieve maximum control of Asian carp

STATUS: Work on this action has been delayed pending receipt of the antimycin-incorporated microparticles.

Initiate non-target testing of a selective targeted delivery system of rotenone to native fish and mussel species.

STATUS: Work on this action has been delayed pending receipt of the antimycin-incorporated microparticles.

Initiate a contract to develop microspheres for encapsulation and release of piscicidal compounds. USGS will work with bio-medical microsphere development companies to develop and evaluate various formulations of microspheres for use as a potential selective targeted delivery system of chemicals for controlling AIS.

STATUS: Development of contracts to prepare a control agent-incorporated microparticle has delayed work on this action.

Complete comparisons of seasonal and regional gill raker ultrastructures of Asian carp and native planktivorous fish.

STATUS: Mean pore size from gill rakers of silver carp and interraker spacing from gill rakers of gizzard shad have been compared seasonally in the Illinois River, and among the Illinois, Wabash, and James Rivers. Drafts of two manuscripts were completed and will be submitted in late 2012 or early 2013.

Complete work with UIUC on bacterial sequencing to describe the bacterial fauna of the digestive tracts of bighead and silver carp.

STATUS: Enteric bacterial sequencing has been completed. Grass carp have several unique bacterial species, and silver carp intestines are dominated by Bacteriodes. Development of a more extensive library is required to identify specific Bacteriodes species unique to silver carp. Specific genetic markers are currently being developed. Sequencing of bacteria from foreguts of silver carp, gizzard shad, and bigmouth buffalo has been completed. Limited bacteria were observed in the foregut of silver carp and bigmouth buffalo, but a consistent bacterial composition was found in the foregut of gizzard shad. Publications describing these results are under development; manuscript was submitted to a peer-review journal in November 2012.

Supported by funding through the USGS Science Support Partnership Program, determine toxicants for inclusion in possible selective targeted delivery systems, and determine optimal toxicant loading rates, treatment concentration rates, and treatment duration to achieve maximum control of dreissenid mussels.

STATUS: Niclosamide was selected as a control agent to incorporate into initial microparticle formulations for proof-of-concept evaluation. Substantial data reduction has been completed to describe comparative particle filtration of native and dreissenid mussels

Identify potential field trial locations to evaluate a selective targeted delivery system of rotenone.

STATUS: After discussions with several partner agencies, selection of field trial locations has been delayed until completion of target and non-target toxicity testing.

Submit Experimental Use Permit application to USEPA to allow field trials of a selective targeted delivery system of rotenone.

STATUS: Submittal of an Experimental Use Permit has been postponed pending completion of laboratory and controlled mesocosm trials. This work was postponed to accommodate need to develop target (bighead and silver carp) and non-target toxicity data that would inform the parameters of the permit. Additionally, examination of comparative oral toxicity and microparticle ingestion data has resulted in changing the control agent to be incorporated into the microparticle to antimycin. This change will allow for greater treatment flexibility and substantially lower ingestion requirements to achieve a lethal dose

Initiate field trials of a targeted delivery system of rotenone.

STATUS: This action has been postponed pending completion of laboratory and controlled mesocosm trials expected to generate target and non-target toxicity data that would inform the parameters of the required Experimental Use Permit. Additionally, examination of comparative oral toxicity and microparticle ingestion data obtained has resulted in changing the control agent to be incorporated into the microparticle to antimycin. This change will allow for greater treatment flexibility and substantially lower ingestion requirements to achieve a lethal dose.

FY 2013 Actions Proposed:

- Continue work to evaluate toxicity of a selective targeted delivery system of antimycin in order to determine field exposure rates for controlling bighead and silver carp.
- Continue non-target testing of a selective targeted delivery system of antimycin to native fish and mussel species.
- Develop application techniques for delivering a selective targeted delivery system of antimycin to bighead and silver carp. This work will include optimization of loading rates, treatment concentration rates, and treatment duration to achieve maximum control of Asian carp.
- Initiate aquatic metabolism studies to determine the degradation characteristics of a toxicant-incorporated microparticle in order to make a preliminary assessment of the environmental fate of the toxicant when applied using microparticle technology.
- Identify potential field trial locations to evaluate a selective targeted delivery system of antimycin. The evaluation was to occur in 2011 but was delayed due to unavailability of the number of fish needed for the studies, and need to await results of laboratory and controlled mesocosm trials
- Submit Experimental Use Permit application to USEPA to allow field trials of a selective targeted delivery system of antimycin. This was to occur in 2011 but was delayed to accommodate need to develop target (bighead and silver carp) and non-target toxicity data that would inform the parameters of the permit.

- Establish collaborations with South Dakota State University to collect digestive tract samples (enzymes and bacterial flora) of bighead and silver carp from the James River, SD. This will allow comparisons of the digestive enzymes of bighead and silver carp with native detritivores.
- Continue work to evaluate inclusion of palatability enhancers (e.g., algal constituents, amino acids, etc.) to increase consumption of rotenone by bighead and silver carp via a selective targeted delivery system.
- Initiate work to evaluate inclusion of palatability repellents for native species (e.g., blue-green algal constituents, etc.) to decrease consumption of antimycin by bighead and silver carp via a selective targeted delivery system.
- Initiate a contract to develop microspheres for encapsulation and release of piscicidal compounds. USGS will work with bio-medical microsphere development companies to develop and evaluate various formulations of microspheres for use as a potential selective targeted delivery system of chemicals for controlling AIS.
- Complete work with UIUC on bacterial sequencing to describe the bacterial fauna of the digestive tracts of bighead and silver carp.
- Initiate research to determine which subcomponents of algal diets act as feeding deterrents for native planktivorus fish.

Expected end date: September 2015.

If not completed after 2013, explain follow-up activities: Work in 2014 and 2015 would transition to registration of antimycin-incorporated microparticles.

Expected Milestones:

- May 2013: Complete work to evaluate toxicity of a selective targeted delivery system of antimycin in order to determine field exposure rates for controlling bighead and silver carp.
- September 2013: Complete non-target testing of a selective targeted delivery system of antimycin to native fish and mussel species.
- September 2013: Conduct on-site field evaluations in a mobile bio-assay trailer of a selective targeted delivery system of antimycin to native fish and mussel species. Originally planned for 2012, this was delayed pending completion of target (bighead and silver carp) and non-target toxicity data to inform the parameters of required permits.
- May 2013: Initiate assays to determine which components of algal diets deter feeding in native species.
- May 2013: Initiate aerobic aquatic metabolism study to determine degradation characteristics of toxicant-incorporated microparticle technology.
- September 2013: Apply for Experimental Use Permit to conduct field application of antimycin-incorporated targeted delivery system formulation at limited application sites.

Outcomes/Output:

- Development of a selective targeted delivery system of antimycin for selective control of bighead and silver carp

Potential Hurdles:

- Establishment of contracts with industry to prepare microparticles or deliver biocides for incorporation into the microparticles.

2.5.15 Develop Alternate Traps/Technologies to Enhance Asian Carp Capture Rates

Lead Agency: Illinois DNR

FY 2012 Funding: $200,000 GLRI funds.

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 hydroacoustic 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 combinations of gears and fine-tuning, are undergoing examination with the aim of further increase in 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. Through these efforts, gears can be fine-tuned and recommended for full implementation and inclusion in response, removal, or monitoring efforts.

FY 2010 Actions Undertaken:_INHS evaluated several barrier techniques for responses in laboratory and field (pond) settings. Water gun trials occurred in fall 2010 as well. Both showed promise for killing and/or repelling fish. Evaluation of deployment of these tools at a scale environmentally relevant continued through 2011.

FY 2012 Actions Undertaken:

- Performed experiments at Osage Beach, Missouri on Asian carp eggs and fry. Subjected eggs and fry to the various durations and concentrations of carbon dioxide. Collected a total of 600 eggs and 1800 fry of each species.
- Utilized a “shuttlebox” system to observe and quantify active avoidance of Asian carp fingerlings to increased concentrations of dissolved carbon dioxide.
- Experiments performed in an isolated pond with bubbler system.
- Identified efficient technology to introduce carbon dioxide into water that will result in quicker application time and less release to the environment.
- Planned implementation at an environmentally relevant scale at barriers.

- Deployed Great Lakes Pound nets in Lake Calumet (CAWS) and Hanson Material Services Gravel Pit, Illinois River, Morris, Illinois. Compared results to those using other fisheries gears.
- Fished surface to bottom gill nets successfully within Restricted Navigation Area within electric barriers to remove fish (common carp).
- Used surface to bottom gill nets in rapid responses in 2012.
- 2-m hoop nets used in rapid responses in 2012.
- 2-m hoop nets used in gear comparison sampling.
- 2-m hoop nets used in fixed sites sampling in 2012.

FY 2013 Actions Proposed:

- Separate framework item for carbon dioxide work.
- Upon 2012 data analyses, drop ineffective gears from gear comparisons and any monitoring activities.
- Further assess most successful gears, as data obtained in just one season or year are not likely sufficient to support broad and accurate predictions.
- Combine gears (shocking and netting) to determine if further increased catches can be achieved.
- Identify new and efficient technologies (e.g , large-framed fyke nets or prolonged “dead” set nets).
- Identify efficacy of pound nets in new habitats, and identify new areas in CAWS for deployment for detection, as well as potential harvest areas below electric barrier.

Expected Milestones:

- Summer 2013: Fish pound nets in Illinois River backwater where carp are abundant (e.g. Peoria Lake)
- Summer 2013: Fish-framed fyke nets in areas with other gears to define efficacy for carp capture.

Outcomes/Output:

- Further development of new gears and fine tuning of existing ones to maximize detection and removal of Asian carp
- Additional tools for stopping and eliminating Asian carp from the waterway
- 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 hard to sample using more conventional gears
- Development of tools that lead to more effective and cost-effective capture of Asian carp while minimizing mortality to native species.

Potential Hurdles:

- Cost of applying new technology may not be lower than costs of existing methods.
- New technologies may not improve upon sampling efficiencies when actually deployed.
- New gears may be more expensive and require more equipment to deploy than traditional fisheries gear.
- Gears may catch fish where they are abundant, but may not increase ability to catch fish significantly where they are very rare.

2.5.16 Development of a Rapid and Quantitative Genetic-Based Asian Carp Detection Method

Lead Agency: USGS

Agency Collaboration: UIUC for genetic analysis, and INHS, Purdue University, and South Dakota State University for assistance in sample collections.

FY 2013 Funding: $140,000 Base funding.

Project Explanation: Early detection is a vital part of managing any invasive species, including Asian carp. Methods for early detection have thus far relied on capture of fishes or presence of eDNA (mitochondrial DNA [mitDNA]) from sloughed cells from Asian carp. The initial goal of this project was to develop and validate a genetic-based method that can complement the current surveillance methods for Asian carp through identification of microbial populations unique to the Asian carp gut microbiota in a manner similar to microbial source tracking. Microbial source tracking is based on the concept that microbes from a polluted site can be traced to source species, thus indicating the origin of the fecal contamination. This approach has been successfully applied to identify the sources (e.g., human, cow, swine, water fowl) of fecal contamination in rivers, lakes, and drinking water distribution systems. If key microbial populations can be identified in the gastrointestinal tract of Asian carp, these could be used for development of a genetic-based method to detect presence of Asian carp in water bodies.

Promising preliminary results indicate that microbial source tracking could complement eDNA monitoring for Asian carp. Specific microbial populations associated with grass carp, gizzard shad, and silver carp were observed in initial work of this project, suggesting primers specifically targeting these microbial populations can be designed and used as biomarkers. Therefore, we propose to extend this project to systematically evaluate and compare the loading and degradation rates of eDNA genetic markers and AC-specific microbial populations in different water matrices under controlled environmental conditions. Comparing results (e.g., degradation rates and quantitative Polymerase Chain Reaction (qPCR) detection thresholds) from both methods will allow us to better evaluate the effectiveness of these tools for use in surveillance programs of Asian carp.

FY 2012 Actions Undertaken:

- Completed next-generation sequencing of the 16S ribosomal ribonucleic acid (rRNA) extracted from microbes present in the gastrointestinal tract (foregut and hindgut) of silver carp, bighead carp, grass carp, gizzard shad and bigmouth buffalo taken from the Wabash River, Illinois River, Mississippi River, Missouri River, and James River—454 pyrosequencing of the microbiome present in the foregut and hindgut of silver carp, bighead carp, grass carp, gizzard shad and bigmouth buffalo. High-quality sequences were aligned and compared using appropriate molecular taxonomic approaches tailored for microbial taxonomy to identify operational taxonomic units (OTU) present, and to compare intra/interspecies similarities/dissimilarities in the OTUs present.
- Identified unique bacterial species present in the hindgut of silver carp and grass carp. Identified bacterial species present in the hindgut of silver carp that were not present in gizzard shad collected at the same sample location and time. Unique bacterial species were present in the hindgut of all three species relative to other Asian carp and to native species.
- Developed initial markers to identify some of the unique bacteria associated with silver carp and grass carp; these will be used to amplify the 16S rRNA of selected unique bacteria associated with silver carp and grass carp.

FY 2013 Actions Proposed:

- Characterize the microbial population in waters with and without Asian carp.
- Initiate collection of samples to determine how the population of microbes in the CSSC changes throughout the year.
- Determine the loading and degradation rates of eDNA genetic markers and Asian carp-specific microbial populations in aquarium systems.
- Initiate work to determine degradation rates of Asian carp-specific microbial populations in water matrices within waters typically sampled as part of the Asian carp monitoring program.
- Compare use of microbial markers with eDNA markers in waters with and without Asian carp.

Expected end date: September 2014.

If not completed after 2013, explain follow-up activities: Funds will be requested to support final collection of samples to identify temporal changes in the microbial community of the CSSC, and to complete field degradation studies for calibration of Asian carp-specific microbial markers. Work in 2014 would also be completed to provide a formal workshop and training to convey information on the process of collection, concentration, and analysis of samples to implement use of microbial markers for monitoring Asian carp.

Expected Milestones:

- May 2013: Complete a final report to describe the composition of gastrointestinal bacteria of Asian carp and native planktivores.

- August 2013: Determine the background signal from microbial communities that could compromise use of certain unique bacterial markers.
- August 2013: Develop qPCR method to detect Asian carp-specific microbial populations.
- September 2013: Initiate studies that determine the degradation of Asian carp-specific microbial populations in different water matrices (including water from the CSSC) under controlled environmental conditions.
- September 2013: Initiate validation studies for microbial markers with eDNA sampling using water samples collected along the CSSC and Illinois River. Validation studies will leverage on lessons learned from completion of work associated with Asian carp eDNA surveillance (e.g., ECALS).
- October 2013: Initiate studies to identify how the unique microbial population changes throughout the monitoring season.
- April 2014: Complete studies to determine loading rates of Asian carp-specific microbial populations into environmentally-relevant systems under controlled conditions.
- September 2014: Complete a final report describing microbial populations that describe the presence of Asian carp, including molecular response to different populations and degradation/persistence of microbial markers in the environment.

Outcomes:

- Completion of this project will provide a complementary method that can be used in conjunction with detection of Asian carp DNA in environmental samples. For example, presence of 16-s rRNA of a microbe specific to the intestinal tract of a silver carp in a sample that also contains the DNA of a silver carp could strongly indicate recent presence of a live silver carp.

Potential Hurdles:

- Weather may delay or preclude field collections, particularly during the winter.
- Bacterial sequencing will be performed by the University of Illinois Genomics Core. Because this is a high-demand laboratory, and sample analysis of partial runs is neither cost- nor time-effective (partial runs require more processing time per sample than full runs), digestive tract samples will be pooled until a full sample set is obtained. Demand by other projects on the Genomics Core remains unknown; thus, the impact of this potential demand is indeterminate

2.5.17 Chicago Area Waterway System Monitoring Network Evaluation

Lead Agency: USGS

Agency Collaboration: Illinois DNR, USFWS, USACE, Metropolitan Water Reclamation District (MWRD) of Greater Chicago

FY 2012 Funding: $40,000 Base funding.

Project Explanation: The CAWS is on the front line of the battle to prevent migration of Asian carp into the Great Lakes because of the continuous waterway connection present. This has resulted in a number of areas where the USGS has been asked to provide hydraulic and water-quality information to assist in eDNA detection, rapid response actions, ecological separation

evaluations, and flow reversals through the electric fish barrier. Currently, flow monitoring stations on the CAWS are insufficient to properly address many of these issues. Hydraulic and water quality models of the CAWS are important tools for data-based decisions such as those that may affect ecological separation. Development and calibration of these models requires flow data from throughout the CAWS. One goal of this project was to compile historical flow and water-quality data from the CAWS into a single database that would streamline model development and calibration. Another goal of this project was to evaluate the historical database and the current network of gaging stations on the CAWS to identify critical inputs and gaps in information. Some of the identified data gaps have been addressed through synoptic field measurements and some new monitoring locations. Continued efforts are underway to address these gaps and develop a summary report, and enhance web delivery of data and other products as necessary.

FY 2012 Actions Undertaken: Historic CAWS flow and water-quality data were mined and compiled into a single database to streamline model development and calibration. A network evaluation of the historic and current CAWS monitoring stations was started to identify gaps in the critical information. USGS conducted field reconnaissance, synoptic water temperature surveys, and other data collection activities to address data gaps at strategic waterway locations. Additional field measurements supported stakeholder agencies in determining reversal of flows through the electric fish barrier and bathymetry of Lake Calumet. A list of recommendations regarding the CAWS monitoring network was compiled.

FY 2013 Actions Proposed: Host a Chicago Area Waterway science meeting in Chicago to discuss with stakeholder agencies future monitoring needs and a coordinated funding mechanism for long-term monitoring. Complete additional temperature profiling after two power plants go off-line to evaluate thermal loading changes. Complete bathymetric map of Lake Calumet (a focus area for Asian carp rapid response actions), and publish a map report. Complete analysis of reverse flows in the vicinities of electric fish barriers. Complete report on CAWS monitoring network analysis.

Expected Milestones:

- October 1, 2012-Mar. 31, 2013: Continue to mine historic CAWS monitoring data and build onto existing CAWS database on-line observatory (USGS-Chicago Waterway Observatory: http://il.water.usgs.gov/data/cwo/).
- November 30, 2012: Complete analysis of reverse flows through fish barriers.
- December 31, 2012: Complete data collection for bathymetric survey of Lake Calumet.
- January 30, 2013: Host CAWS science meeting with stakeholder agencies and other groups.
- March 31, 2013: Complete draft CAWS monitoring network evaluation report for peer review, which will include a section on reverse flows, with an expected final publication in September 2013. (Note: Publication schedule is affected by length of time various reviewers need, which is beyond the control of project personnel.)

- September 2013: Publish USGS Map report on bathymetric survey in Lake Calumet.

Outcomes/Output:

- Presentation of findings on reverse flow at fish barrier and discussion of strategies for minimizing reverse flows with stakeholder agencies. (Conference call with stakeholders held November 8, 2012).
- Completion of bathymetric map of Lake Calumet and publication as a USGS map report. (Draft map completed January 25, 2013, is under colleague review.)
- Continuation of compilation of flow data from the CAWS into USGS database and to the USGS-Chicago Waterway Observatory for model development and analysis of waterway separation scenarios.
- USGS report on monitoring network evaluation methods and identification of critical gaps in monitoring.
- Coordination of funding mechanism among stakeholder agencies for long-term CAWS monitoring. (CAWS Science meeting hosted in Chicago on January 24, 2013.)

Potential Hurdles:

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

2.5.22 Use of Acoustic Video and Side-scan Technology to Determine Behavior of Asian Carp

Lead Agency: USGS

Agency Collaboration: Illinois DNR

FY 2013 Funding: $180,000 Base funding.

Project Explanation: Asian carp are notoriously difficult to catch with typical entanglement or trap gear types. This is in part due to their body morphology (no spines or teeth to entangle, and a body shape that provides only a small difference between the mesh size that will gill and a size that will allow passage) and in part due to their preferred pelagic lifestyles and avoidance of tight spaces. However, based on limited observations, it is clear that Asian carp have behavioral methods of net avoidance. In the turbid waters inhabited by Asian carp, direct observation or normal photography is normally impossible. With acoustic technology, it will be possible to understand exactly how Asian carp avoid nets, and to adjust tactics accordingly. In field applications of scent or pheromone attractants together with capture gear, acoustic video technology will allow us to determine the interaction of scent and gear—for example, if an attractant is working but a netting design is not, it will allow us to make that determination and adjust net type or set accordingly.

USGS scientists have been assisting the Illinois DNR and the USFWS in separate efforts to test and develop new, more efficient and less labor-intensive netting technologies. Currently,

evaluations of new gears are based on catch only. Incorporation of DIDSON imaging technology into these evaluations will allow examination of carp behavior near nets and thus provide insight into gear modifications to nullify or take advantage of that behavior. These technologies may detect "near misses" on catches that would otherwise result in dismissing a gear type that would otherwise prove useful in control or detection activities. Furthermore, use of side-scan sonar in combination with these gear tests will allow enumeration of carp present and potentially subject to the gear, allowing more accurate comparisons among gear types.

FY 2012 Actions Undertaken: NA

FY 2013 Actions Proposed: Deploy acoustic imaging technologies to evaluate both commonly used and "innovative" gears. Assess behaviors of carp that allow them to avoid nets. Recommend potential changes in gear design or deployment to nullify or take advantage of those behaviors. Perform evaluations of carp behavior in both winter and summer periods, because carp behaviors are likely different in cold and warm periods. Two stages in analysis of data will occur:
(1) subjective observations from viewing videos will lead to generation of hypotheses, and
(2) digital images and video will be parameterized and transformed into data using techniques common to terrestrial and avian behavior research, possibly allowing statistical tests of those hypotheses generated in the first round of viewing. These activities would be combined with efforts of collaborators in the Illinois DNR and the USFWS, and will also include imaging around commercial netting activities or simulated commercial netting activities.

Tests will occur in the Illinois River, the Mississippi River, and the Missouri River, because these very different regions will require different fishing techniques, and conditions may result in different behaviors.

Expected end date: Fall 2014.

If not completed after 2013, explain follow-up activities: This project is expected to provide new information on fish behavior and effectiveness of fish harvest methods that cannot be predicted prior to completion of 2013 work. For this reason, in 2014, an adaptive research strategy will be adopted, based on 2013 results, to more tightly focus this project on evaluation of specific harvest tactics for improved catch rates.

Expected Milestones:

- Winter 2012-2013: Preliminary testing in cold water; hypothesis generation
- Summer, 2013: Preliminary testing in warm water; hypothesis generation and some hypothesis testing
- Fall 2013: Preliminary results presented at American Fisheries Society meeting or Midwest Fish and Wildlife Conference
- Winter 2013-2014, and spring 2014: Continued gear evaluation and hypothesis testing
- Fall 2014: Final report and recommendations.

Outcomes/Output:

- Understanding of the interaction of bighead, silver, and carp behavior and capture technologies
- New tactics that nullify or use the gear avoidance behaviors of these fishes to increase gear effectiveness.

Potential Hurdles:

- Weather conditions may impede data collection.
- Early measurements depend on early availability of dollars and rapid processing of purchasing and hiring; otherwise, the project will be delayed.

2.5.23 Movement, Habitat Selection and Behavior of Asian Carp and Native Planktivores in Newly Invaded River Segment: Implications for Control

Lead Agency: USGS

Agency Collaboration: Minnesota DNR, Iowa DNR, IL DNR, Wisconsin DNR, Missouri Department of Conservation, University of Oklahoma

FY 2013 Funding: $110,000 Base funding.

Project Explanation: Locating and understanding movements, habitat selection, and behaviors of Asian carp and native fish planktivores at invasion fronts will be necessary to effectively implement physical and chemical control measures for Asian carp without negatively impacting native fishes. An approach for control is to apply these measures at invasion fronts to keep Asian carp from establishing new populations "upstream" and to push fronts back. Current Asian carp invasion fronts to the Great Lakes, Upper Mississippi River (UMR), and glacial lakes of Minnesota and Wisconsin include the Marseilles Navigation Pool in the Illinois River System, the upper Wabash River in the Ohio River System, and Pool 19 near Keokuk, Iowa in the UMR System. If these fronts can be effectively maintained via control measures and public education, the important recreational fishery and ecosystems of the upper Midwest will be better protected.

Ongoing and recently completed studies in the Illinois and Wabash Rivers are partially addressing movement and habitat information needs in general and on a front-specific basis to inform control efforts. We propose a study focused on Pool 19 of the UMR to further our understanding of Asian carp and native planktivore movement, habitat selection, and behavior in general at this strategically important front. We will use telemetry (passive and active), netting, and sonar surveys at locations of adult Asian carp tagged with depth sensing sonic transmitters in Pool 19 to obtain information necessary for safe and effective application of control measures. Information will be obtained on seasonal habitat use, feeding and schooling behavior, water column positions, overlap with native planktivores, timing and conditions during migration and aggregations, tributary use, and dam passage timing and conditions.

In tandem with the telemetry of resident Asian carp in Pool 19, we propose to test the feasibility of using telemetered fish to locate other resident fish to assist in their capture and removal. This concept has been used effectively in control and eradications of other invasive species (e.g., common carp). The approach may be similarly effective with Asian carp because they typically exhibit schooling behavior. The approach is further warranted because Asian carp are very difficult to detect and quantify with traditional fish sampling methods, especially at low densities. Consequently, fishing for Asian carp as a rapid response to prevent establishment of reproductive populations in large systems is ineffective.

FY 2012 Actions Undertaken: NA

FY 2013 Actions Proposed:

- Establish a network of passive telemetry receivers including sites immediately upstream and downstream of Pool 19 by May 2013.
- Implant transmitters into 50 adult bighead carp, 50 adult silver carp, and 50 adult bigmouth buffalo from Pool 19 of the UMR for the Movement and Habitat Selection part of the study by June 2013.
- Implant transmitters into an additional five adult bighead carp and five adult silver carp by July 2013 to determine if these fish can be used to locate resident fish.
- Conduct telemetry, habitat, fish behavior (sonar), and netting surveys through November 2013.
- Produce surgically sterilized and triploid Asian carp by June 2013.
- Evaluate surgically sterilized fish for gonad re-growth at 6, 12, and 24 months post-sterilization.
- Evaluate triploid fish for sterility at age of maturity.
- Initiate development and evaluation of an implanted device to kill telemetered carp and allow for retrieval.

Expected end date: September 2015.

If not completed after 2013, explain follow-up activities:

- Preliminary data analysis and summary of the Movement and Habitat Use part of the study will occur during winter 2013-2014, and will be presented to managers at scientific and partner meetings by June 2014.
- Data collection from telemetered fish will occur through November 2014 to allow for a second field season of data on which to base final conclusions and recommendations regarding implications for control measures.
- Final data analysis, summary, conclusions, and recommendations will be: (1) presented to managers at scientific and partner meetings, and (2) incorporated into a manuscript for publication in a scientific peer-review journal by September 2015.

Expected Milestones:

- March 2013: Complete study plan, determine locations of telemetered carp deployment, acquire needed permissions and permits, acquire needed supplies and equipment, and initiate hiring.
- May 2013: Examine surgically sterilized carp for regrowth of gonads
- May 2013: Establish passive receiver network.
- June 2013: Produce triploid bighead carp.
- June 2013: Tag Asian carp and bigmouth buffalo with transmitters.
- Fall 2013: Examine surgically sterilized carp for regrowth of gonads.
- Fall 2013: Complete 4 months of tracking, behavioral, and habitat surveys.
- Spring 2014: Attempt recapture of translocated telemetered carp, and enumerate other Asian carp captured along with the translocated telemetered carp. Compare to captures by fishing activity without use of telemetered fish.
- Spring and Summer 2014: Present to appropriate research and management groups preliminary results on movement and habitat use, and success of telemetered carp technique in locating other fish.
- Fall 2014: Complete second field season of data collection pertaining to movement and habitat use.
- Fall 2014: Examine surgically sterilized carp for regrowth of gonads and report on findings.
- Spring 2015: Complete final data analysis and summary on movement and habitat use.
- September 2015: Report findings on movement and habitat use and triploid fish for sterility to researchers and managers in the form of scientific presentations and a manuscript submitted to a peer-review scientific journal.

Outcomes:

- Information on movement, habitat selection, and behaviors of Asian carp and native planktivores to be used for development and implementation of effective and safe control measures for Asian carp at an invasion front.
- Determination of feasibility of deploying telemetered fish to locate Asian carp at low densities so that control measures can be implemented while avoiding addition of fertile individuals to invasive population and complicating eDNA studies.

Potential Hurdles:

- Delays in funding allocations, purchasing, or hiring could result in commensurate delays in project actions and associated milestones.
- Adverse environmental conditions such as floods could delay project actions and associated milestones.

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

Lead Agency: USGS

Agency Collaboration: Illinois DNR

FY 2013 Funding: $50,000 GLRI funds.

Project Explanation: Results of studies utilizing previous and subsequent developments of novel control technologies to control and monitor Asian carp—such as pheromones, food cues, and targeted oral-delivery platforms—must be communicated to managers responsible for implementing these control technologies. USGS will communicate these results by coordinating site visits at field-scale sites—demonstrating how technologies are applied and encouraging production of fact sheets and other publications to share new technologies with stakeholders and managers. Information must be presented straightforwardly, and include details of how to apply each new technology in a field setting. USGS will coordinate this communication across multiple projects to most efficiently demonstrate technologies and convey information to stakeholders and managers. When possible, USGS will communicate information regarding complementary capabilities among multiple control technologies. A long-term goal is to develop field sites (and infrastructure there, as needed) where multiple control technologies can be evaluated over time. As demonstrations of effectiveness of control technologies occur, this project expectedly would include a training program to facilitate implementation of these control technologies.

FY 2012 Actions Undertaken: NA

FY 2013 Actions Proposed:

- Conduct conference calls to determine which projects have products ready to demonstrate, and identify complementary control technologies.
- Arrange site visits for control managers and other partners to observe control technologies being applied at USGS pond facilities.
- Draft and publish fact sheets or similar materials to disseminate to stakeholders in the fight against Asian carp.

Expected end date: Project to continue as long as Asian carp control technologies are developed to ensure conveyance of information in a timely manner.

If not completed after 2013, explain follow-up activities: Continue to produce communication products regarding projects from which new results are obtained, and develop a training program to help managers implement these control technologies.

Expected Milestones:

- March 2013: A list of projects with results to share.

- June 2013: Fact sheets drafted for selected projects.
- Summer 2013: Site visits arranged to see control technologies applied.

Outcomes:

- Quicker technology transfer from laboratory to field application
- Managers better informed about what control technologies are available for use
- Possible implementation of control technologies more targeted toward elimination of Asian carp.

Potential Hurdles:

- Project schedule would depend heavily on progress of projects developing Asian carp controls.

2.5.25 Hydraulic and Water-Quality Evaluation of Asian Carp Habitat in the Upper Illinois River

Lead Agency: USGS

Agency Collaboration: USACE (Rock Island), Illinois DNR, Metropolitan Water Reclamation District of Greater Chicago, USFWS, Southern Illinois University

FY 2013 Funding: $150,000 Base funding.

Project Description: Upstream movement of Asian carp through the Illinois River has been documented through intensive field surveys and contracted commercial fishing by Illinois DNR and USFWS. These efforts have documented distribution of the Asian carp population within the pools of the Illinois River and have identified habitats favorable for Asian carp. Since 2006, upstream expansion of the carp population has stalled in the Marseilles and Dresden Island Pools. Several hypotheses have been proposed for the apparent stalling of Asian carp in this reach of the Illinois River. Sharp contrasts in habitat, flow conditions, water quality, and food supply between these pools and the CAWS may be acting as controlling factors that stall migration. A major objective of this project is to identify the controlling factor(s)—with the possibility of exploiting one or more of these factor(s) to prevent future migration or reduce Asian carp populations.

FY 2013 Actions Proposed: Several techniques will be used to characterize the factors that may be stalling the migration. Acoustic Doppler current profilers (ADCP) will be used to collect detailed velocity data over a range of flows in the main channel and backwater areas of the river and these data will be mapped using the Velocity Mapping Tool (VMT). Multi-parameter water-quality sondes (water temperature, pH, dissolved oxygen, specific conductance, chlorophyll-a, blue-green algae, nitrate, and turbidity) will be deployed at strategic locations (main channel and backwater areas), and existing water-quality data will be reviewed to document water-quality conditions within the river. These data collections will be coordinated with sampling and characterization efforts of other agencies to achieve maximum data collection and analysis.

Plankton sampling data will be used to characterize the available food supply in this reach of the river. Day-to-day movement of Asian carp recorded from telemetered fish (IDNR/USFWS/USACE/Southern Illinois University) will be analyzed with the flow and water-quality data to evaluate fish response to changing flow conditions. ADCP velocity and flow data also will be evaluated to determine optimum locations (channel constrictions, pinch points, backwater areas, etc.) within the river that may be suitable for testing Asian carp control strategies.

Expected end date: Sept. 30, 2015. Data collection will be used to evaluate seasonal movements of Asian carp, variation of Asian carp habitat through the year, and other factors. During the first year, intensive data collection will occur in the Dresden Island and Marseilles Pools. During the second year, a more focused data collection and analysis will be based on results from the first year. Completion of a draft report, peer review, and publication will occur during the third year.

Expected Milestones:

- January 1, 2013: Coordinate existing fish telemetry data with planned deployments for collection of hydraulic and water quality data.
- April 1, 2013-March 31, 2014: Collect detailed hydraulic and water-quality data in Dresden Island and Marseilles pools of the Illinois River.
- April 1, 2014-March 31, 2015: Analyze river conditions that contribute to the apparent control, and refine data collection for evaluation of Asian carp migration in the Illinois River.
- April 1-Sept. 30, 2015: Complete USGS Scientific Investigation Report. (Note: Publication schedule is affected by length of time various reviewers need, which is beyond the control of project personnel.)

Outcomes:

- Documentation of Asian carp life history and habitat at the leading edge of the migration front in the Illinois River
- Evaluation of potential factors controlling migration in the Upper Illinois River and how these factors could be used to control migration in other rivers
- Evaluation of river settings and conditions that could be used to test Asian carp control strategies.

Potential Hurdles:

- Extreme hydrologic conditions may affect data collection and analysis.

2.5.26 Feeding Habits of Asian Carp and Native Planktivores in Newly Invaded River Segment to Inform Chemical Control Strategies

Lead Agency: USGS

Agency Collaboration: Minnesota DNR, Iowa Department of Natural Resources, Illinois DNR, Wisconsin DNR, Missouri Department of Conservation, University of Oklahoma

FY 2013 Funding: $90,000 Base funding.

Project Explanation: Formulation and effective application of microparticles to deliver chemical agents to control Asian carp in the Mississippi River and Great Lakes basins will require accurate knowledge of prey selection for planktivores, including by Asian carp. While generalities of predation are known for some planktivores, very little is understood of whether and how prey selection occurs in river systems, particularly regarding season, water column depth, habitats (channels, backwater, side channels), system trophic status/prey availability, and inter- and intra-specific overlap and variability. This knowledge for rivers containing source populations of Asian carp is of critical importance to determine the most safe and effective (1) size, composition, and buoyancy of piscicide-containing microparticles; and (2) field-application strategies for these piscicides.

This study will be conducted in conjunction with the Movement and Habitat Selection (telemetry) study proposed for Pool 19 of the UMR to determine seasonal habitats and water column positions of Asian carp and other planktivores. The primary energy pathways (e.g., planktonic versus benthic) to Asian carp and native planktivores might also vary temporally and spatially among taxa, depending on availability and preferences for prey. For example, gizzard shad are known to switch from planktonic sources to benthic/detrital sources when zooplankton abundance is low. The extent to which other planktivores, including Asian carp, derive energy via alternative pathways in various seasons, habitats, and systems is unknown. A combination of traditional (e.g., microscopy) and molecular (DNA, fatty acids, and stable isotopes) methods will be used to characterize the seasonal prey ingestion, selection, and general energy pathways of planktivores (i.e., silver carp, bighead carp, gizzard shad, bigmouth buffalo, and unionid mussels) in habitats and water column positions used by telemetered fishes. Ingested prey samples will be collected from the gastrointestinal tracts of Asian carp and native planktivores. Ambient prey will be collected by volumetric nets and whole-water sampling in river and lake habitats including channels, channel borders, side channels, and backwater lakes at the bottom, middle, and surface strata. DNA will be extracted from composite ambient samples (mix of algal, zooplankton, bacteria, and detritus) and gastrointestinal tract contents of planktivores, and will be sequenced using next-generation sequencing technologies. Traditional taxonomic methods to identify and enumerate algae and zooplankton will be used on a subset of ambient samples and gut contents to compare with results from DNA sequencing methods. Stable isotope and fatty acid analyses of gut contents, algae, detritus, zooplankton, benthic invertebrates, and fishes will be used to

determine seasonal and spatial variation and overlap in energy pathways and condition for Asian carp and native planktivores.

FY 2012 Actions Undertaken: NA

FY 2013 Actions Proposed:

- Complete literature review of diets of Asian carp and native planktivores.
- Collect year 1 samples at locations and water column depths determined by telemetry and sonar data (Movement and Habitat Selection Study included in this package).
- Initiate taxonomic identification (genomic and traditional) and size distribution of ambient and ingested prey.
- Initiate fatty acid and stable isotope analyses of food resources and consumers.

Expected end date: September 2015.

If not completed after 2013, explain follow-up activities:

- Chemical analyses including stable isotope, fatty acid, and DNA sequencing will be conducted on 2013 ambient food resources, diet and consumer (Asian carp and native planktivores) samples during winter 2013-2014.
- Preliminary findings from analyses will be presented to researchers and managers at scientific and partner meetings by fall 2014.
- Collect year 2 samples at locations and water column depths determined by telemetry and sonar data (Movement and Habitat Selection Study included in this package).
- Chemical analyses including stable isotope, fatty acid, and DNA sequencing will be conducted on 2014 ambient food resources, diet and consumer (Asian carp and native planktivores) samples during winter 2014-2015.
- Final data analysis, summary, conclusions, and recommendations regarding feeding habits of Asian carp and native planktivores will be (1) presented to scientists and managers at scientific and partner meetings, and (2) incorporated into a manuscript for publication in a scientific peer-review journal by September 2015

Expected Milestones:

- March 2013: Complete literature review and study plan on diets of planktivores, acquire needed permissions and permits, acquire needed supplies and equipment, and initiate hiring.
- November 2013: Complete year 1 sampling in coordination with the telemetry and sonar surveys.
- April 2014: Complete chemical analyses (DNA sequencing, metagenomics, fatty acid, and stable isotopes) of year 1 samples of ambient food resources, diet, and consumers.
- September 2014: Present preliminary findings from analyses to researchers and managers at scientific and partner meetings.

- November 2014: Complete year 2 sampling of ambient food resources, diet, and consumers.
- April 2015: Complete chemical analyses (DNA sequencing, metagenomics, fatty acid, and stable isotopes) of year 2 samples.
- September 2015: Present final findings from analyses to researchers and managers (1) at scientific and partner meetings, and (2) in a manuscript submitted to a peer-review journal.

Outcomes:

- Information on spatial and temporal prey selection by Asian carp and native planktivores that will be used to develop and implement effective and safe control measures for Asian carp at an invasion front.
- Information on major energy pathways and conditions of Asian carp and native planktivores that will inform control efforts by identifying areas and taxa most vulnerable to the effects of Asian carp.

Potential Hurdles:

- Delays in funding allocations, purchasing, or hiring could result in commensurate delays in project actions and associated milestones.
- Adverse environmental conditions such as floods could delay project actions and associated milestones.

2.5.27 Assessing Natural Recruitment Constraints on Asian Carp in River Reaches with Established and Emerging Populations: Implications for Control

Lead Agency: USGS

Agency Collaboration: Minnesota DNR, Iowa DNR, Illinois DNR, Wisconsin Department of Natural Resources, Missouri Department of Conservation, University of Oklahoma

FY 2013 Funding: $225,000 Base funding.

Project Explanation: Asian carp are prone to boom and bust years of recruitment. For example, in 2007, a very large year class of Asian carp was recruited to the population in the La Grange reach of the Illinois River (LTRMP data). However in 2010, Asian carp larvae were briefly ubiquitous in off-channel habitats in the Illinois River, but little recruitment occurred. As well, the upper Illinois River seems to be resistant to population establishment as compared to the lower river. It is not certain what conditions affect annual recruitment or system resistance to Asian carp, but it is reasonable to assume that with a more complete understanding of larval and juvenile behavior, predators, and habitat requirements, we can better devise control strategies that take advantage of recruitment constraints. These recruitment constraints might be the Achilles heel of Asian carp, affecting productivity in systems with established populations and establishment in systems with low abundance.

Habitats of young-of-year Asian carp, especially beyond the short pelagic-drift phase, are little studied, and most reports on the subject are anecdotal. Recent descriptions of the age at which larvae were first found in off-channel habitats suggest that these areas might be important to recruitment. In addition, reports indicating that Asian carp generally thrive in turbid rather than clear-water systems suggest that Asian carp recruitment might be constrained by abundant sight-feeding piscivores in clear, aquatic, macrophyte-dominated systems, and enhanced in turbid, algae-dominated systems. We do not clearly understand how environmental parameters such as depth, presence, and density of terrestrial or aquatic vegetation; current velocity; connectivity to channels; river stage and timing; turbidity; temperature; planktonic or detrital food availability; and predator types and densities affect habitat selection by, and recruitment of, young Asian carp. Such knowledge will provide a basis for developing mechanisms to control this life stage of Asian carp, and thus eventual adult population density. For example, we might determine optimal habitats for young-of-year Asian carp that could then be targeted for control measures, or we might be able to tailor control methods, including toxicants, for use in these habitats. We might also determine if, when, and where predator introductions or habitat enhancement for predators would be viable control measures.

FY 2012 Actions Undertaken: NA

FY 2013 Actions Proposed: In 2013, we will sample larval and juvenile Asian carp and potential Asian carp predators in off-channel and channel habitats of river reaches with established Asian carp populations (e.g., Illinois River La Grange reach, lower Missouri River, and Pool 26 of the Mississippi River), and those habitats with potentially emerging Asian carp populations (e.g., Pool 19 UMR) to determine recruitment success, habitat selection, and potential predators of post-drift larval and juvenile Asian carp. Bighead, silver, and grass carp will be considered in this study. Concurrently, a series of pond or mesocosm studies will occur at USGS research centers (CERC; Columbia, Missouri; and UMESC, La Crosse, Wisconsin) to assess the potential of various fish predators to control larval and juvenile Asian carp under a variety of conditions of turbidity, physical structure (e.g., macrophyte density), and water depth.

- Complete year 1 sampling with block nets and electrofishing in potential nursery areas for post-drift larval and juvenile Asian carp and potential predators at field locations in the Illinois River, Missouri River, and Pool 19 of the UMR.
- Initiate taxonomic identification (genomic and traditional) of juvenile Asian carp and gut contents of potential predators sampled in the field.
- Initiate pond studies at CERC and UMESC to evaluate predator effectiveness under gradients of environmental conditions including predator species and density, water column depth, turbidity, and aquatic vegetation coverage.
- Present preliminary findings from analyses to researchers and managers at scientific and partner meetings.

Expected end date: September 2015.

If not completed after 2013, explain follow-up activities:

- Complete year 2 sampling with block nets and electrofishing in potential nursery areas for post-drift larval and juvenile Asian carp and potential predators at field locations in Illinois River and Pool 19 of the UMR.
- Complete taxonomic identification (genomic and traditional) of juvenile Asian carp and gut contents of potential predators sampled in the field during year 2.
- Complete pond studies to evaluate predator effectiveness under gradients of environmental conditions including predator density, water column depth, turbidity, and aquatic vegetation coverage.
- Present to scientists and managers at scientific and partner meetings the final data analysis, summary, conclusions, and recommendations regarding recruitment success, habitat selection, and potential predators of post-drift larval and juvenile Asian carp.
- Incorporate this information into a manuscript for publication in a scientific peer-review journal by September 2015.

Expected Milestones:

- September 2013: Complete year 1 sampling with block nets and electrofishing in potential nursery areas for post-drift larval and juvenile Asian carp and potential predators at field locations in Illinois River and Pool 19 of the UMR.
- September 2013: Complete first season of pond studies at CERC and UMESC to evaluate predator effectiveness under gradients of environmental conditions including predator density, water column depth, turbidity, and aquatic vegetation coverage.
- April 2014: Complete taxonomic identification (genomic and traditional) of juvenile Asian carp and gut contents of potential predators sampled in the field.
- April 2014: Present preliminary findings from analyses to researchers and managers at scientific and partner meetings.
- September 2014: Complete year 2 sampling with block nets and electrofishing in potential nursery areas for post-drift larval and juvenile Asian carp and potential predators at field locations in Illinois River and Pool 19 of the UMR
- September 2014: Complete pond studies to evaluate predator effectiveness under gradients of environmental conditions including predator density, water column depth, turbidity, and aquatic vegetation coverage.
- April 2015: Complete taxonomic identification (genomic and traditional) of juvenile Asian carp and gut contents of potential predators sampled in the field during year 2.
- September 2015: Present to scientists and managers at scientific and partner meetings the final data analysis, summary, conclusions, and recommendations regarding recruitment success, habitat selection, and potential predators of post-drift larval and juvenile Asian carp. Incorporate this information into a manuscript for publication in a scientific peer-review journal.

Outcomes:

- Information on spatial and temporal habitat selection of post-drift larval and juvenile Asian carp that will be used to develop and implement effective and safe control measures for Asian carp in areas with established populations and at an invasion front.
- Information on Asian carp predator effectiveness under natural and controlled conditions that will be used to develop and implement effective and safe control measures for Asian carp in areas with established populations and at an invasion front.

Potential Hurdles:

- Delays in funding allocations, purchasing, or hiring could result in commensurate delays in project actions and associated milestones.
- Adverse environmental conditions such as drought or floods could delay project actions and associated milestones.

2.6. eDNA Analysis and Refinement

2.6.1 eDNA Program Transition to USFWS (previously eDNA Monitoring of the CAWS)

Lead Agency: USACE

Agency Collaboration: USFWS

FY 2013 Funding: $125,000 GLRI funds.

Project Explanation: eDNA is a genetic surveillance tool used to monitor for presence of bighead and silver carp DNA in the CAWS since 2009. This task encompasses activities necessary to transition to USFWS activities previously led and undertaken by USACE.

FY 2012 Actions Undertaken: From 2010 to 2012, USACE led coordination and execution of eDNA sampling, filtering, and processing. In 2012, USACE continued to coordinate with Illinois DNR and USFWS collection of samples, filtering of the samples at a local USEPA laboratory, and processing of the samples at the USACE-Engineer Research and Development Center (ERDC). USACE and USFWS began efforts to work together to transition leadership of eDNA oversight of sampling, filtering, and processing from USACE to USFWS, aligned with progress of the eDNA calibration study in 2013.

FY 2013 Actions Proposed: Concurrent with opening the USFWS eDNA processing laboratory in Whitney Genetics Lab, La Crosse, Wisconsin, the transition described above is planned to occur from August 2012 to May 2013. USACE has committed to support this effort in terms of technical support, lab validation and inspection, processing of archived samples, and extraction and processing of new samples for cross-checking, as well as ensuring quality assurance (QA)/quality control (QC) compliance. USFWS and USACE eDNA personnel have established a Technical eDNA Work Group to oversee and execute the transition, and have developed a transition plan. Funding is requested to ensure a seamless transition of eDNA methodology from USACE to USFWS, assist in achieving the requested capacity requirement at USFWS, and share lessons learned from the transition from the University of Notre Dame to USACE for eDNA processing in 2009.

Expected Milestones:

- January 2013: Train USFWS lab personnel, and procure lab equipment.
- February 2013: Process blind prepared and archived samples.
- March 2013: Process field samples.
- April 2013: Implement laboratory information management system (LIMS); run additional samples if necessary.
- June 2013: Finalize transition of operations and processing to USFWS.
- Ongoing 2013: Provide technical support and QA/QC to USFWS.

Outcomes/Output:

- USFWS processing of eDNA samples at full capacity as scheduled.

Potential Hurdles:

- Need to repeat analysis of samples (failure of intended outcomes).

2.6.2 USFWS Fisheries Program Capacity for eDNA Sampling and Early Detection

Lead Agency: USFWS

Other Agencies Involved: Illinois DNR, Ohio DNR, Michigan DNR, USACE

FY 2013 Funding: $1,050,000 Total funding ($400,000 base funds and $650,000 GLRI funds).

Project Explanation: USFWS Great Lakes Fish and Wildlife Conservation Offices are uniquely poised to collect samples from around the Great Lakes to be analyzed for eDNA at the La Crosse Fish Health Center. However, no comprehensive, effective, and efficient program currently exists in the Great Lakes to detect incipient invasions. This task will provide USFWS Fish and Wildlife Conservation Office facilities with resources and expertise to conduct integrated, long-term early detection activities. Funding received under this action item will support sample collection around the Great Lakes Basin, and samples will be analyzed for eDNA at the LaCrosse Fish Health Center.

FY 2012 Actions Undertaken: Monitor for eDNA outside the CAWS utilizing a statistically tenable sampling protocol. Additionally, the first mobile eDNA filtering trailer has been completed and is ready for use in FY2013.

FY 2013 Actions Proposed: Expand sampling protocols in southern Lake Michigan, western Lake Erie, and other potential invasion hotspots. Further test and develop mobile eDNA filtering trailers to allow more effective and efficient use of resources.

Expected end date: Unknown—expected to continue until threat of Asian carp range expansion no longer exists.

If not completed after 2013, explain follow-up activities: Sampling will continue beyond FY2013.

Expected Milestones:

- February 2013: Fully developed capacity for implementing an eDNA sampling program at USFWS Great Lakes Fish and Wildlife Conservation Offices.
- June 2013: Implementation of an eDNA draft sampling protocol for other areas of concern, with particular focus on southern Lake Michigan, western Lake Erie, and other potential hotspots.

Outcomes/Output:

- USFWS conservation offices conducting eDNA sampling in areas of concern, with emphasis on southern Lake Michigan, western Lake Erie, and other potential invasion hotspots.

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.

2.6.3 eDNA Calibration and Probabilistic Model

Lead Agency: USACE

Agency Collaboration: USGS, USFWS

FY 2013 Funding: $1,300,000 GLRI funds.

Project Explanation: The project will develop the knowledge and understanding needed to interpret eDNA monitoring results so that this information can be used effectively to make risk management decisions regarding the CAWS and other water bodies. To date, efforts to understand what positive eDNA monitoring results imply about presence or absence of Asian carp in a water body have been frustrated by uncertainty about alternative sources and vectors of eDNA. A model for statistical inference from eDNA monitoring results will be developed to quantify uncertainty about which sources and vectors of Asian carp DNA may be causing positive detections in the CAWS (i.e., estimate the probability that any potential source and vector of eDNA in the CAWS is the actual source and vector of eDNA in monitoring samples testing positive for eDNA). The model will be implemented to derive the probability that Asian carp are present in the CAWS given the historical sequence of Asian Carp MRRWG monitoring results (positive and negative) and other information about the site and the water samples. Such information is a prerequisite for making risk-based invasive species management decisions. The model can also be used for value of information studies to assess the relative benefits of reducing sources of uncertainty. These results will enable resource managers to employ an analytical approach to prioritizing data collection and research needs. The proposed model is a long-term investment in actively managing the threat of Asian carp invasion in the Great Lakes. In the future, natural resource managers will be able to continuously update conclusions from the CAWS model as results from Asian carp monitoring and other relevant research efforts emerge, and as new information about environmental conditions and eDNA sources or vectors in the CAWS becomes available. Used in this way, the model could provide a continuous, real time "risk meter," enabling natural resource managers to use future eDNA monitoring results (or information about changes in the system) to periodically update their assessment of whether or not Asian carp are present in the CAWS. While the proposed model will be developed and parameterized specifically for the CAWS, this model is expected to be transferable to other water bodies along the Asian carp invasion front.

FY 2013 Actions Proposed: The probabilistic model will be complete by October 2014. The benefits of such a model are:

- A platform to make statistical inferences based on monitoring data, including estimates of:
  - The probability that a live fish is present given the historical sequence of monitoring results.
  - The probability that a potential source of eDNA is the source of DNA detected in a monitoring result.
- A platform for evaluating future research plans:
  - What type of eDNA sampling should occur?
  - What locations should be sampled and at what time intervals?
  - What is the value of information (i.e., reducing sources of uncertainty)?
  - Which experiments or tests are worth conducting?

Expected Milestones:

- August 2013: Draft problem formulation report—including a proposed graphical model and preliminary plans for parameterization of network nodes.
- October 2013: Draft problem formulation report revised in response to comments. Summary of comments and ECALS responses to comments on the problem formulation report.
- May 2014: Probabilistic model fully parameterized. Draft report on parameterization of the graphical model. Begin analysis of historical monitoring results.
- September 2014: Draft final report describing the probabilistic model and summarizing the analysis of historical monitoring results.

Outcomes/Output:

- A model for statistical inference from eDNA monitoring results that will:
  - Estimate the probability that each potential source of eDNA in a water body is, in fact, an actual source of eDNA in that water body.
  - Derive the probability that an Asian carp population is present in that water body above the monitoring location.
- A technical report documenting development and structure of the graphical model, methods used to parameterize each network node, and results of model implementation in the CAWS.

Potential Hurdles:

- Funding delays may impact expected milestones.

2.6.4 USFWS Midwest Region Fisheries Program Capacity for eDNA Sample Processing

Lead Agency: USFWS

Agency Collaboration: USACE, USGS, state agencies

FY 2013 Funding: $1,400,000 Total funding ($500,000 GLRI funds and $900,000 Base funds).

Project Explanation: This project will transition the work of processing eDNA samples from USACE to USFWS and begin eDNA sample analysis at La Crosse Fish Health Center. The additional funding will enable processing of 120 samples per week from the CAWS and other Great Lakes hotspots.

FY 2012 Actions Undertaken: Construction of the new eDNA lab began in July 2012, and was scheduled for completion on time in November 2012. Advertisement and selection of staff were completed. Newly hired staff engaged USACE staff at their ERDC lab to begin transferring operations to USFWS. Archive samples were collected from the CAWS for testing once the lab is up and running. A transition timeline was developed. Additional equipment purchases were completed.

FY 2013 Actions Proposed: Construction should be completed with the final walkthrough scheduled for mid-November 2012. The transition plan from USACE to the USFWS will be implemented. USFWS will work toward assuming a lead role for processing eDNA samples from the CAWS, and processing additional samples pending results of calibration and capacity development. The current Quality Assurance Plan (QAPP) is under review and will dictate the number of samples analyzed per week.

Expected end date: Project will be ongoing to meet sample processing needs of the MRRWG for the CAWS, and needs of other partners as capacity and calibration allow.

If not completed after 2013, explain follow-up activities: USFWS will continue to process eDNA samples at the La Crosse Fish Health Center.

Expected Milestones:

- November 2012: Laboratory completion and final walk-through.
- January 2013: Complete transition of eDNA sample processing from USACE to USFWS, and formal assumption by USFWS as the lead for Asian carp eDNA sample processing.
- March 2013: Ribbon cutting and formal opening of eDNA Lab.

Outcomes/Output:

- USFWS eDNA sample processing and analysis at a rate of 120 samples per week at La Crosse Fish Health Center.

Potential Hurdles:

- Possible uncertainty in eDNA calibration outcomes.
- Transition process to USFWS from USACE.

2.6.5 Removing Uncertainty of eDNA Monitoring for Invasive Species in the Upper Mississippi River Basin

Lead Agency: USGS

Agencies Involved: Minnesota DNR, Wisconsin DNR, University of Minnesota, University of Wisconsin.

FY 2013 Funding: $60,000 Base funding.

Project Description: Asian carp have been reported in the UMR as far north as St. Paul, MN, but have not been reported in many of the large UMR tributaries. Tributaries like the Wisconsin River and St. Croix River have close connections to the Fox and Bios Rivers, respectively, which feed into the Great Lakes. Unfortunately, other similar linkages between watersheds have not been identified. Uncertainty hinders acceptance of using eDNA to monitor invasive species. Mitochondrial DNA (mtDNA has been used to monitor for possible presence of Asian carp, bighead carp, and silver carp throughout the CSSC, Des Plaines River, near-shore waters of Lake Michigan, and the UMR. This technique is potentially useful for early detection of Asian carp DNA and identification of distribution patterns of DNA in the waterway, because it can presumably detect presence of DNA in waters where only a few fish may exist. A positive eDNA sample indicates presence of Asian carp DNA and possible presence of live fish, allowing resource managers to implement an appropriate management strategy. This molecular monitoring technique has focused on the CSSC, which has a very low diversity of fish species compared with the waters of the UMR and its tributaries. Uncertainty derives from dependence of this technology on the specificity of markers used in the assay, and the fact that few fishes found in these waters have sufficient DNA sequence information to compare the eDNA markers. The number of species with pertinent sequence information in public genetic databases is continually expanding, but with little urgency evident for addressing the uncertainty of eDNA assays. Therefore, a systematic sequencing of DNA (specifically mtDNA because most eDNA markers target mtDNA) from fin-clips of native fishes found in the UMR and its Iowa, Minnesota, and Wisconsin tributaries will help minimize uncertainty surrounding eDNA. This approach will not only provide valuable sequence information to compare with eDNA markers for invasive species, but also provide sequence information that can be used to develop markers for monitoring these native species. This project will remove much of the uncertainty around eDNA monitoring of Asian carp and provide resource managers with additional information that can be used to develop surveillance programs for native fish populations, including imperiled species.

FY 2010-11 Actions Undertaken: None

FY 2012 Actions Undertaken: None

FY 2013 Actions Proposed:

- Initiate contact with state natural resource agencies and universities to assist in collection of native fishes.
- Collect and extract DNA from tissues of native fishes.
- Sequence mtDNA from native fishes using Next-Generation Sequencing.
- Develop searchable library of mtDNA sequences from native fishes.
- Deposit sequence information into GenBank.

Expected end date: September 2013.

If not completed after 2013, explain follow-up activities: This project should be completed in FY 2013.

Expected Milestones:

- March 2013: Develop collaborations with state natural resource agencies and universities.
- April 2013: Initiate sampling / begin mitochondrial sequencing of native fishes.
- September 2013: Deposit mtDNA sequences into GenBank and compare current markers to mtDNA sequences.

Outcomes:

- Sequencing the mitochondrial DNA of native fishes will provide the sequence information needed to evaluate whether native fish DNA could be amplified by the markers used to detect the DNA of silver carp or bighead carp in environmental samples
- This project will assess whether the DNA markers used to detect silver carp or bighead carp are capable of amplifying the DNA of native fishes endemic to the UMR.

Potential Hurdles:

- Collecting species that are rare. This can be overcome by using preserved museum specimens.
- Establishing a laboratory that can process a large volume of eDNA samples.

2.6.6 Environmental DNA Surveillance – Applied Early Detection

Lead Agency: University of Notre Dame/USFWS

Agency Collaboration: Great Lakes States

FY 2013 Funding: No additional FY 2013 funds necessary.

Project Explanation: Using Asian carp as an initial case study, and in partnership with state and federal agencies, a demonstration surveillance program will be implemented within high-risk areas of multiple tributaries to multiple Great Lakes. In subsequent years, surveillance efforts will extend to additional species and invasion hotspots (e.g., ports, ballast water discharge areas) associated with other invasion pathways (e.g., maritime shipping, trade in live organisms). The most important outcome will be early detection of incipient invasions, which will guide rapid management responses to reduce establishment and spread of Asian carp and other invasive species in the Great Lakes.

FY 2012 Actions:

- Sample four rivers identified as capable of supporting reproductively viable populations of Asian carp.
- Process water sampling and tests for bighead and silver carp (20,000 PCR reactions).
- Test sampling for black carp and grass carp (5,000 PCR reactions).
- Develop and test markers for four additional target species.
- Conduct detection threshold mesocosm studies for four additional target species.
- Sample 40 of the remaining water bodies throughout Chicago.
- Process 1,200 samples and test for presence of goldfish and other targeted species.
- Develop an eDNA protocols manual to facilitate transitioning of technology to other agencies—to include details of water collection procedures, QA/QC protocols, laboratory techniques, and staff training.

Expected Milestones: See Project Timeline and Milestones Table below. Note that the ends of the years of the project will coincide, respectively, with the ends of fiscal years 2011, 2012, and 2013.

Project Timeline & Milestones	Year		
	1	2	3
Objective 1: Asian carp surveillance in the Great Lakes			
1. Identify priority rivers with partners and Asian carp experts	x		
2. Sampling of 14 rivers identified as capable of supporting reproductively viable populations of Asian carps Milestones: Six rivers surveyed (yr 1), Four additional rivers surveyed (yrs 2 & 3)	x	x	x
3. Process water samples and test for presence of bighead and silver carp Milestones: 30,000 PCR reactions (yr 1.), 20,000 PCR reactions (yr.2), 20,000 PCR reactions (yr 3)	x	x	x
4. Test samples for black carp and grass carp Milestones: 5,000 PCR reactions (yr.2), 7,500 PCR reactions (yr.3)		x	x
5. Sampling of Lake Michigan and Lake Erie using large volume centrifuge trials			x
Objective 2: ***Marker development and detection capability for priority invasive species***			
1. Identify priority species for molecular marker development	x		
2. Development of grass carp, black carp, goldfish, and snakehead markers	x		
3. Development and testing of markers for eight additional target species Milestones: Four additional markers produced each year (yrs. 2 & 3)		x	x
4. Detection threshold mesocosm studies for target species Milestones: Four detection thresholds determined each year (yrs. 1, 2, & 3)	x	x	x
Objective 3: ***Intentional release of species in trade: delimitation of Chicago as a case study***			
1. Identify and sample ponds, lakes, harbors, and lagoons with reported Asian carp captures	x		
2. Sample and process priority ponds in Chicago for presence of Asian carps	x		
3. Sample remaining water bodies throughout Chicago Milestones: 40 lakes sampled each year		x	x
4. Process samples and test for presence of goldfish and other targeted species Milestones: 1,200 PCR reaction in each year (yrs. 2 and 3)		x	x
Objective 4: Development of eDNA surveillance program for the Great Lakes			
1. Surveillance of Asian carps meeting with USFWS, DFO Canada, USGS, and other key persons.	x		
2. On river assessment and consultation for Asian carp spawning habitat of rivers samples as part of Objective 1	x		
3. Biannual reports to all primary federal contacts and key personal on sampling effort and results Milestones: One report December (yr. 1.), June, December reports (yrs 2 &3).	x	x	x
4. Development of an eDNA protocols manual to facilitate transitioning technology to other agencies, which includes detailing water collection procedures, QAQC protocols, laboratory techniques, and staff training. Milestones: Interim reports provided in December reports. Final report May 2013.		x	x
5. Development of an eDNA sampling plan for high risk port facilities most likely to receive new invasive species via maritime shipping pathway. Interim report December 2012, Final report May 2013.			x

Outcomes/Output:

- Demonstration of the effectiveness of eDNA surveillance by evaluating presence, absence, and extent of Asian carp in 14 rivers likely capable of supporting reproductively viable populations that could enter the Great Lakes.
- Development of molecular markers for other invasive species and screening of their eDNA in samples previously collected, and at additional high-risk sites (e.g., ports, ballast water discharge sites), as resources allow.
- Assessment of the threat of accidental and deliberate release of Asian carp and other species (e.g., northern snakehead) from the trade pathway, using Chicago area lakes, ponds, and lagoons as an initial test case.

- In collaboration with partners, transfer of eDNA technology and surveillance program to willing agencies for early detection of species to prevent and slow spread of biological invasions to the Great Lakes.

Potential Hurdles:

- Possible issues of sampling logistics (e.g., access, weather)
- Possible uncertainties in genetic marker development outcomes.

2.6.7 eDNA Instructional Video Development

Lead Agency: USFWS

Other Agencies Involved: ACRCC Agencies involved in eDNA sampling

FY 2013 Funding: $10,000 GLRI funds.

Project Description: eDNA is an emerging scientific process increasingly used by the ACRCC. To help the public and the media better understand what eDNA is, how eDNA sampling and processing works, and to what extent eDNA results impact ACRCC management decisions, USFWS would like to enhance eDNA outreach through creation of a short eDNA video. This project is timely, with the opening of the Service's new eDNA facility during fall 2012 in La Crosse, Wisconsin.

FY 2012 Actions Undertaken: Template not in place in FY 2012. USFWS developed the concept and began work composing the script and recording and editing video of eDNA sampling.

FY 2013 Actions Proposed: Complete creation of an educational eDNA video that would be available to the public on AsianCarp.us via YouTube. This project will help the ACRCC enhance its multimedia outreach tools.

Expected end date: June 30, 2013.

Expected Milestones:

- May 2013: Complete collection of video footage.
- June 2013: Release final video to agencies.

Outcomes:

- Instructional video for agency use for eDNA sample collection procedures.

Potential Hurdles: None.

2.6.8 Correlating Asian Carp eDNA or Microbial Tracking with Telemetry Data in the Wabash River

Lead Agency: USGS (UMESC)

Other Agencies Involved: USFWS La Crosse Fish Health Center, Purdue University

FY 2013 Funding: $80,000 Base funding.

Project Explanation: Purdue University emplaced a telemetry monitoring system for Asian carp, primarily silver carp, in the Wabash River, Indiana. Presently, about 200 tagged silver carp are in the river. Purdue has identified probable spawning locations based both on fish movement and egg capture, with work continuing this summer to monitor fish movement.

The project would collect water samples downstream of potential spawning locations before, during, and after periods of fish movement and probable spawning activity. Those water samples would be processed using new eDNA markers (short and long markers) using quantitative PCR—this would allow determination of how recently a detection occurred (>response to the long marker means the fish was there recently, >response to the short marker means the fish was there some time ago), and compare this to movement of tagged fish in the area. It would also allow correlation of changes in DNA response with fish movement and possible spawning activity—detecting a spike in DNA response correlated with a spike in egg collections would correlate with spawning activity. Correlating eDNA detection with fish movement and/or spawning activity would dramatically increase understanding of the meaning of an eDNA detection and how this might be applied in a management context.

FY 2013 Actions Proposed:

- Establish collaboration and agreement with Purdue University.
- Provide training to Purdue on proper procedures for collecting and processing eDNA samples.
- Initiate studies linking Asian carp movement, spawning activity, and abundance with eDNA and microbial source tracking in the Wabash River.
- Initiate final report.

Expected end date: December 2013.

Expected Milestones:

- February 2013: Develop collaboration with Purdue University.
- April 2013: Train Purdue staff on how to collect eDNA samples.
- April 2013: Initiate sampling correlated with fish telemetry monitoring.
- December 2013: Complete sampling, process collected samples using current Asian carp and Asian carp-associated microbial markers, and issue final report correlating fish movement (as monitored by telemetry) with eDNA detection.

Outcomes:

- A field evaluation of the correlation between presence/movement of Asian carp at/near eDNA sampling locations and detection of the eDNA of Asian carp

Potential Hurdles: None.

2.7. Enforcement and Outreach Activities

2.7.1 Outreach to Northeast Illinois' Bait Shops

Lead Agency: Illinois DNR

Agency Collaboration: University of Notre Dame

FY 2013 Funding: No additional GLRI funds needed (state funded).

Project Explanation: Investigation of potential pathway of ANS through bait industry

- **FY 2010 Actions Undertaken:** Sampling by Illinois DNR at 52 Chicago-area bait shops in nine Illinois counties during February and March 2010, and during summer 2010. Visual inspections were completed, and water samples were collected for eDNA analysis.
- Visitation of bait shops during winter 2010.
- Visitation of bait shops during summer 2010.
- Detection of no visual evidence of Asian carp in bait shops.
- Report from Notre Dame 2011 showing no positive DNA results from any of the 52 Chicago-area bait shops in the nine counties.
- Responses to questionnaire indicating that no bait shops collect bait from the wild, and that most purchase bait from one of three regional minnow suppliers.

FY 2012 Actions Proposed:

- A relatively affordable study of an industry that can bypass the majority of efforts against Asian carp, and can screen for multiple species with a single water grab.
- Provision of education opportunities for individuals at the bait shop and wholesaler.
- With 2010 and 2011 results in mind, minimal examination during 2012 within the Chicago bait trade, and possible extension beyond the borders to wholesalers outside of state boundaries.

Expected Milestones:

- Summer 2012: Initiate follow-up study to confirm results, broaden surveillance, and take region-wide approach, possibly looking at wholesalers instead of end suppliers.

Outcomes/Output:

- Wholesalers into Great Lakes states will be identified as Asian carp-free or as posing some level of risk.

Potential Hurdles:

- Possible incompatibilities of seasonal bait trade with test dates.
- Possible lack of cooperation by out-of-state wholesalers.
- Unknown level of illegal bait suppliers.
- Possible difficulty of detection in rotating bait stocks.

2.7.2 Increased Lacey Act Enforcement of Illegal Transport of Injurious Wildlife

Lead Agency: USFWS

Agency Collaboration: State agencies.

FY 2013 Funding: $400,000 GLRI funds.

Project Explanation: Although transfer of AIS is currently illegal, stricter enforcement is necessary to mitigate the risk of transfer. Specific activities cannot be revealed, because disclosing those details will jeopardize law enforcement investigations underway.

FY 2012 Actions Undertaken: USFWS, Office of Law Enforcement expanded surveillance and enforcement of illegal transportation of federally listed invasive species. USFWS wildlife inspectors increased their efforts to target and interdict federally listed invasive species at border locations. In addition, USFWS has acquired a van that can be utilized to remotely scan containers and vehicles, and that can be deployed at all international ports of entry. This van will allow USFWS wildlife inspectors to be more effective and efficient in their search for invasive species. In addition, the Office of Law Enforcement is working with state partners to control the spread of invasive species (including Asian carp) through investigations here in the United States. Specifics are considered law enforcement sensitive.

FY 2013 Actions Proposed: Investigative and inspection work will expand in 2013. Specifics are considered law enforcement sensitive.

Expected end date: Unknown—expected to continue until threat of Asian carp range expansion no longer exists.

If not completed after 2013, explain follow-up activities: Investigative and inspection work will continue to expand beyond 2013. Specifics are considered law enforcement sensitive.

Expected Milestones: None—specifics are considered law enforcement sensitive.

Outcomes/Output:

- Prosecutions of individuals involved in illegally importing or transporting federally listed injurious species in interstate commerce.

Potential Hurdles: None.

2.7.3 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; Department of Fisheries and Oceans–Canada/Canadian enforcement, as necessary; Illinois Natural History Survey, and Illinois/Indiana Sea Grant

FY 2013 Funding: $300,000 GLRI funds.

Project Explanation: While transport of live bighead and silver carp is listed under the Lacey Act as illegal, many local communities and/or markets continue to buy and sell live Asian carp for consumption and/or release into the wild according to ethnic customs or traditions. Illinois DNR proposes to increase officer presence and friendly enforcement activities related to Asian carp in a manner similar to the bait shops visits. This has proven successful in promoting open dialogue among 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 present or likely to have been present. These activities will focus on markets known for preferring live fish for release or food preparation.

Illinois 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 conducted to ensure compliance with both the federal Lacey Act and Illinois Injurious Species Rule. Conservation Police officers (CPO) 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:

- At least four investigations of live fish in markets per year, regionally.
- Coordinated outreach and education for best management practices and regulations.
- Development of techniques to share information across language/cultural barriers.
- Increased surveillance of live fish haulers to prevent spread of ANS, specifically live Asian carp.
- Development of recommendations for policy or regulatory changes to address any identified gaps in control or management of Asian carp and of other ANS.

FY 2012 Actions Undertaken: Illinois DNR staff and CPOs performed education and outreach activities, as well as on-site enforcement through informal site visits at fish processors, fish markets, and retail food establishments. In addition, import and export audits and inspections

were conducted to ensure compliance with both the federal Lacey Act and Illinois Injurious Species Rule.

Unintentional contamination has been suspected in other ANS; thus fish transportation and importation were also investigated. Increased officer presence, education, and communication have increased our understanding of this practice. The following activities occurred:

- Investigations of live fish in markets, regionally.
- Coordinated outreach and education for best management practices and regulations.
- Initiation of interactions with local businesses to develop techniques to share across language/cultural barriers.
- Increased surveillance of live fish haulers.
- Evaluation of live grass carp sales in Chicago area and clarification of rules that now will permit only live triploid grass carp to be sold as food (fish are dispatched upon sale).

FY 2013 Actions Proposed:

In 2013, Illinois DNR will continue efforts started in 2012 throughout the greater Chicago Area, and will 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 jurisdictions.

Expected Milestones:

- Develop outreach and interpretive materials for businesses and consumers for awareness.
- Increase enforcement and establish expectations regarding live fish sales in Illinois.
- Increase coordination with City of Chicago and USFWS regarding these issues.

Outcomes:

- Develop outreach and interpretive materials for businesses and consumers for awareness.
- Increase enforcement and establish expectations regarding live fish sales in Illinois.
- Increase coordination with multijurisdictional and regional fish hauling and movement of fish.
- Increase awareness and education by December 2012, and then build upon this in 2013 to ensure compliance.
- Decrease or eliminate any illicit transportation of Asian carp within or across Illinois.
- Educate law enforcement not regularly involved with resource conservation regarding Asian carp issues, further increase ability to stop illicit ANS movement, and enforce regulations.

Potential Hurdles:

Difficult to inspect non-registered locations or black market dealers.

2.7.4 Increased Web Outreach

Lead Agency: USFWS

Agency Collaboration: All contributing members of ACRCC

FY 2013 Funding: $50,000 GLRI funds.

Project Explanation: Ability to provide information in a timely and accessible format is a critical component in ACRCC's stakeholder participation efforts. Ongoing maintenance and continued expansion of AsianCarp.us as both a window into the ACRCC actions and reliable source of information on Asian carp requires additional resourcing support.

FY 2012 Actions Undertaken: As the site administrator, USFWS continued to provide staff support to maintain and enhance the website in 2012. To further increase awareness about the website and ACRCC actions, USFWS expanded into new media. Creation of an ACRCC Flickr site provided a site to which the media or public could download high-resolution images of ACRCC activities. The website was also modified to interface with YouTube videos, such as the USFWS-produced *How to Identify and Asian Carp* video, as well as GLFC's Asian carp b-roll video archive.

FY 2013 Actions Proposed: AsianCarp.us will continue to be the ACRCC's central platform for public outreach and education reaching thousands of people each month from over 80 countries. As the site administrator, USFWS will continue to maintain and develop the website, working toward increased visitation.

Expected end date: Unknown—expected to continue until threat of Asian carp range expansion no longer exists.

If not completed after 2013, explain follow-up activities: The website has become a trusted source of information for the public and the media. A valuable outreach tool, it will likely be needed beyond 2013 as central point of information for stakeholders, project partners, and the public.

Expected Milestones: None.

Outcomes:

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

Potential Hurdles: None.

2.7.5 Great Lakes Sea Grant Network Education and Outreach

Lead Agency: NOAA through the Sea Grant Great Lakes Network

FY 2013 Funding: No additional funding needed.

Project Explanation: The Great Lakes Sea Grant Network (GLSGN) includes the seven Sea Grant programs from the States of Minnesota, Wisconsin, Indiana-Illinois, Ohio, Michigan, Pennsylvania, and New York. These programs are geographically positioned to provide local outreach and education on Asian carp, and to address regional response and control issues at various public forums in their individual states. These state programs will work with and advise the ACRCC, and provide advice in order to (1) develop additional educational materials, (2) develop productive partnerships, and (3) conduct education and outreach within their individual states. To perform this function, the programs require funding for material development, staff time, and travel expenses. Having Sea Grant perform these needed services and functions locally, within each state, is more efficient, effective, and economical.

GLSGN has the organizational experience and a plan for the timely and successful achievement of this campaign's goals and objectives, including concrete, measureable activities. Collaboration will involve quarterly meetings and conference calls to ensure that project objectives are met. A regional communication and education plan will be developed. Partners will play important roles by assisting with coordination, providing advice and expertise, leveraging resources, and assisting in implementation. NOAA will contact the lead investigators on related GLRI-funded or other sponsored projects to identify points of synergy in order to leverage resources, expertise, and reach of the projects to meet mutual goals.

FY 2012 and 2013 Actions Proposed: The GLSGN will respond to opportunities and requests for education and outreach on Asian carp and regional control efforts within each of the eight Great Lakes states. Target audiences may include anglers, charter captains, teachers and students, the general public, elected officials, resource managers, decision makers, marina operators, boaters, port directors, coastal county commissioners and mayors, and many partner or collaborating organizations including The Nature Conservancy, DNRs, USEPA, USGS, GLFC, the International Joint Commission, and others.

Expected Milestones:

- In cooperation with ACRCC and its Communication Working Group, identification of: (1) a list of already developed Asian carp outreach materials, (2) gap analysis, and (3) additional materials to be developed
- Participation in development of materials
- As needed and requested, participation of Sea Grant Education and Outreach and Extension staff in conducting and contributing to local/state outreach regarding Asian carp.

Outcomes/Output:

- Specific materials to be developed and specific activities regarding education and outreach on Asian carp to be determined as needed in cooperation with stakeholders
- Expansion of existing GLRI AIS efforts.

Potential Hurdles:

- Possible limitations of knowledge of Asian carp distribution and establishment
- Possible lack of education materials
- Misinformation
- Possible conflicts regarding ecosystem services (e.g., Asian carp marketing vs. management/control).

2.7.9 Ecological Separation: Public Awareness and Education

Lead Agency: John G. Shedd Aquarium

FY 2013 Funding: $130,000 GLRI funds ($195,000 total project cost).

Project Explanation: As the USACE develops its options for ecological separation of the Chicago Area Waterway System, there is a great need to increase the public's capacity to understand the associated issues of this complex effort. As part of its Great Lakes Initiative, The John G. Shedd (Shedd) Aquarium proposes a three-pronged approach to expand this capacity throughout the Great Lakes basin in 2013, in preparation for the release of the USACE's findings and the subsequent public discussion. This approach includes: (1) creation of a collaborative network of Great Lakes learning centers, (2) production of a media product that can be regionally customized, and (3) launch of a basin-wide Science, Technology, Engineering, and Math (STEM) curriculum initiative based on the principles driving the USACE's work.

FY 2012 Actions Undertaken: NA

FY 2013 Actions Proposed: The Shedd Aquarium will include the following three initiatives as part of the overall Public Awareness and Education Campaign as funding allows: (1) creation of a Great Lakes Learning Network, (2) the production of a public awareness video suite, and (3) STEM Curriculum Development.

<u>Great Lakes Learning Centers Network</u>

Shedd Aquarium plans to host a three-day meeting with senior staff from six to eight "Great Lakes learning centers" (i.e., prominent organizations with Great Lakes research and/or public awareness programs already in place). The learning centers represent a diversity of cities around the basin, including Canada. They include Great Lakes Aquarium (Duluth), Discovery World (Milwaukee), Detroit Zoo, Toronto Zoo, Great Lakes Science Center (Cleveland), Seneca Park Zoo (Rochester) and Aquarium du Quebec (Quebec City). The purpose of the meeting is to establish a

collaborative community among these Great Lakes learning centers for the purpose of basin-wide information sharing and public outreach.

The primary focus of the 2013 meeting is to formalize the network. The Shedd Aquarium will propose that the first joint project be based on building public understanding of ecological separation. The goal is for the network to assist us with message creation, regional customization, and distribution of the proposed video. A portion of the 2013 meeting will be dedicated to learning more about ecological separation, including information conveyed by guest speakers.

Public Awareness Video Suite

In February 2013, Shedd Aquarium began producing a suite of customizable public awareness videos for use by key stakeholders around the Great Lakes basin. The content of the videos will be informed by the learning center network, as well as issue experts. The videos will give the end user the unique opportunity to address ecological separation in a way that is relevant to his/her local community. Phase 1 of the project will provide a comprehensive view of the issues surrounding ecological separation. Phase 2, slated for 2014, will provide information on potential solutions. The network will reconvene in early spring 2013 to focus on finalizing the video and plans for basin-wide distribution.

STEM Curriculum Development

During the network meeting, the education representative from each learning center will participate in a break-out session designed to outline a basin-wide STEM curriculum appropriate for grades 6-12. This curriculum will align with the most current version of the Next Generation Science Standards to provide case studies and problem-based learning to students. Using promising practices in science education, including science inquiry and project/problem-based learning techniques, the curriculum will:

- Introduce students to the current and potential future effects of invasive species in the Great Lakes by taking the perspective of relevant stakeholder groups (shipping, recreation, government, etc.)
- Provide students access to authentic scientific data related to water quality and genetic sampling of Asian carp
- Pose an engineering design challenge, such as that faced by the USACE, to address ecological separation
- Enable students to present their design solutions to real-world experts for comment and review.

Depending on the needs and resources of each learning center, this curriculum can be customized to connect to state and local standards, local expertise, and unique assets. It will be made available in both physical and digital formats to ensure widespread usability across classrooms with different accessibility needs. After the network meeting, development of the curriculum will

begin with formative input sessions with teacher and student advisors. The advisors will also provide critical review as the curriculum is developed and produced. The curriculum will be promoted and launched across the basin in fall 2013.

Expected Milestones:

- January 2013: 3-day meeting with Senior Staff from around the Great Lakes
- Spring 2013: Network meeting
- Fall 2013: Launching of STEM Curriculum across the Great Lakes Basin.

Potential Hurdles: None.

2.8. Other Asian Carp Support Activities

Lead Agency: USEPA

FY 2013 Funding: $2,650,000 GLRI funds ($340,000 – CEQ for Asian carp program support; $400,000 – USFWS [$150,000 for contractor support, and $400,000 for emergent technology development]; $1,060,000 – USACE, and $700,000 – USGS for emergent technology development).

Project Explanation: Support for Great Lakes National Program Office, CEQ, 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 Framework item. These include emergency funding to support rapid response barrier defense; 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; funding of emergent technologies that can control, eradicate, or suppress fish populations; development and deployment of training and exercises throughout the basin to enhance agencies' rapid response capabilities; continued support of the 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.

FY 2012 Actions Undertaken: USEPA continued to work closely with its Asian carp stakeholder partners to mitigate the effects Asian carp may have on local ecosystems and to decrease potential for the species to spread to new waterways. With GLRI funding, USEPA supported ACRCC activities and worked closely with CEQ. USEPA provided support for the following Asian carp-related activities:

- Compilation and refinement of the FY2012 Asian Carp Control Strategy Framework
- Development and delivery of rapid-response training courses and exercises for Great Lakes agencies
- Contractor support to provide technical expertise and services
- Public meetings and outreach activities to keep the public aware and engaged in the control process
- Expansion of the monitoring and rapid response support program to allow for increased eDNA testing and for rapid response activities by USFWS, Illinois DNR, USGS, and other ACRCC partners
- Facilitation of research and development regarding formation of toxicant oral delivery platforms for Asian carp and of additional field studies to test chemical attractants by USGS
- Procurement of additional detection equipment to accelerate calibration studies and provide additional tools for field detections and quantification surveys of both bighead and silver carp

- Additional funding to accelerate development of specialized Paupier nets and purse seines
- Funding to enhance Lacey Act enforcement activities by developing outreach and training tools for increased vigilance and interdiction of illegal live shipments of Asian carp
- Acceleration of GLMRIS efforts for waterway separation and support for increasing USACE capacity to meet the congressional mandates of completion.
- Funding to allow continuation of engagement of White House-appointed staff in these efforts.

FY 2013 Actions Proposed: Funding will be used for Asian carp efforts to include the following:

- Federal Executive Committee and ACRCC support
- Contractor support
- Funding of ecosystem separation activities
- Development and field testing of control technologies
- Expansion of removal activities regarding Asian carp below the barriers
- Continued commercial harvest activities throughout the year
- Development and deployment of a CAWS watercraft-mounted repellent system
- Closure of medium risk pathways for Asian carp across Great Lakes basin identified under the GLMRIS Other Pathways report
- Multi-agency assessment, monitoring, and surveillance efforts in the Great Lakes basin
- CEQ personnel support.

Expected Milestones: None.

Potential Hurdles: None.