

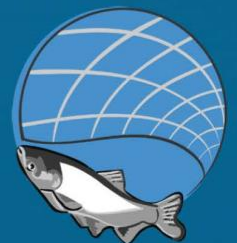
2022

INVASIVE CARP

ACTION PLAN



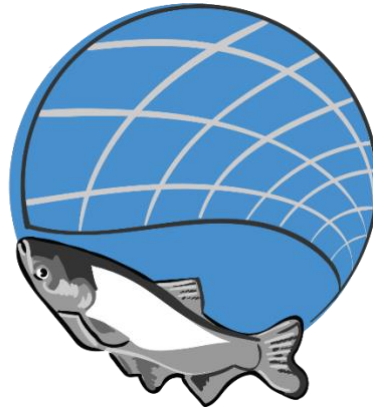
INVASIVE CARP REGIONAL
COORDINATING COMMITTEE



Invasive Carp Action Plan for Fiscal Year 2022

March 2022

Invasive Carp Regional Coordinating Committee



Contributing Members:

Illinois Department of Natural Resources
Illinois Environmental Protection Agency
Indiana Department of Natural Resources
Michigan Department of Natural Resources
Michigan Department of Environment, Great Lakes
& Energy
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
Grand Traverse Band of Ottawa and Chippewa
Indians
Ontario Ministry of Northern Development, Mines,
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Québec Ministère de la Forêt, de la Faune et des
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U.S. Geological Survey
National Park Service
Fisheries and Oceans Canada
City of Chicago
Great Lakes Fishery Commission
Great Lakes Commission
Metropolitan Water Reclamation District of
Greater Chicago

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EXECUTIVE SUMMARY

The Invasive Carp Regional Coordinating Committee’s (ICRCC) Fiscal Year (FY) 2022 Invasive Carp Action Plan (Action Plan) outlines a comprehensive and science-based invasive carp management strategy. The mission of the ICRCC and the intent of this Action Plan is to prevent the introduction and establishment of invasive carp in the Great Lakes. The Action Plan serves as a foundation for the work of the ICRCC partnership — a collaboration of 28 U.S. and Canadian federal, state, provincial, tribal, regional, and local agencies.

Projects in the 2022 Action Plan are supported by a combination of \$262,980,344 in agency funding and \$21,000,000 in Great Lakes Restoration Initiative funding provided through FY 2022 appropriations. FY 2022 appropriations are provided by the “Consolidated Appropriations Act, 2022” that provides FY2022 appropriations to Federal agencies. In addition, the U.S. Army Corps of Engineers budget includes \$230,778,000 of which \$4,940,000 is from the FY 2022 President’s budget and \$225,838,000 from the Infrastructure, Investment and Jobs Act for design of the aquatic nuisance species barrier in the vicinity of Joliet, Illinois and near Brandon Road Lock and Dam.

The 2022 Action Plan consists of a portfolio of high-priority prevention, detection, and control projects for populations of Silver Carp, Bighead Carp, Grass Carp and Black Carp (collectively referred to in this document as invasive carp) and includes actions that address potential pathways or vectors for their movement into the Great Lakes.

The activities conducted by the ICRCC under the Action Plan efforts are geographically focused to mitigate risk of introduction and spread at key points, as follows:

- Preventing the introduction of Silver Carp and Bighead Carp into the Great Lakes, with a focus on the State of Illinois’ efforts within the Illinois Waterway.
- Preventing the establishment of Grass Carp in the Great Lakes, with a focus on the States of Ohio’s and Michigan’s efforts within the western basin of Lake Erie and its tributaries.
- Better understanding and preventing the spread of Black Carp toward the Great Lakes, with a focus on populations within the Illinois River.
- Blocking potential migration pathways at other locations, including the State of Ohio’s planning activities for Little Killbuck Creek and the ongoing maintenance of constructed

A Terminology Change for the FY 2022 Action Plan

The ICRCC, formerly the Asian Carp Regional Coordinating Committee, has transitioned to the use of new terminology for ‘invasive carp’ within the Committee’s internal and external communications and operations. Throughout this document, the term ‘*invasive carp*’ refers to the following four species: Silver Carp, Bighead Carp, Grass Carp, and Black Carp.

barriers by Indiana at Eagle Marsh (Fort Wayne, Indiana) and by Ohio at the Ohio & Erie Canal (Akron, Ohio).

The Action Plan also includes work outside of these key areas to further reduce the risk of introduction and establishment of invasive carp. New control/management technologies are being developed and refined to enhance the effectiveness of management strategies. A multi-agency Contingency Response Plan is ready in the unexpected event of new detections of invasive carp in the Chicago Area Waterway System and the Illinois and Des Plaines rivers upstream of the Starved Rock Lock and Dam. FY 2022 funding also supports the basic coordination and communication activities of the ICRCC, including the annual development of this Action Plan.

Developed annually since 2010, the Action Plan has incorporated the most current science on invasive carp population status, life history and behavior, ecological risk, as well as developments in management practices and technologies. The 2022 Action Plan continues to reflect this adaptive approach.

Appendix A includes the FY 2022 Project Funding Matrix. FY 2022 appropriations are provided by the “Consolidated Appropriations Act, 2022” that provides FY2022 appropriations to Federal agencies.

Appendix B provides a full listing of FY 2022 Actions (agency projects) with project descriptions and intended outcomes. Any references to projects in future years are subject to the availability of appropriations.

1.0 INTRODUCTION

The Invasive Carp Regional Coordinating Committee (ICRCC) Fiscal Year (FY) 2022 Invasive Carp Action Plan (Action Plan) contains a portfolio of high-priority prevention, detection, and control projects that constitute a comprehensive and science-based invasive carp management strategy. The mission of the ICRCC and the intent of this Action Plan is to prevent the introduction and establishment of invasive carp in the Great Lakes. The Action Plan serves as a foundation for the work of the ICRCC partnership — a collaboration of 28 U.S. and Canadian federal, state, provincial, tribal, and local agencies.

Projects in the 2022 Action Plan are supported by a combination of \$256,715,590 in agency funding and \$21,000,000 in Great Lakes Restoration Initiative (GLRI) funding provided through FY 2022 appropriations. FY 2022 appropriations are provided by the “Consolidated Appropriations Act, 2022” that provides FY2022 appropriations to Federal agencies. In addition, the U.S. Army Corps of Engineers (USACE) budget includes \$230,778,000 of which \$4,940,000 is from the FY 2022 President’s budget and \$225,838,000 from the Infrastructure, Investment and Jobs Act (IIJA) for design of the aquatic nuisance species (ANS) barrier in the vicinity of Joliet, Illinois and near Brandon Road Lock and Dam.

Additional general information on invasive carp can be found at *InvasiveCarp.us*. Information available at the website includes:

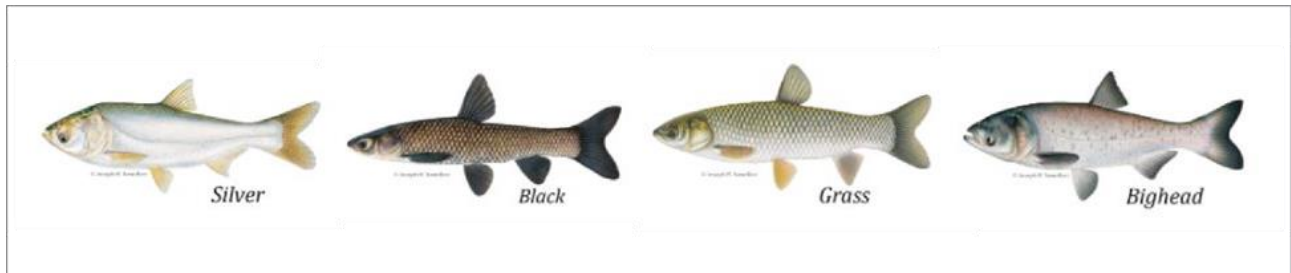
- The Invasive Carp Problem ([The Invasive Carp Problem | InvasiveCarp.us](#))
- Frequently Asked Questions about Invasive Carp ([FAQs | InvasiveCarp.us](#))
- Descriptions/pictures of Invasive Carp ([Bighead Carp | InvasiveCarp.us](#))
- What is the ICRCC ([About the ICRCC | InvasiveCarp.us](#))
- Partnering Agencies ([Partner Agencies | InvasiveCarp.us](#))
- Specific Invasive Carp Handouts ([Printable Handouts | InvasiveCarp.us](#))
- Previous Action Plans and Reports ([Action Plans and Reports | InvasiveCarp.us](#))

THE CHALLENGE

Invasive carp -- Silver Carp, Bighead Carp, Grass Carp, and Black Carp -- have expanded their population and migrated hundreds of miles upstream through the Mississippi River and its tributaries toward the Great Lakes. Natural resource management agencies in the Great Lakes region are preventing the further spread of these species. Management of invasive carp at this scale is unprecedented and has required the experimental development and ongoing refinement of many new prevention, detection, and control techniques. Preventing the introduction and establishment of invasive carp in the Great Lakes is a daunting challenge.

2.0 INVASIVE CARP AND THE GREAT LAKES — THE THREAT

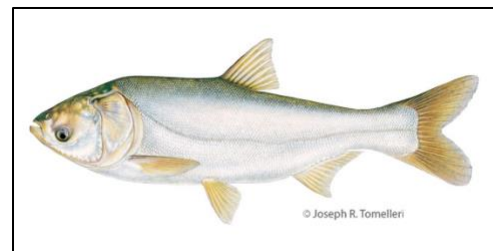
Invasive carp — Silver Carp, Bighead Carp, Grass Carp and Black Carp — have posed a growing challenge to North America’s aquatic resources, resource-dependent communities and economies, and other stakeholders since their initial unintended introductions into open river systems decades ago.



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

2.1 SILVER CARP

Silver Carp feed primarily on phytoplankton, but also on zooplankton, invertebrates, detritus, and bacteria. They efficiently strain suspended material from the water with highly specialized gill rakers. Silver Carp affect many native species adversely because they feed on plankton, the primary food source for mussels, larval fish, and several adult fishes. The establishment of large populations of Silver Carp in the Great Lakes could compromise recreational and commercial fishing. Silver Carp also pose a threat to human safety due to their jumping behavior when startled. These fish, sometimes referred to as “flying carp”, have caused numerous personal injuries and property damage due to collisions with people and their boats during recreational boating and fishing.



Silver Carp are now well established throughout much of the Mississippi River Basin. Range expansion has been observed in the Ohio River and other major sub-basins in recent years (Figure 1). Silver Carp can grow to 60 or more pounds and have been collected as far north as Lake Pepin in Minnesota. The Silver Carp population in the Illinois Waterway (IWW) currently poses the greatest threat to the Great Lakes. The large fish population front of Silver Carp in the IWW remains within Dresden Island pool, approximately 47 miles and two lock structures from Lake Michigan. The population front has remained unchanged for over 10 years.

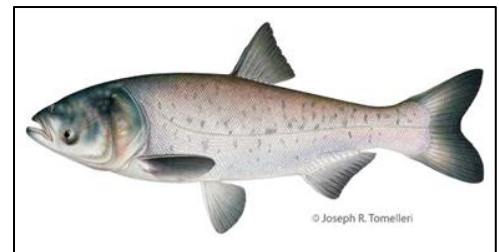
An animated map of the spread of Silver Carp in the United States may be viewed here: <https://nas.er.usgs.gov/queries/SpeciesAnimatedMap.aspx?speciesID=549>.



Figure 1. Historic Occurrence Map of Silver Carp in the Midwest United States. (USGS National Aquatic Species database, October 2021)

2.2 BIGHEAD CARP

Bighead Carp feed on or near the surface of the water, as well as in midwater and benthic (bottom) environments, consuming primarily zooplankton, in addition to blue-green algae, aquatic insects and detritus. Bighead Carp affect many native species adversely because they feed on plankton, the primary food source for mussels, larval fish, and adult fishes. The spread of Bighead Carp may adversely affect the existing commercial fishery in the Great Lakes and the Mississippi River Basin.



Similar to Silver Carp, Bighead Carp are now well established throughout much of the Mississippi River Basin, with range expansion documented in several river sub-basins. (Figure 2). Bighead Carp, which can grow to 100 pounds or more, have since spread through the Mississippi River Basin and have been collected as far north as Lake Pepin in Minnesota. The Bighead Carp population in the IWW currently poses the greatest threat to the Great Lakes. The adult population front of Bighead

Carp in the IWW remains within Dresden Island pool, approximately 47 miles and two lock structures from Lake Michigan. The population front has remained unchanged for over 10 years.

An animated map of the spread of Bighead Carp in the United States may be viewed here: <https://nas.er.usgs.gov/queries/SpeciesAnimatedMap.aspx?speciesID=551>.

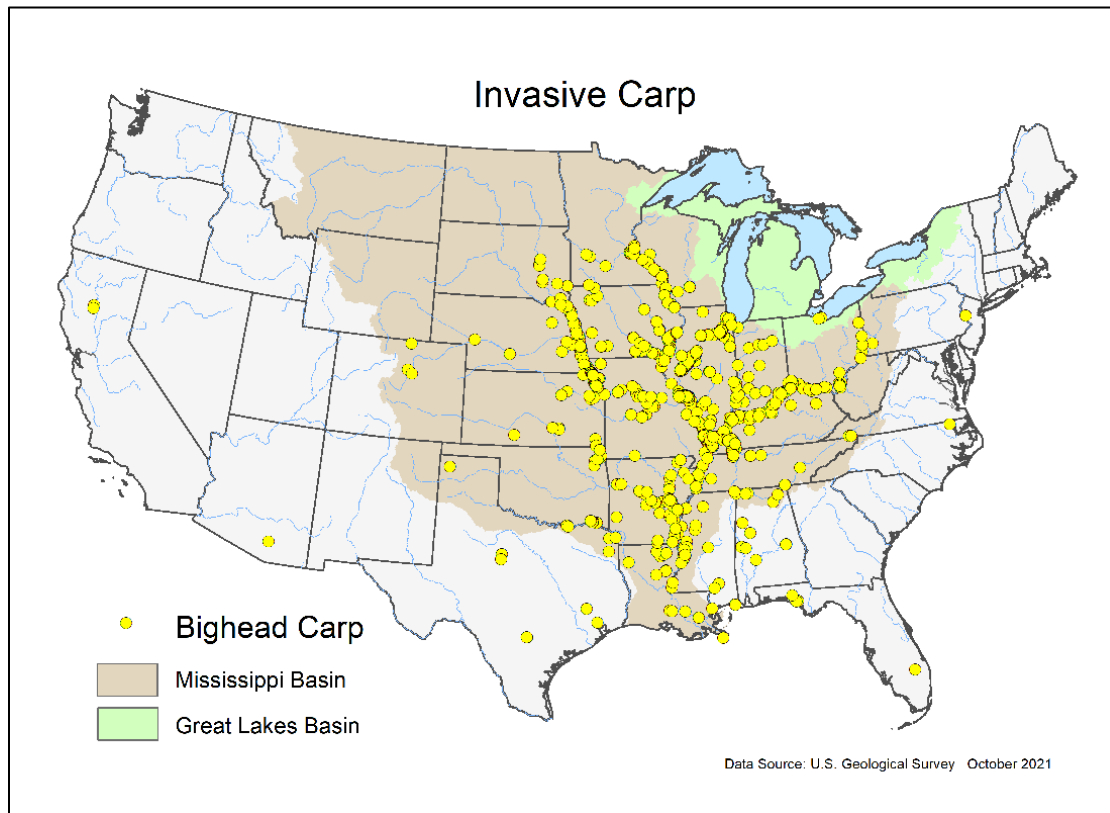


Figure 3. *Historic Occurrence Map of Grass Carp in the Midwest United States. (USGS National Aquatic Species database, October 2021)*

2.3 GRASS CARP

Grass Carp feed on submerged vegetation and historically, infertile Grass Carp were widely available from aquaculture providers for stocking to control nuisance aquatic plants. Infertile Grass Carp are also called “triploid” because they have three sets of genes, rather than the normal two sets, which renders them non-reproducing. Illinois, Indiana, Ohio, Pennsylvania, and New York all allow triploid Grass Carp to be used for vegetative control in ponds.



Grass Carp are widely distributed throughout much of the United States. Populations of Grass Carp are now reproducing in major rivers near the Great Lakes including the Mississippi, Missouri, and

Ohio Rivers and many other smaller tributaries (Figure 3). Grass Carp are present within the IWW and are occasionally removed from the Chicago Area Waterway System (CAWS) during Seasonal Intensive Monitoring (SIM) activities. They have been detected in all of the Great Lakes except Lake Superior. Grass Carp are regularly detected in Lake Erie. Reproduction of Grass Carp populations in tributaries of the western basin of Lake Erie has also been detected. Work is ongoing to understand the long-term survival success of Grass Carp produced within the Lake Erie watershed. The population in the western basin of Lake Erie watershed currently poses the greatest threat to the Great Lakes.

An animated map of the spread of Grass Carp in the United States may be viewed here: <https://nas.er.usgs.gov/queries/SpeciesAnimatedMap.aspx?speciesID=514>.

2.4 BLACK CARP

Adult Black Carp feed primarily on mollusks and snails, using their molar-like pharyngeal teeth to crush the shells. Its preference is to occupy benthic (bottom) areas of rivers. Because of its known feeding ecology, its escape into the Mississippi River raised significant concern among resource managers for the long-term viability of the historical native mussel fauna in the Upper Mississippi River Basin, of which over 70 percent are already imperiled or extinct. If this species were to eventually enter the Great Lakes, there would be serious concern for the mollusk population that is already significantly impacted by invasive dreissenid mussels (quagga and zebra mussels).



Less is known about the distribution and abundance of Black Carp in the United States. Black Carp detections are gradually increasing within the Mississippi River Basin, including detections in the Illinois River. Black Carp expanded considerably in 2021 in the IWW, Wabash River, and Ohio River. Black Carp can grow to 150 or more pounds and are longer lived than other invasive carp species. (Figure 4). The Black Carp population in the Illinois River currently poses the greatest threat to the Great Lakes. Large juvenile and adult Black Carp were initially reported in the Illinois River in 2010. Since the inception of the Illinois Bounty Program in 2015, records have increased throughout the lower 183 miles of the Illinois River. The furthest upstream captures were in 2021, approximately 2.5 miles downstream of Henry, Illinois, within the Peoria Pool, and approximately 135 river miles and six lock structures away from Lake Michigan.

An animated map of the spread of Black Carp in the United States may be viewed here: <https://nas.er.usgs.gov/queries/SpeciesAnimatedMap.aspx?speciesID=573>.

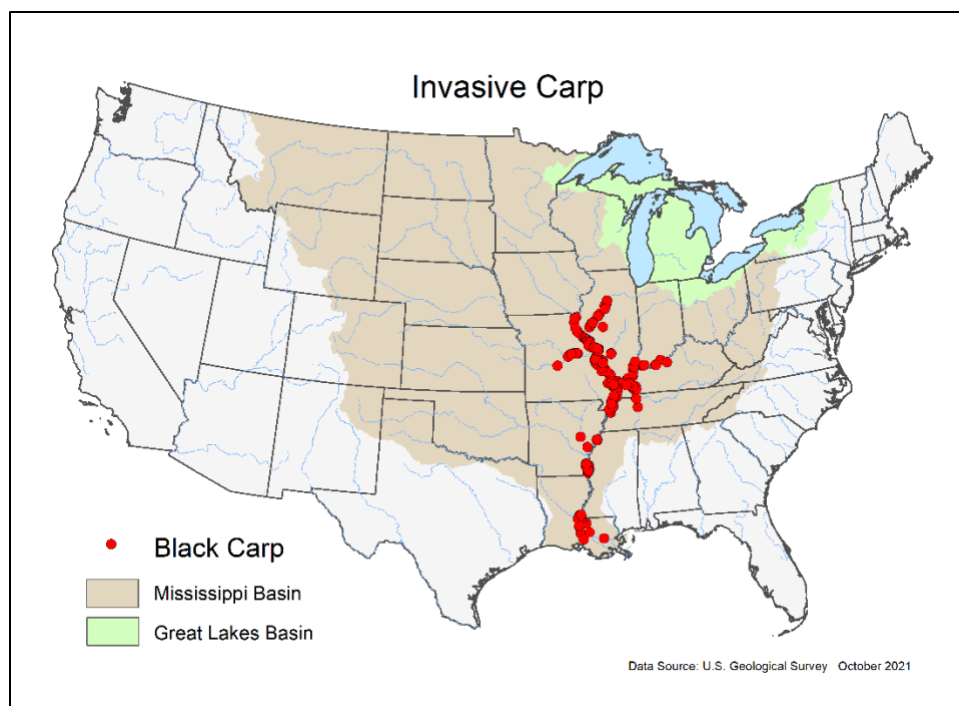


Figure 4. *Historic Occurrence Map of Black Carp in the Midwest United States. (USGS National Aquatic Species database, October 2021)*

2.5 INVASIVE CARP IN THE ILLINOIS RIVER

Within the Illinois River, ICRCC agencies conduct intensive ongoing monitoring for invasive carp using a combination of fishery sampling gears and techniques to ensure a comprehensive sampling approach. Traditional fishery sampling gears, including boat electrofishing and netting; remote sensing, including telemetry tracking and sonar; and eDNA sampling are conducted in targeted locations to best inform the understanding of invasive carp occurrence and population status. Due to the proximity of established populations of invasive Bighead Carp and Silver Carp in the lower (downstream) segments of the Illinois River, intensive ongoing monitoring and control efforts have been focused on the upper IWW, including the CAWS, to lessen the risk of invasive carp migration upstream toward the Great Lakes. These actions have heavily informed the overall understanding of the dynamics and characteristics of invasive carp populations in the IWW, including surveillance actions to detect potential range expansion.

Populations of Bighead Carp and Silver Carp in the IWW are generally characterized by pool. For reference, Figure 5 below illustrates the pools in the upper IWW and the stages of invasion for Bighead Carp and Silver Carp.

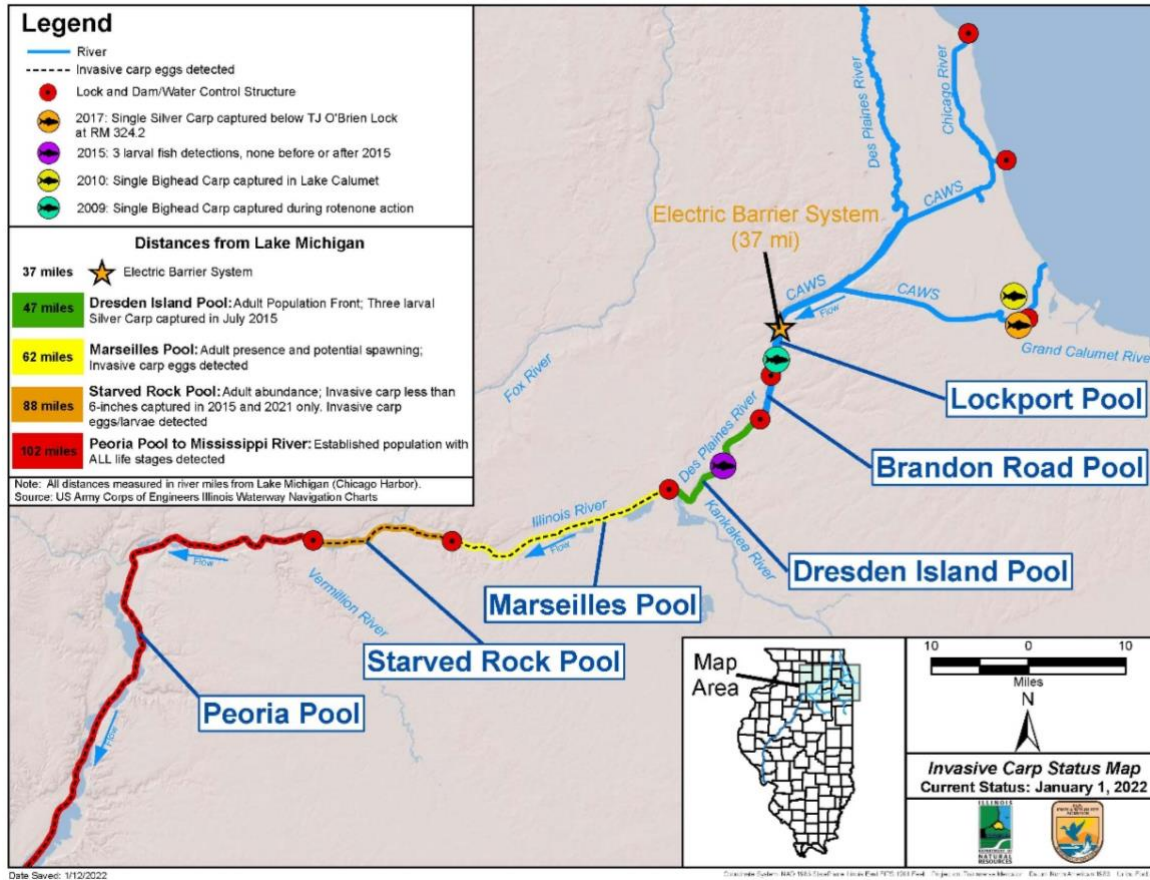


Figure 5. Pools in the Upper IWW and Stages of Bighead Carp and Silver Carp Invasion

3.0 SUMMARY OF 2022 ICRCC ACTIONS

The ICRCC mission and the goal of this Action Plan is to prevent the introduction and establishment of invasive carp in the Great Lakes. This is accomplished through monitoring and control activities focused on key geographic areas of highest risk. Additionally, support is provided for technology development, interagency coordination, and communication and outreach activities of the ICRCC. In this Action Plan, ICRCC actions are organized into six categories:

- Preventing the introduction of Silver and Bighead Carp into the Great Lakes, with a focus on the IWW.
- Preventing the establishment of Grass Carp in the Great Lakes, with a focus on the western basin of Lake Erie.
- Assessing and preventing the spread of Black Carp toward the Great Lakes, with a focus on the Illinois River.
- Blocking potential migration pathways at other locations, including planning activities for Little Killbuck Creek in Ohio and ongoing maintenance of constructed barriers at Eagle Marsh (Fort Wayne, Indiana) and the Ohio & Erie Canal (Akron, Ohio).
- Supporting state-led efforts in Great Lakes basinwide early detection.
- Communicating and coordinating efforts in support of the ICRCC.

3.1 PREVENTING THE INTRODUCTION OF SILVER CARP AND BIGHEAD CARP INTO THE GREAT LAKES, WITH A FOCUS ON THE ILLINOIS WATERWAY

The coordinated interagency effort to address the risk of invasive carp in the IWW began in 2009 with a prevention and fish suppression effort conducted in the CAWS (Figure 6) that supported maintenance actions on the USACE electric dispersal barrier system (EDBS). This was the impetus for creating the ICRCC, which brought together the agencies potentially affected by the expansion of invasive carp into regional waterways. The scope of the ICRCC effort has since evolved beyond a singular focus on the CAWS but, reducing the populations of invasive carp the IWW remains a major focus of the Action Plan.

At this time, both long-term and immediate actions are underway to prevent Silver Carp and Bighead Carp from migrating upstream to the Great Lakes. The State of Illinois and USACE, with support from the State of Michigan, are actively designing significant prevention measures at the Brandon Road Lock and Dam (<https://www.mvr.usace.army.mil/Missions/Environmental-Stewardship/BR-Interbasin-Project/>) and the IJA included funds to initiate construction. Meanwhile, research agencies are refining technologies that can be used at this location, ongoing monitoring and control actions are needed to reduce the spread of Silver Carp and Bighead Carp, and continued operation of the USACE EDBS will further minimize the risk of upstream migration.



Figure 6. Waterbodies making up the Chicago Area Waterway System. Credit: GLC



Figure 7. Waterbodies making up the Illinois Waterway. USACE

ICRCC actions planned for 2022 include:

- **Prevention:** Planning and design of a robust series of deterrents at Brandon Road Lock and Dam, ongoing operation of the EDDBS, and enhanced enforcement activity to prevent unauthorized transport of live invasive carp.
- **Technology Development:** Development and testing of systems that use underwater sound as a deterrent to upstream migration, carbon dioxide and other toxicants, and the use of “bubble curtains” (intense concentrations of bubbles) to prevent the accidental entrainment and movement of small fish by shipping barges.
- **Monitoring and Population Assessment:** Characterization of invasive carp populations in the IWW to assess upstream movement and ensure that no invasive carp have moved beyond the EDDBS.
- **Control:** Capture and removal of invasive carp from the upper Illinois River, enhancement of harvest further downstream on the Illinois River to reduce upstream migration, and refinement of population models to inform future control efforts.
- **Contingency Planning and Response:** Ensuring preparedness to implement effective contingency actions through the Monitoring and Response Work Group (MRWG) Contingency Response Plan (CRP) for the Upper IWW.

3.1.1 Prevention

Prevention actions are focused on high-risk points of potential introduction and spread and include the planning and design of a robust barrier at Brandon Lock and Dam, ongoing operation of the EDDBS, and enhanced enforcement activity to prevent unauthorized transport of live invasive carp.

The FY 2022 USACE budget includes \$230,778,000 of which \$4,940,000 is from the FY 2022 President’s budget and \$225,838,000 from the IJA for USACE, in partnership with the State of Illinois and the State of Michigan, to complete design and initiate construction of the ANS barrier near Brandon Road Lock and Dam (Figure 8) in the Des Plaines River in the vicinity of Joliet, Illinois. This project will consider structural barriers and deterrents including an electric barrier, acoustic deterrent, bubble curtain and flushing lock.

The USACE will continue to operate the EDDBS (Figure 9) in the Chicago Sanitary and Ship Canal (CSSC) and initiate construction of the second high-field array at Barrier I. Since 2002, several operational and procedural improvements have been implemented to improve the effectiveness of the EDDBS and to continuously deliver an uninterrupted flow of electricity to the water to deter fish. This effort is the first line of defense to prevent invasive carp from becoming established in the Great Lakes by maintaining a constant electrical current in the water of the CSSC.

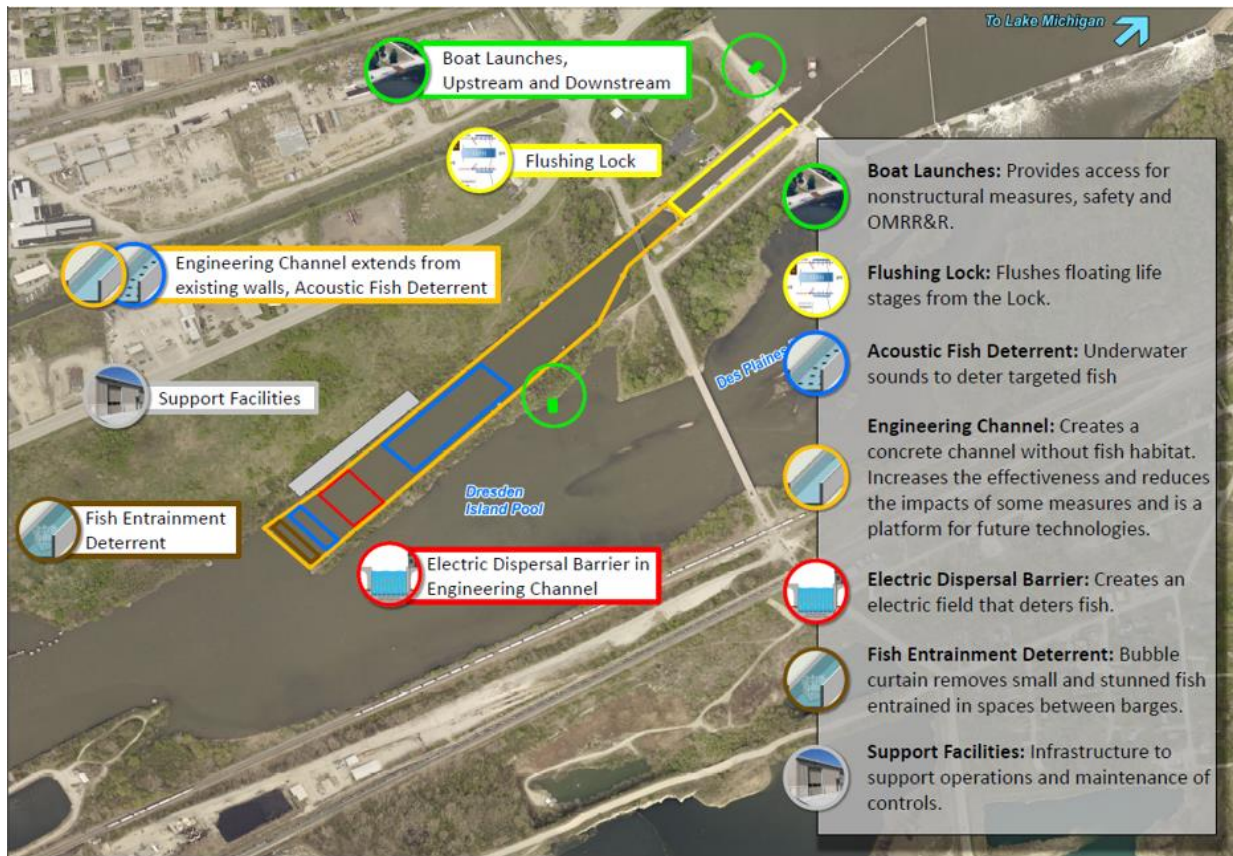


Figure 8. USACE Brandon Road Recommended Structural Plan.



Figure 9. USACE Electric Dispersal Barrier System.

The ICRC will also support the Illinois Department of Natural Resources (DNR) law enforcement efforts searching for illegal activities (e.g. bait transfer and live fish markets) where invasive carp could be transported/spread by human means. Additional support for key State-led law enforcement activities focused on invasive carp and other aquatic invasive species (AIS) in the Great Lakes Basin is provided by USFWS through the GLRI.

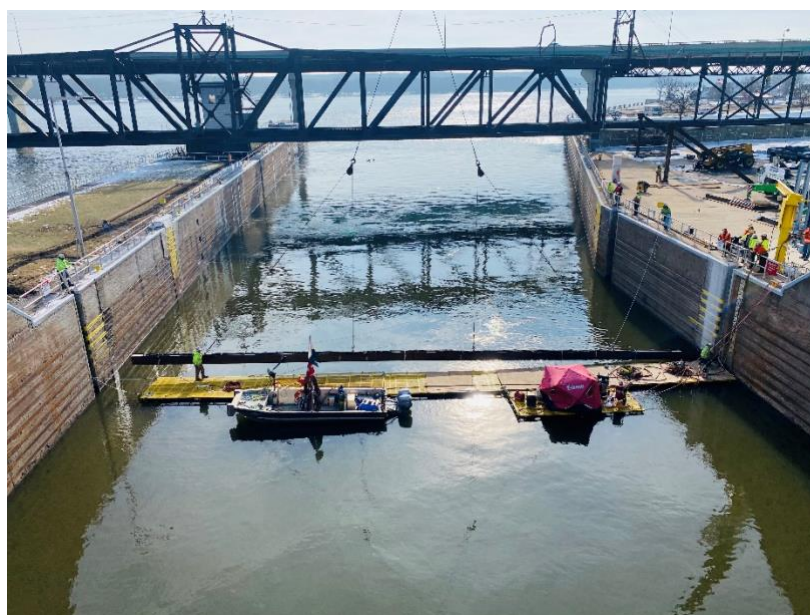
Prevention actions supported by the 2022 Action Plan are:

Project Title <i>(Click on Project Title to go to the Project)</i>	Lead Agency
Alternate Pathway Surveillance in Illinois	Illinois DNR
Electric Dispersal Barrier System	USACE
USGS Support of the GLMRIS Brandon Road Project	USGS
Design and Construction of the Brandon Road Lock and Dam Aquatic Nuisance Species Barrier Project	USACE

3.1.2 Technology Development

The ICRCC continues to support development and testing of technology that can assist in preventing the movement and spread of invasive carp. This work is strongly motivated by the potential use of these technologies to stop Silver Carp and Bighead Carp at the previously mentioned Brandon Road Lock and Dam project, but they are also expected to be useful for managing other invasive carp species in other locations. In 2022, the ICRCC will support work on underwater sound, carbon dioxide and other toxicants, and the use of “bubble curtains” (intense concentrations of bubbles) to prevent the accidental entrainment and movement of small fish by shipping barges.

The ICRCC has led a multi-year effort to investigate the use of underwater sound as a potential management technology, including piloting the use of the Bioacoustics Fish Fence (BAFF) and the underwater Acoustic Deterrent System (uADS). The BAFF Deployment Project is a large-scale experimental deployment of the BAFF system at Barkley Dam near Grand Rivers, Kentucky. The test is being conducted at Barkley Dam on the Tennessee-Cumberland River due to the presence of a high-head dam with no overflow conditions and telemetry monitoring infrastructure in place, as well as the presence of an established population of invasive



Installation of the soundbar (16 underwater speakers), part of the underwater Acoustic Deterrent System for invasive carp installed at Lock 19 (Keokuk, Iowa).

carp. Once completed in 2023, the results of the study will reveal the effectiveness of the BAFF so that if this technology is effective as a deterrent, the technology may be transferred to other locations to protect the Great Lakes from invasive carp. A uADS has been installed at Lock 19 near Keokuk, Iowa, to test the efficacy of acoustic signals at deterring invasive carp. This project will result in information about the use of these deterrents in rivers with locks and dams. FY 2022 funding will continue evaluation of the uADS at Lock 19 and evaluation of a small-scale acoustic deterrent in a backwater of the Illinois River.



Downbound tow traverses the underwater Acoustic Deterrent System installed at Lock 19 on the Mississippi River at Keokuk, Iowa.

Use of carbon dioxide (CO₂) injected into water is being evaluated as a non-lethal behavioral deterrent for invasive carp. In 2019, the U.S. Geological Survey (USGS), USACE, and other partners demonstrated the temporary application of a CO₂ infusion system at a navigational lock in Wisconsin. The ICRCC will support the feasibility testing of using CO₂ to clear fish from the EDBS within the CAWS. The EDBS undergoes annual maintenance, which could present an opportunity for fish to move upstream towards Lake Michigan. In 2022, the effort will result in the design, cost estimate, and identification of permit and regulatory requirements associated with implementation.

ICRCC agencies are also evaluating the use of bubbler arrays and other technologies to prevent inadvertent entrainment and transport of small fish through locks and electric barriers by commercial barges. In 2022, USACE, U.S. Fish and Wildlife Service (USFWS), and USGS, and partnering agencies will field test the efficacy of bubbles in removing small invasive carp from the rake-box junction of commercial barges in the IWW. Results of this project will also help to address known vulnerabilities at the CAWS electrical barriers and assist in design of deterrents at Brandon Road Lock and Dam. The USACE will also explore testing the interactions of multiple deterrent technologies to optimize their effectiveness and minimize possible negative interference between technologies.

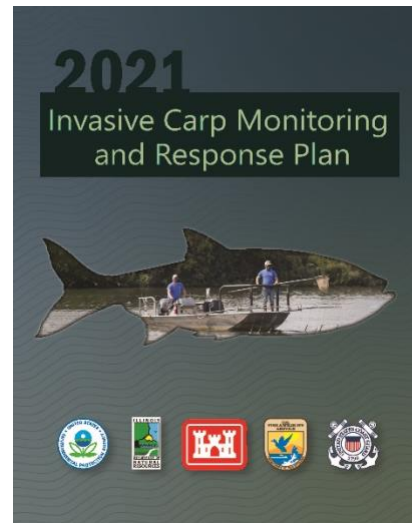
In FY 2022, Illinois DNR and the Illinois Natural History Survey will also evaluate a mobile fish movement system/ladder to support fish scanning and sorting capabilities in the Illinois River waterway. This effort will evaluate potential implementation of a mobile pilot fish passage system that could selectively remove invasive carp at strategic locations in the IWW.

Technology development projects supported by the 2022 Action Plan are:

Project Title <i>(Click on Project Title to go to the Project)</i>	Lead Agency
Evaluation of Fish Sorting Technology to Promote Invasive Carp Harvest and Native Species Passage	Illinois DNR
Acoustic Deterrents for Invasive Carp	USACE
Acoustic Deterrents for Invasive Carp	USFWS
Acoustic Deterrents for Invasive Carp	USGS
Carbon Dioxide Deterrence for Invasive Carp	USACE
Implementation and Planning for a Carbon Dioxide Deployment	USGS
Carbon Dioxide Deterrence for Invasive Carp	USGS
Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation	USACE
Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation	USFWS
Prevention of Barge-Induced Transport of Aquatic Nuisance Species	USGS
Science Support for Control Efforts in the Illinois Waterway and Other Priority Sites	USGS
Technology Registration and Environmental Review	USFWS
USGS Multi-Deterrent Efficacy and Operations	USGS
USACE Multi-Deterrent Efficacy and Operations	USACE

3.1.3 Monitoring and Population Assessment

Continued monitoring and assessment of the invasive carp population in the IWW are critical to the ICRCC’s ability to assess the threat of upstream movement and range expansion and is used to inform where to target prevention and control actions. In addition, surveillance above and below the EDBS ensures no invasive carp have moved beyond this critical control point. A key component of the Action Plan is the monitoring and response work of the MRWG. The MRWG is tasked with implementing coordinated monitoring, response, control, and management efforts in the IWW and CAWS. The MRWG Monitoring Response Plan (MRP), developed annually, evaluates invasive carp status on a pool-by-pool basis within the IWW, and prescribes control effort accordingly.



SIM activities upstream of the EDBS will continue in upper IWW during spring and fall of 2022 focusing on the detection and, if present, capture of invasive carp in areas where they are not currently present. This effort will utilize targeted sampling with a variety of gears including seines, trammel nets, and hoop nets to detect, capture, and remove any captured invasive carp from upstream locations. USFWS boat electrofishing and electrified dozer trawling in Lockport Pool upstream of the EDBS will continue to be completed during months in which the SIM is not being implemented.

Downstream of the EDBS, fixed and random site sampling and contracted netting will be implemented at four fixed sites in each of the four pools below the EDBS. This effort focuses on the Lockport, Brandon Road, Dresden Island, and Marseilles pools utilizing boat electrofishing, electrified dozer trawling, hoop netting, and mini-fyke netting.

The ICRCC continues to support sampling using a variety of gear at sites between the Peoria reach of the Illinois River and the EDBS to detect upstream migrations of small and juvenile Silver Carp and Bighead Carp.





USGS field biologist surgically implants an acoustic transmitter into an adult Silver Carp.

Telemetry tracking and hydroacoustic monitoring of invasive carp in the Alton through Lockport pools of the IWW will continue in 2022. Through the telemetry project, invasive carp are implanted with acoustic transmitters (captured and released in areas where they are already established), and their movement is tracked across an acoustic receiver array. Hydroacoustic sampling will also be conducted in the upper Illinois River throughout the Marseilles, Dresden Island, Brandon Road, and Lockport pools to identify areas with high densities of large-bodied fish that could potentially be invasive carp. Hydroacoustic sampling will also occur in Alton to Dresden Island pools in October to quantify pool-wide invasive carp densities for comparison to long-term data collected since 2012. Hydroacoustic sampling will also occur within the EDBS and in the 2 km downstream of the barrier every two weeks throughout the year. These surveys

are intended to identify the presence of any large-bodied fish within close proximity to the EDBS and help to evaluate risk of operational changes on potential fish passage.

For more information on the efforts of the MRWG and the MRP, please see the 2020 MRP at: <https://invasivecarp.us/Documents/Monitoring-Response-Plan-2020.pdf>.

Monitoring and assessment actions supported by the 2022 Action Plan are:

Project Title <i>(Click on Project Title to go to the Project)</i>	Lead Agency
Illinois Waterway Detection, Management and Control, and Contingency Planning for Invasive Carp	Illinois DNR
Assessment of Invasive Carp Reproduction and Ecosystem Response in the Illinois Waterway	Illinois DNR
Invasive Carp Stock Assessment in the Illinois River/Management Alternatives	Illinois DNR
Great Lakes Early Detection, Monitoring, and Evaluation	USFWS
Invasive Carp Demographics	USFWS
Des Plaines River Overflow Monitoring	USFWS
Illinois River Monitoring and Response Team Support	USFWS
Midwest Region Fisheries Program Capacity for eDNA Sampling and eDNA Processing	USFWS
Telemetry in the Upper Illinois River	USACE
Telemetry Support for the Spatially Explicit Invasive Carp Population (SEICarP) Model	USFWS
Illinois River Hydroacoustics	USFWS
Real-Time Telemetry and Multi-State Modeling	USGS
Early Detection of Invasive Carp in the Upper Illinois Waterway	USFWS
Upper Illinois Waterway Small Invasive Carp Distribution Monitoring	USFWS

3.1.4 Control

Control actions are designed to contain and stop the expansion of populations of invasive carp in the Illinois River, in order to reduce population pressure threatening the EDDBS and the Great Lakes Basin. This includes both the removal of invasive carp in the upper Illinois River as well as populations downstream in the Peoria Pool of the Illinois River. The ICRCC supports continued targeted harvest of invasive carp in the Illinois River using contracted fishing. As part of this effort, the ICRCC also supports the continued development of objective data-driven models to inform decisions concerning invasive carp control efforts in pools of the Illinois River. To reduce the population pressure, the MRWG set a goal of removing 15 million pounds of invasive carp annually by 2022 below the Starved Rock Dam and at least 1 million pounds of invasive carp annually in the upper IWW.

Through September 2020, contracted fishing took place in Lockport, Brandon Road, and Dresden Island pools of the IWW (Figure 10) and contracted fishers removed 106,373 pounds of Bighead Carp, Grass Carp, and Silver Carp. In September 2019, the Enhanced Contract Fishing Program was initiated in the Peoria Pool of the IWW. The program offers Illinois-licensed commercial fishermen a financial incentive for each pound of invasive carp removed from the Peoria Pool and sold to fish processors or other buyers. To date, 30 fishermen have entered into contracts with Illinois DNR. From inception through the remainder of calendar year 2019, 518,132 pounds of invasive carp were removed. In calendar year 2020, 2,882,725 pounds were removed, and through September 2021, an additional 2,450,451 pounds were removed. The ICRC control effort also includes a marketing program to support the creation of a positive commercial brand for invasive carp. Market engagement and increased product use will support increased intensive removal through commercial harvest. In 2022, there will be a national launch of a brand for harvested invasive carp to help develop a market for fishers and processors.

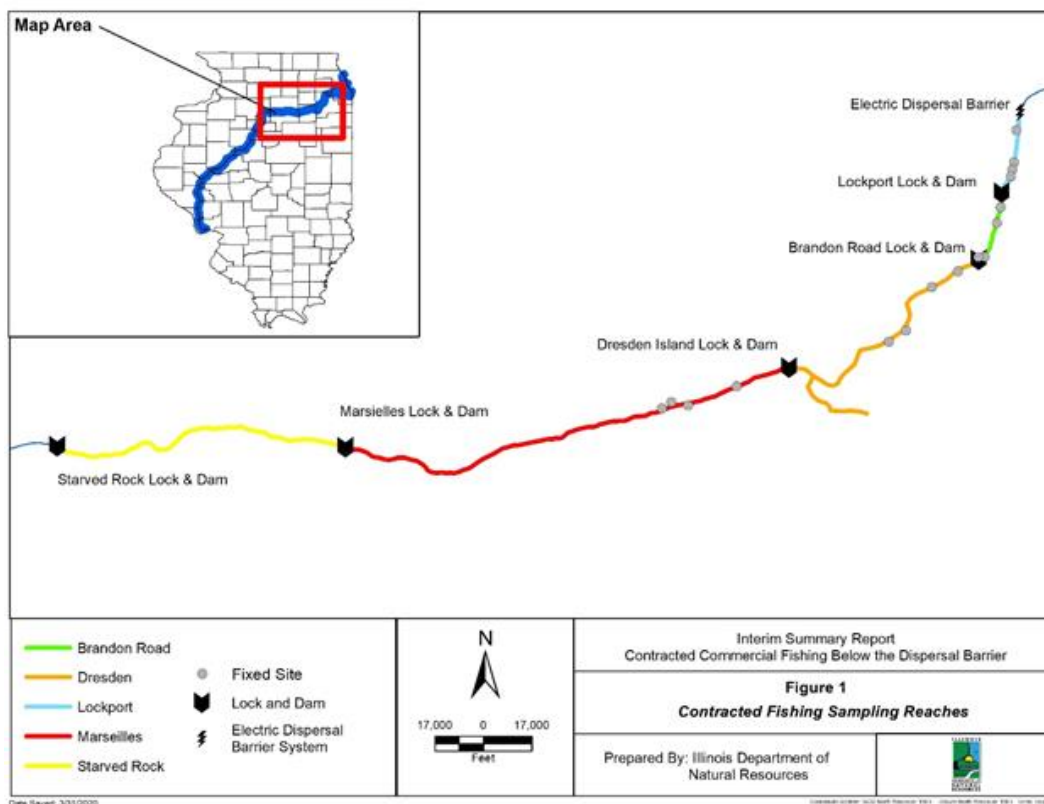


Figure 10. Contracted commercial fishing sampling area and locations of fixed sites sampling of the contract fishing below the electric dispersal barrier project.

In 2022, the ICRCC will also continue to support advancements to Spatially Explicit Invasive Carp Population (SEICarP) decision-support tool to assess population dynamics in the Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island pools of the Illinois River. This population model will help direct control actions for maximum population reduction.

Control measures supported by the 2022 Action Plan are:

Project Title <i>(Click on Project Title to go to the Project)</i>	Lead Agency
Contract Fishing for Invasive Carp Detection and Removal	Illinois DNR
Invasive Carp Enhanced Contract Removal	Illinois DNR
Invasive Carp Removal, Brand Implementation, and Marketing	Illinois DNR

3.1.5 Contingency Planning and Response

In FY 2022, the ICRCC will remain prepared to implement contingency (rapid response) actions through the MRWG CRP for the Upper IWW. The CRP is triggered in the event a change is detected in the status/risk of invasive carp in the Starved Rock, Marseilles, Dresden Island, Brandon Road, and Lockport pools. An interagency CRP tabletop exercise is planned for FY 2022 to ensure agency personnel are prepared to implement response actions. The ICRCC will be prepared to shift resources from other activities to support response actions deemed necessary by the appropriate jurisdictional authority in response to new invasive carp detections.

The contingency response action supported by the 2022 Action Plan is:

Project Title <i>(Click on Project Title to go to the Project)</i>	Lead Agency
ICRCC Contingency Actions in the Upper Illinois River	USFWS, USGS and Illinois DNR

3.2 PREVENTING THE ESTABLISHMENT OF GRASS CARP IN THE GREAT LAKES, WITH A FOCUS ON THE WESTERN BASIN OF LAKE ERIE

Grass Carp have been detected in Lakes Erie, Huron, Michigan, and Ontario and pose a significant environmental risk, as indicated in the [Ecological Risk Assessment of Grass Carp \(*Ctenopharyngodon idella*\) for the Great Lakes Basin](#), a binational, peer-reviewed risk assessment published in 2017. The risk assessment analysis indicated that it is "very likely" that Grass Carp will become established in Lakes Erie, Huron, Michigan and Ontario within 10 years unless effective steps are taken to control the population growth and dispersal. Accordingly, U.S. and Canadian agencies are addressing Grass Carp within their jurisdictional waters.

The ICRCC supports the activities of the Great Lakes Fishery Commission's (GLFC) Lake Erie Committee (LEC) fishery managers to monitor, assess, better understand, and control the Grass Carp population in Lake Erie (Figure 11) as articulated in the [*Lake Erie Grass Carp Adaptive Response Strategy 2019-2023*](#). The binational LEC, comprised of fishery managers from Michigan, Ohio, Pennsylvania, New York, and Ontario, and supported by Canadian and U.S. federal agencies, adopted this 5-year adaptive response strategy to reduce the threat of Grass Carp to Lake Erie through common and coordinated efforts. In 2022, the ICRCC is providing funding for 11 strike teams to remove Grass Carp from Lake Erie and its tributaries in efforts to contribute to a meaningful reduction in the population and resulting potential for reproduction.

In summary, ICRCC actions planned for 2022 that will support efforts led by the LEC include:

- Conduct removal efforts focused in Lake Erie, led by 11 strike teams across the Lake Erie basin.
- Develop a web-based decision support tool ('SpawnCast') that produces forecasts of potential Grass Carp spawning events which can be used to inform targeted control actions.
- Conduct research to predict Grass Carp locations, estimate origin, study movement via telemetry, assess ploidy, and evaluate potential baits/attractants.
- Evaluate Grass Carp response to experimental deterrents in large rivers to inform control efforts in Great Lakes tributaries.
- Identify optimal river conditions for spawning and recruitment of invasive carp in tributaries of the western basin of Lake Erie to inform future targeted management actions.
- Determine the feasibility of a Grass Carp deterrent on the Sandusky River.

In 2022, the USACE will study the feasibility of a behavioral and/or a physical-hydraulic Grass Carp barrier in the Sandusky River, a key tributary for Grass Carp spawning. The effort will produce a Federal Interest Determination document, a Project Management Plan, and a draft Feasibility Cost-Share Agreement to guide negotiation with the non-federal sponsor.



Figure 11. Ohio rivers currently monitored for Grass Carp.

Grass Carp actions supported by the 2022 Action Plan are:

Project Title <i>(Click on Project Title to go to the Project)</i>	Lead Agency
Adaptive Management Framework for Grass Carp in Lake Erie	Ohio DNR
Implementation of an Adaptive Management Framework for Grass Carp in Lake Erie	Michigan DNR
Implementation of an Adaptive Management Framework for Grass Carp for the Great Lakes	USFWS
SpawnCast - A Grass Carp Spawning Event Prediction Tool	USGS
Identification of Optimal River Conditions for Spawning and Recruitment of Invasive Carps in Tributaries of the Western Basin of Lake Erie	USGS
Evaluation of Bait and Attractants to Increase Aggregation and Harvest of Grass Carp in the Lake Erie Basin	USGS
Efficacy of an Oblique Bubble Screen System as a Two-Way Dispersal Barrier for Invasive Carp	USGS
Improved Control Efficiency through Better Understanding of Grass Carp Movements and Habitat Use	USGS
Identifying Spawning Tributaries and Specific Spawning Areas of Grass Carp	USGS
Characterization of Hydrology and Sediment Mobility to Inform Design of a Seasonal Barrier in the Sandusky River	USGS
Development and Testing of Deterrent Technologies for Grass Carp	USGS
Grass Carp Ploidy Analysis to Assess Reproductive Risk of Detected Populations	USFWS
Sandusky River Grass Carp Barrier	USACE

3.3 ASSESSING THE SPREAD OF BLACK CARP TOWARD THE GREAT LAKES, WITH A FOCUS ON THE ILLINOIS RIVER.

While Black Carp have not been found in the upper reaches of the Illinois River, they have been found in the lower Illinois River, and there is increased concern for their potential movement toward the Great Lakes. Naturally reproducing populations of Black Carp are now present and increasing their range in the Mississippi River Basin. Recognizing the emerging threat, the ICRCC formed an interagency Black Carp Work Group (BCWG) to collaboratively evaluate the status of the species, identify management needs and objectives, and develop a strategy for implementing high-priority monitoring and control actions to abate the further expansion and establishment in U.S. waters.

In summary, ICRCC actions planned for 2022 include:

- Monitoring and population assessment to track movement upstream in the Mississippi and Illinois rivers, including sampling with experimental baits to assess the presence, abundance and expansion of Black Carp and the efficacy of various baits in the lower Illinois River.
- A Structured Decision Making process to incorporate new information from existing research and identify new potential Black Carp management actions.
- Research to assess the movement behavior of Black Carp in the wild, as well as diet composition, reproductive development, population demographics, and larval development.

The ICRCC also supports the evaluation of potential Black Carp control actions. While technologies to specifically control Black Carp have not yet been extensively studied, numerous control tools targeting Bighead Carp and Silver Carp may also provide management options for this emerging species.

Recently the ICRCC developed a brochure, [*Keep, Cool, Call: What to do if you capture a black carp*](#). Scientists and fisheries managers from Illinois DNR, USGS, USFWS, and other agencies are seeking assistance in locating invasive Black Carp and in obtaining carcasses of fish captured in the wild for research. This brochure explains what to do if a commercial or recreational fisher captures a Black Carp and how they may be eligible for a \$100 per carcass bounty.

Black Carp actions supported by the 2022 Action Plan are:

Project Title	Lead Agency
<u>Enhanced Detection of Black Carp in the Lower Illinois River</u>	Illinois DNR
<u>Black Carp Management and Control-Coordination and Support</u>	USFWS
<u>Black Carp Monitoring, Assessment and Control</u>	USGS

3.4 BLOCKING POTENTIAL MIGRATION PATHWAYS AT OTHER LOCATIONS

In 2022, the ICRCC will continue to support work on other Great Lakes and Mississippi River Interbasin Study (GLMRIS)-identified pathways for invasive carp introduction and spread. This will include the design, real estate negotiations, permitting, and construction, phased over multiple years, for efforts to close the pathway on Little Killbuck Creek in Ohio. The ICRCC agencies will also continue to maintain the barriers at Eagle Marsh (Fort Wayne, Indiana) and the Ohio & Erie Canal Aquatic Nuisance Species Barrier project (Akron, Ohio), two additional GLMRIS pathways addressed in prior years (Figure 12).



Figure 12. Map showing alternative pathways.

3.5 SUPPORTING STATE-LED EFFORTS IN BASINWIDE EARLY DETECTION

Many natural resource agencies continue to monitor for invasive carp as part of their standard monitoring activities. Through USFWS, the ICRC supports collaborative efforts with state and federal partner agencies to implement an ongoing early detection program for AIS, including invasive carp, in the nearshore U.S. waters of the Great Lakes. Sampling will use a wide array of traditional and novel gears to sample all potential life stages of invasive carp species.

USFWS also offers additional support for environmental deoxyribonucleic acid (eDNA) sampling as an early detection monitoring tool. USFWS maintains program capacity to support strategic eDNA surveillance for invasive carp in the Great Lakes and Mississippi River basins. In 2022, this work includes the continued refinement and development of state-of-the-art tools, field sampling and laboratory protocols, and expanded analytical capacity to support a robust eDNA monitoring program for efficiently sampling high-priority locations for the presence of invasive carp.

Basinwide early detection monitoring supported by the 2022 Action Plan are:

Project Title	Lead Agency
<u>Invasive Carp Enhanced Contract Removal, Marketing, Assessment, and Management</u>	Illinois DNR
<u>Modeling Potential Invasive Carp Recruitment, Population Growth, and Food Web Effects in Great Lakes Tributaries</u>	NOAA
<u>Invasive Carp Population Modeling to Support an Adaptive Management Framework</u>	USFWS
<u>Invasive Carp Population Modeling to Support an Adaptive Management Framework</u>	USGS
<u>Invasive Carp Database Management and Integration Support</u>	USGS

3.6 COMMUNICATION/COORDINATION EFFORTS IN SUPPORT OF THE ICRCC

Actions to continue effective communication and coordination efforts of the ICRCC are supported by the FY 2022 Action Plan. These efforts are necessary to support and coordinate the many collaborative actions undertaken by the ICRCC to address the invasive carp challenge.

Providing information to the public, government agencies and officials, and other stakeholders is critical to achieving the ICRCC mission. Continuing these key communications is necessary to ensure effective management and control of invasive carp, especially efforts that will assist the ICRCC in making decisions related to preventing the introduction, establishment and spread of Bighead Carp and Silver Carp in the Great Lakes. The public outreach efforts of the ICRCC promote transparency and accountability and support strategic and timely communications on key ongoing and emerging issues. Strategic communication efforts contribute to key audiences’ understanding and appreciation for the ICRCC’s purpose, function, current actions and successes. Ongoing communication work of the ICRCC increases stakeholder engagement and directly supports the ICRCC’s mission of protecting the Great Lakes from invasive carp.

ICRCC communication efforts are organized by the Communication Work Group (CWG), which is co-chaired by USFWS and Illinois DNR. The CWG is comprised of communication specialists from each partner agency and serves the essential function of coordinating messaging and communications in a complex multi-agency response and management setting. A primary component of the ICRCC’s communications approach is the website, [*InvasiveCarp.us*](http://InvasiveCarp.us). As the site administrator, USFWS organizes content and leads website development efforts.

In summary, the ICRCC, with its partners, will continue to collaborate to:

- Provide timely and substantive technical information to Congress, the public, the media, and other stakeholders about the status of the invasive carp threat, and the coordinated strategic actions undertaken by the ICRCC to address the threat.
- Collaborate with other invasive carp management efforts and partnerships outside the Great Lakes to leverage opportunities, best practices, strategies, and resources on invasive carp prevention and control across multiple basins, in support of the goals of the national *Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States* (National Plan).
- Continue to support the CAWS AIS Stakeholder Advisory Group as a platform to engage Great Lakes regional stakeholders on potential solutions to prevent invasive carp from moving through the CAWS and establishing self-sustaining populations.
- Continue working with the Technical and Policy Work Group (TPWG), a non-federal entity composed of members from stakeholder organizations, public-sector agencies, the scientific community, academia, and others.

These collaborative efforts will further support the efforts of partners to identify and leverage expertise, share data, and increase capacity to more broadly and holistically address the challenge of addressing invasive carp on a national, regional, multi-basin scale.

Communication and partnership operations actions supported by the 2022 Action Plan are:

Project Title (<i>Click on Project Title to go to the Project</i>)	Lead Agency
ICRCC Strategic Communications	USFWS
ACRCC Partnership Operations Assistance	USFWS
Coordination and Facilitation for the Chicago Area Waterway System Aquatic Invasive Species Stakeholder Group	USFWS
GLMRIS Program Management	USACE

4.0 NATIONWIDE AND BINATIONAL INVASIVE CARP MANAGEMENT

The ICRCC’s efforts to prevent the introduction and establishment of invasive carp in the Great Lakes takes place within a greater nationwide and international context. Invasive carp represent a significant challenge to natural resource managers across much of the United States and Canada.

4.1 NATIONWIDE INVASIVE CARP MANAGEMENT

Within the United States, the Mississippi River Basin acts as a potential invasion pathway to the 32 States within its watershed. Figure 13 shows the extent of Bighead Carp and Silver Carp populations within the Mississippi River Basin. Working through the Mississippi Interstate Cooperative Resource Association (MICRA) framework, interagency invasive carp partnerships have been formed in each of the six major river sub-basins to address the threat of invasive carp across the Mississippi River Basin. Individual, geographically-focused management strategies are now being implemented, stepped down from the national guidance provided in the *Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States* (https://invasivecarp.us/Documents/Carps_Management_Plan.pdf).

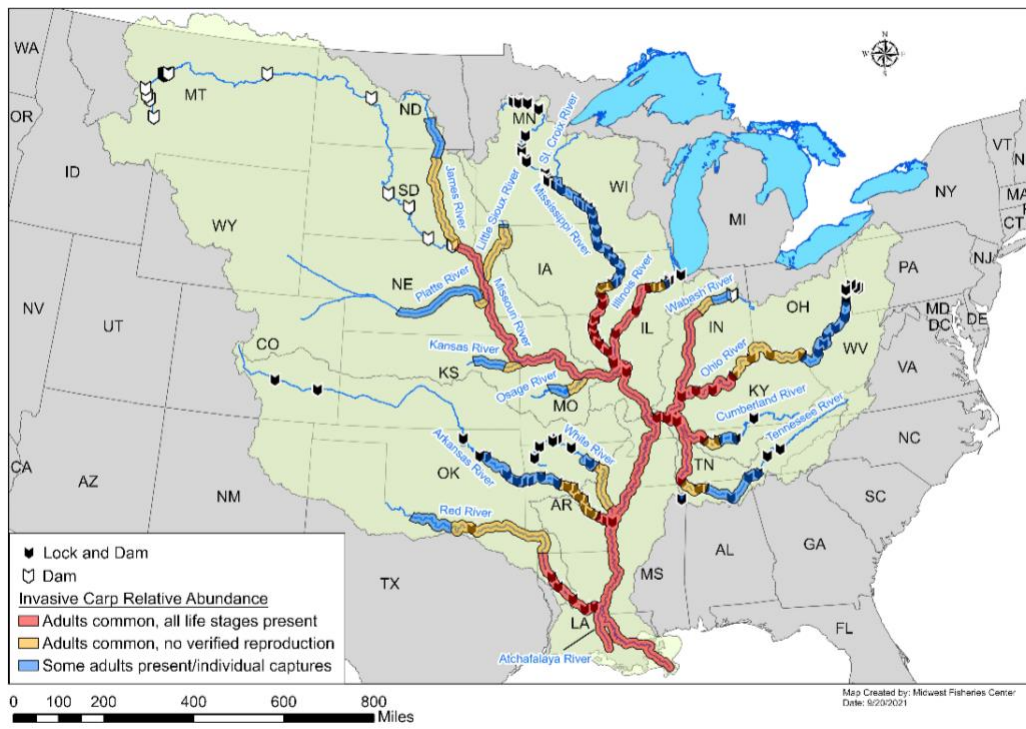
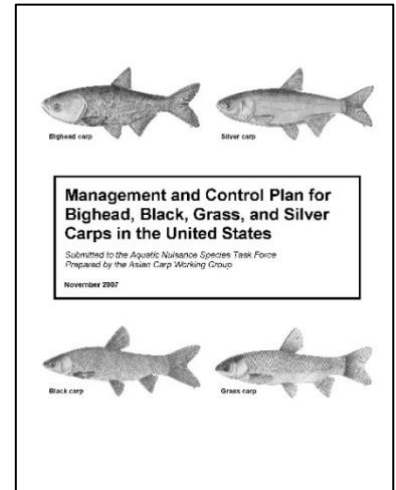


Figure 13. Characterization of the relative abundance of Bighead Carp and Silver Carp in the Mississippi River Basin.

Monitoring, tracking, and managing multiple populations of the four species across large, complex, multi-jurisdictional watersheds underscores the challenging and evolving nature of effectively addressing the threat posed by invasive carp. Accordingly, agencies have developed strategies and approaches to scientifically assess invasive carp and collect critically-needed information to inform actions, while continuing to focus on aggressive measures to prevent and control further introduction and range expansion.

4.2 CANADIAN EFFORTS IN SUPPORT OF THE ICRCC

Internationally, Fisheries and Oceans Canada (DFO), the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry (OMNDMNRF), and the Québec Ministère des Forêts, de la Faune et des Parcs (MFFP) are key Canadian Federal and Provincial ICRCC partner agencies working to address the threat of Grass, Bighead, Silver and Black carps to the Great Lakes and St. Lawrence River. Their efforts include policy, prevention, early detection surveillance, research and scientific oversight activities in the Canadian waters of the Great Lakes and St. Lawrence River, representing a critical component to ensuring a basin wide approach to addressing the threat. More information on these efforts can be found at the following agency websites:

DFO: <https://www.dfo-mpo.gc.ca/species-especes/profiles-profil/asiancarp-carpeasiatique-eng.html>

Quebec: <https://mffp.gouv.qc.ca/the-wildlife/wildlife-conservation/invasive/asian-carps/?lang=en>

Ontario: <https://docs.ontario.ca/documents/3194/stdprod-104398.pdf>

Asian Carp Response Plan: <https://www.asiancarp.ca/surveillance-prevention-and-response/asian-carp-response-plan/>

Appendix A

FY 2022 Funding Matrix

FY 2022 Invasive Carp Action Plan Funding

No.	Lead Agency	Project Title	GLRI Funding FY 2022(\$)	Agency Funding FY 2022 (\$)
Prevention Actions				
P-1	Illinois DNR	Alternate Pathway Surveillance in Illinois	\$150,000	\$0
P-2	USACE	Electric Dispersal Barrier System	\$0	\$19,498,000
P-3	USGS	USGS Support of the GLMRIS Brandon Road Project	\$80,000	\$0
P-4	USACE	Design and Construction of the Brandon Road Lock and Dam Aquatic Nuisance Species Barrier Project	\$0	\$230,778,000
Technology Development Actions				
T-1	Illinois DNR	Evaluation of Fish Sorting Technology to Promote Invasive Carp Harvest and Native Species Passage	\$625,000	\$0
T-2	USACE	Acoustic Deterrents for Invasive Carp	\$1,469,700	\$0
T-3	USFWS	Acoustic Deterrents for Invasive Carp	\$1,150,000	\$800,000
T-4	USGS	Acoustic Deterrents for Invasive Carp	\$1,695,000	\$469,000
T-5	USACE	Carbon Dioxide Deterrence for Invasive Carp	\$350,000	\$0
T-6	USGS	Implementation and Planning for a Carbon Dioxide Deployment	\$200,000	\$0
T-7	USGS	Carbon Dioxide Deterrence for Invasive Carp	\$150,000	\$360,000
T-8	USACE	Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation	\$1,600,000	\$0
T-9	USFWS	Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation	\$250,000	\$0
T-10	USGS	Prevention of Barge-Induced Transport of Aquatic Nuisance Species	\$100,000	\$0
T-11	USGS	Science Support for Control Efforts in the Illinois Waterway and Other Priority Sites	\$100,000	\$75,000
T-12	USFWS	Technology Registration and Environmental Review	\$40,000	\$15,000
T-13	USGS	USGS Multi-Deterrent Efficacy and Operations	\$50,000	\$0
T-14	USACE	USACE Multi-Deterrent Efficacy and Operations	\$527,900	\$0

FY 2022 Invasive Carp Action Plan Funding

No.	Lead Agency	Project Title	GLRI Funding FY 2022(\$)	Agency Funding FY 2022 (\$)
Early Detection, Monitoring and Evaluation Actions				
M-1	Illinois DNR	Illinois Waterway Detection, Management and Control, and Contingency Planning for Invasive Carp	\$3,973,800	\$0
M-2	Illinois DNR	Assessment of Invasive Carp Reproduction and Ecosystem Response in the Illinois Waterway	\$462,000	\$0
M-3	Illinois DNR	Invasive Carp Stock Assessment in the Illinois River/Management Alternatives	\$550,000	\$0
M-4	USFWS	Great Lakes Early Detection, Monitoring, and Evaluation	\$350,000	\$1,400,000
M-5	USFWS	Invasive Carp Demographics	\$240,000	\$120,000
M-6	USFWS	Des Plaines River Overflow Monitoring	\$15,000	\$0
M-7	USFWS	Illinois River Monitoring and Response Team Support	\$70,000	\$275,000
M-8	USFWS	Midwest Region Fisheries Program Capacity for eDNA Sampling and eDNA Processing	\$0	\$2,400,000
M-9	USACE	Telemetry in the Upper Illinois River	\$0	\$200,000
M-10	USFWS	Telemetry Support for the Spatially Explicit Invasive Carp Population (SEICarP) Model	\$110,000	\$250,000
M-11	USFWS	Illinois River Hydroacoustics	\$125,000	\$0
M-12	USGS	Real-Time Telemetry and Multi-State Modeling	\$105,000	\$104,000
M-13	USFWS	Early Detection of Invasive Carp in the Upper Illinois Waterway	\$350,000	\$600,000
M-14	USFWS	Upper Illinois Waterway Small Invasive Carp Distribution Monitoring	\$150,000	\$200,000
Control Actions				
C-1	Illinois DNR	Contract Fishing for Invasive Carp Detection and Removal	\$1,600,000	\$0
C-2	Illinois DNR	Invasive Carp Enhanced Contract Removal	\$885,300	\$0
C-3	Illinois DNR	Invasive Carp Removal, Brand Implementation, and Marketing	\$100,000	\$0

FY 2022 Invasive Carp Action Plan Funding

No.	Lead Agency	Project Title	GLRI Funding FY 2022(\$)	Agency Funding FY 2022 (\$)
Response Action				
R-1	USFWS, USGS and Illinois DNR	ICRCC Contingency Actions in the Upper Illinois River	\$0	\$0
Grass Carp Actions				
GC-1	Ohio DNR	Adaptive Management Framework for Grass Carp in Lake Erie	\$600,000	\$0
GC-2	Michigan DNR	Implementation of an Adaptive Management Framework for Grass Carp in Lake Erie	\$325,000	\$150,000
GC-3	USFWS	Implementation of an Adaptive Management Framework for Grass Carp for the Great Lakes	\$1,160,000	\$650,000
GC4	USGS	SpawnCast - A Grass Carp Spawning Event Prediction Tool	\$90,000	\$0
GC-5	USGS	Identification of Optimal River Conditions for Spawning and Recruitment of Invasive Carps in Tributaries of the Western Basin of Lake Erie	\$85,000	\$0
GC-6	USGS	Evaluation of Bait and Attractants to Increase Aggregation and Harvest of Grass Carp in the Lake Erie Basin	\$175,000	\$1,075,687
GC-7	USGS	Efficacy of an Oblique Bubble Screen System as a Two-Way Dispersal Barrier for Invasive Carp	\$205,000	\$205,000
GC-8	USGS	Improved Control Efficiency through Better Understanding of Grass Carp Movements and Habitat Use	\$200,000	\$630,000
GC-9	USGS	Identifying Spawning Tributaries and Specific Spawning Areas of Grass Carp	\$200,000	\$485,067
GC-10	USGS	Characterization of Hydrology and Sediment Mobility to Inform Design of a Seasonal Barrier in the Sandusky River	\$280,000	\$0
GC-11	USGS	Development and Testing of Deterrent Technologies for Grass Carp	\$195,000	\$0
GC-12	USFWS	Grass Carp Ploidy Analysis to Assess Reproductive Risk of Detected Populations	\$65,000	\$110,590
GC-13	USACE	Sandusky River Grass Carp Barrier	\$250,000	\$0
*	GLFC	Grass Carp Control in the Lake Erie Basin	\$0	\$1,000,000

FY 2022 Invasive Carp Action Plan Funding

No.	Lead Agency	Project Title	GLRI Funding FY 2022(\$)	Agency Funding FY 2022 (\$)
Black Carp Actions				
BC-1	Illinois DNR	Enhanced Detection of Black Carp in the Lower Illinois River	\$188,000	\$0
BC-2	USFWS	Black Carp Management and Control-Coordination and Support	\$68,500	\$61,000
BC-3	USGS	Black Carp Monitoring, Assessment and Control	\$450,000	\$120,000
Decision Support Actions				
DS-1	Illinois DNR	Invasive Carp Enhanced Contract Removal, Marketing, Assessment, and Management	\$188,600	\$0
DS-2	NOAA	Modeling Potential Invasive Carp Recruitment, Population Growth, and Food Web Effects in Great Lakes Tributaries	\$110,800	\$60,000
DS-3	USFWS	Invasive Carp Population Modeling to Support an Adaptive Management Framework	\$200,000	\$100,000
DS-4	USGS	Invasive Carp Population Modeling to Support an Adaptive Management Framework	\$100,000	\$270,000
DS-5	USGS	Invasive Carp Database Management and Integration Support	\$82,000	\$378,000
Communication Action				
Comm-1	USFWS	ICRCC Strategic Communications	\$200,000	\$100,000
Partnership Operations Actions				
PO-1	USFWS	ACRCC Partnership Operations Assistance	\$41,000	\$41,000
PO-2	USFWS	Coordination and Facilitation for the Chicago Area Waterway System Aquatic Invasive Species Stakeholder Group	\$54,000	\$0
PO-3	USACE	GLMRIS Program Management	\$0	**
TOTAL FUNDING*			\$23,136,600	\$262,980,344
FY 2022 GLRI Funding			\$ (21,000,000)	
FY 2021 Carry-over Funding			\$ (2,136,600)	

*Agency funding subject to final appropriation. All FY 2022 funding projections are based on appropriations provided by H.R. 6119, the “Further Extending Government Funding Act” which includes a short-term continuing resolution that provides fiscal year 2022 appropriations to Federal agencies through February 18, 2022.

**Funding for GLMRIS Program Management is included in USACE Base funding under Coordination with Other Water Resource Agencies.

FY 2022 Invasive Carp Action Plan Funding by Agency

Agency	GLRI Funding FY 2022 (\$)	Agency Funding FY 2022 (\$)
Illinois DNR	\$8,722,700	\$0
Ohio DNR	\$600,000	\$0
Michigan DNR	\$325,000	\$150,000
NOAA	\$110,800	\$60,000
GLFC	\$0	\$1,000,000
USACE	\$4,197,600	\$250,476,000
USFWS	\$4,638,500	\$7,122,590
USGS	\$4,542,000	\$4,171,754
TOTALS	\$23,136,600	\$262,980,344

Appendix B
FY 2022 Invasive Carp
Action Plan Actions

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APPENDIX B ACRONYM LIST

Acronym	Definition
ADS	Acoustic Deterrent System
AIS	Aquatic Invasive Species
ANS	Aquatic Nuisance Species
Arkansas GFC	Arkansas Game and Fish Commission
BAFF	Bio-Acoustic Fish Fence
BCWG	Black Carp Work Group
BRLD	Brandon Road Lock and Dam
CAWS	CAWS
CO ₂	Carbon Dioxide
CO ₂ -Carp	Carbon Dioxide-Carp
CRP	Contingency Response Plan
CSSC	Chicago Sanitary and Ship Canal
CWG	Communications Work Group
DC	Department of Conservation
DFO	Fisheries and Oceans Canada
DFWR	Department of Fish and Wildlife Resources
DNR	Department of Natural Resources
DWF&P	Department of Wildlife, Fisheries, and Parks
EDBS	Electric Dispersal Barrier System
eDNA	Environmental Deoxyribonucleic Acid
ERDC	Engineer Research and Development Center
FID	Federal Interest Determination
FWCO	Fish and Wildlife Conservation Office
FY	Fiscal Year
GFC	Game and Fish Commission
GLATOS	Great Lakes Acoustic Telemetry Observation System
GLFC	Great Lakes Fishery Commission
GLMRIS	Great Lakes and Mississippi River Interbasin Study
GLRI	Great Lakes Restoration Initiative
IBM	Individual-Based Bioenergetics Model
ICRCC	Invasive Carp Regional Coordinating Committee
IJA	Infrastructure, Investment and Jobs Act
Illinois DNR	Illinois Department of Natural Resources
Illinois EPA	Illinois Environmental Protection Agency
Indiana DNR	Indiana Department of Natural Resources
INHS	Illinois Natural History Survey
Iowa DNR	Iowa Department of Natural Resources
ISU	Invasive Species Unit

Appendix B Acronym List (continued)

Acronym	Definition
IWW	Illinois Waterway
I/O&M	Implementation/Operation and Maintenance
JSP	Joint Strategic Plan
Kentucky DFWR	Kentucky Department of Fish and Wildlife Resources
kHz	Kilohertz
LEC	Lake Erie Committee
LTRM	Long-term Resource Monitoring
MAM	Multi-Agency Monitoring
MFFP	Ministère des Forêts, de la Faune et des Parcs
Michigan DNR	Michigan Department of Natural Resources
Minnesota DNR	Minnesota Department of Natural Resources
Mississippi DWF&P	Mississippi Department of Wildlife, Fisheries & Parks
Missouri DC	Missouri Department of Conservation
MRP	Monitoring Response Plan
MRWG	Monitoring and Response Work Group
MWRD	Metropolitan Water Reclamation District
NER	National Ecosystem Restoration
New York DEC	New York Department of Environmental Conservation
NOAA	National Oceanic Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OBS	Oblique Bubble Screen
Ohio DNR	Ohio Department of Natural Resources
RDT&E	Research, Development, Testing and Evaluation
SDM	Structured Decision Making
SEICarP	Spatially Explicit Invasive Carp Population
SIM	Seasonal Intensive Monitoring
SIUC	Southern Illinois University Carbondale
Tennessee WRA	Tennessee Wildlife Resources Agency
TPWG	Technical and Policy Work Group
U.S.	United States
uADS	Underwater Acoustic Deterrent System
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USCG	US. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WLE	Western Basin of Lake Erie
WRA	Wildlife Resources Agency

P-1 ALTERNATE PATHWAY SURVEILLANCE IN ILLINOIS

Lead Agency: Illinois DNR

Agency Collaborators: None

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$150,000	\$0

Project Summary:

This project will prevent deliberate and unintentional introductions of invasive carp in Illinois and the Great Lakes. The project facilitates a multi-jurisdiction approach to the long-term protection of the Great Lakes Basin by increasing communication and enforcement capabilities amongst law enforcement personnel and other stakeholders. FY 2022 funding will produce a minimum of 20 aquatic life inspections of industries linked to the invasive carp trade where the highest priority for regulatory compliance has been identified; 10 fish truck transportation inspection details; responses to all aquatic invasive species law enforcement-related issues; and the implementation and coordination of enforcement objectives developed by the GLFC Law Enforcement Committee. In 2022, the training of a minimum of 20 Conservation Police Officers in invasive species enforcement techniques will further enable efforts and results beyond ISU outcomes only.

Project Description:

The Illinois DNR ISU created in 2012 is a specialized law enforcement component within the overall invasive carp project. The unit is fully dedicated to searching for illegal activities within the commercial fishing, aquaculture, transportation, bait, pet, aquarium, and live fish market industries. ISU focuses its time and resources on the likely pathways invasive carps can be spread by human means. Enforcement objective results demonstrate that human activities pose credible risks in every industry ISU enforces. ISU coordinates with other state and federal partners to protect the region and can assemble a team of Conservation Police Officers to address any threats or concerns that arise. ISU works alongside its non-law enforcement partners to further reduce the risk invasive carp and other invasive species present to the Great Lakes region.

P-2 ELECTRIC DISPERSAL BARRIER SYSTEM

Lead Agency: USACE

Agency Collaborators: None

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$0	\$19,498,000*

**Includes \$12,748,000 provided in the FY 2022 President’s Budget and \$6,750,000 provided in the IJA.*

Project Summary:

This project will operate and maintain the EDBS in the CSSC in Illinois. This project will result in continued first line of defense to prevent invasive carp from migrating upstream from the Illinois River and becoming established in the Great Lakes by maintaining a constant electrical current in the water of the CSSC. FY 2022 funding will support continuous operation of the EDBS, as well as continued efforts to improve efficacy.

Project Description:

The EDBS is located in Romeoville, Illinois on the CSSC, a man-made waterway creating the only continuous connection between Lake Michigan and the Mississippi River Basin. The EDBS was developed to prevent the spread of invasive fish species between these watersheds.

- USACE has operated electric barriers in the CSSC since 2002, beginning with the Demonstration Barrier (also known as Barrier I). Over the years, several operational and procedural improvements have been implemented to improve the effectiveness and to continuously deliver an uninterrupted flow of electricity to the water to deter fish.
- In 2004, USACE initiated construction of Barrier II, which includes several design improvements, including the use of steel billets for the electrodes instead of cables. Barrier II was implemented in two phases, known as Barriers IIA and IIB, with the capability of generating a more powerful electric field than the original demonstration project. Barrier IIA began full-time operation in 2009. Barrier IIB became fully operational in 2011.
- USACE was authorized to upgrade the demonstration project of 2002 to a permanent status. Permanent Barrier I is being implemented in two phases and will have the capability to operate at higher voltage levels than Barrier II. Construction activities for the Barrier I northern array have been completed. Performance verification and safety testing for normal operating parameters were completed in the second quarter of FY 2021, and it is currently operating. Award of the option to construct the southern array was completed in September 2021 and construction is scheduled to begin in FY 2022.



Figure 1. Electric Dispersal Barriers

P-3 USGS SUPPORT OF THE GLMRIS BRANDON ROAD PROJECT

Lead Agency: USGS

Agency Collaborators: USACE

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$80,000	\$0

Project Summary:

This effort will support the operation and maintenance of a real-time, continuous water-velocity and water-quality gaging station in the downstream approach channel to BRLD in the IWW in Illinois. This project will document pre-construction hydrologic and water chemistry conditions in the approach channel and temporal variations associated with the river and lock and dam operations. Data will inform planning to address potential impacts and engineering challenges associated with the deployment of barrier technologies in the approach channel to BRLD.

Project Description:

In support of the GLMRIS-Brandon Road project, USGS will continue monitoring water-velocity and water-quality in the downstream approach channel to BRLD (Figure 2). This USGS gaging station was established in 2015 and provides valuable data needed by the USACE for various phases of the project and serves as a record of pre-construction conditions in the approach channel. Data include water temperature, specific conductance, dissolved oxygen, pH, turbidity, chlorophyll-a, and carbon dioxide concentration and water velocity measured in nine cells across the downstream approach channel.

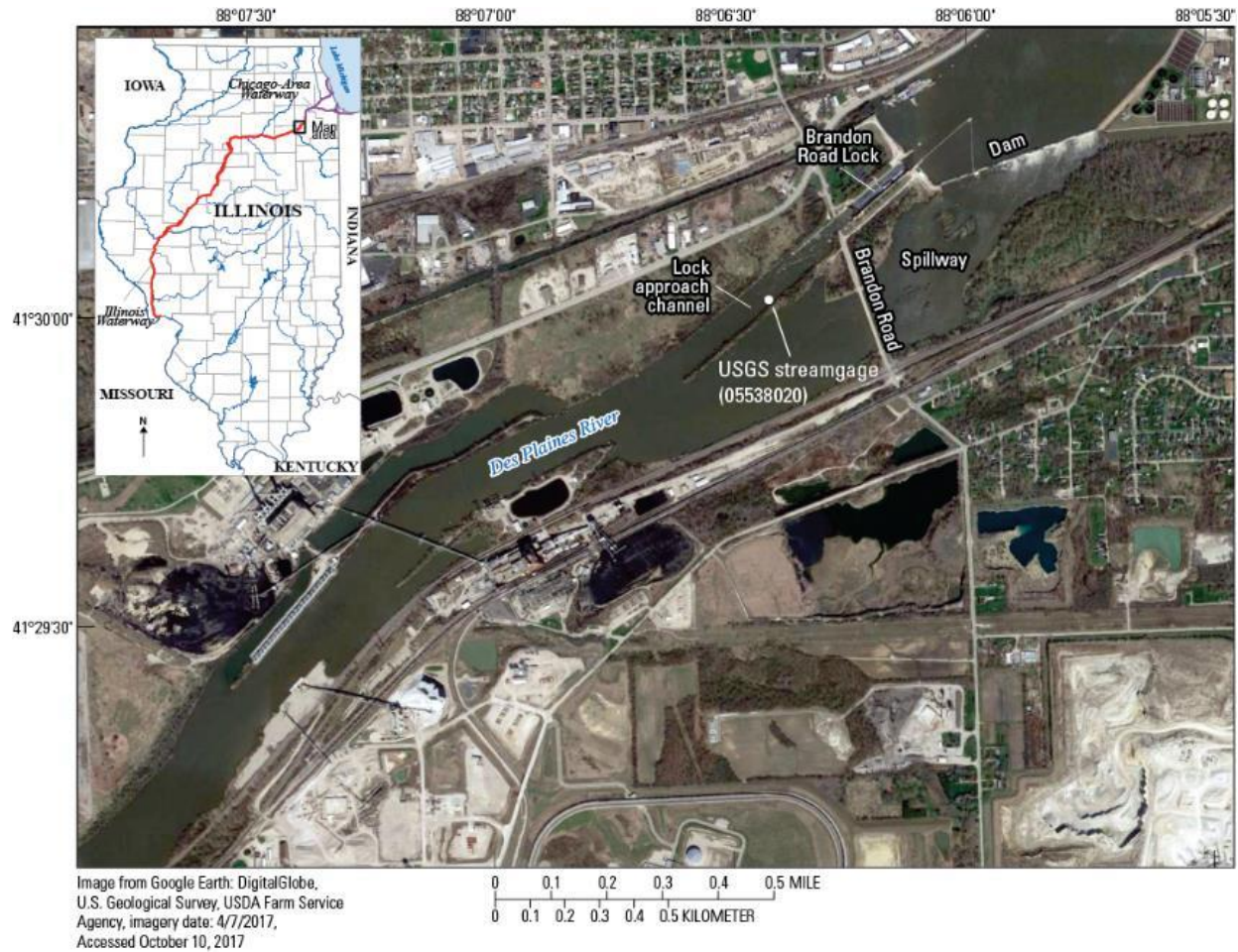


Figure 2. Map of the Des Plaines River (Illinois) near the BRLD and the location USGS streamgage.

P-4 DESIGN AND CONSTRUCTION OF THE BRANDON ROAD LOCK AND DAM AQUATIC NUISANCE SPECIES BARRIER PROJECT

Lead Agency: USACE

Agency Collaborators: None

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding*
\$0	\$230,778,000*

**\$230,778,000 includes \$4,940,000 from the FY 2022 President’s budget and \$225,838,000 from the IJA*

Project Summary:

This project will support design, construction and implementation of structural and nonstructural measures in the vicinity of the Brandon Road Lock and Dam near Joliet, Illinois that will prevent to the maximum extent possible the upstream transfer of ANS that swim (i.e. fish), float (i.e. fish eggs or larvae and plant fragments), and foul/hitchhike on vessel hulls (i.e. hull fouling crustaceans or plants attached to vessels) from the Mississippi River Basin into the Great Lakes Basin while minimizing impacts to waterway uses and users.

FY 2022 funding will be used to secure real estate rights of entry, and complete geotechnical exploration, physical modeling of the downstream channel, ANS Control Interaction Studies, shallow electric deterrent research, (stray current numeric model for insulation termination & channel length shortening), two value engineering charrettes, an Engineering & Evaluation Report, 65% level of completion of plans and specifications for Increment I acoustic deterrent and bubbler deterrents, and continue physical modeling of the Flushing Lock.

The IJA funds will be used to complete the plans and specifications for Increments I and II, execute a project cost share agreement with the local sponsor, the State of Illinois (scheduled for December 2022), and complete construction of Increment I, the first layer of risk reduction measures.

Project Description:

The project includes a layered system of structural controls and non-structural measures. The structural plan includes a new control point at Brandon Road Lock and Dam in addition to the control point that is already provided by the Chicago Sanitary and Ship Canal electric dispersal barrier system at Romeoville, Illinois. The new structural control point would include the Technology Alternative Acoustic Fish Deterrent with Electric Barrier, which includes an acoustic fish deterrent, a bubble deterrent, an engineered channel, an electric deterrent, and a flushing lock. The project includes managing the waterway below Brandon Road Lock and Dam

as a ‘population reduction zone’ where monitoring and overfishing would occur. Non-structural measures that may be implemented primarily by other federal and state agencies include public education and outreach, nonstructural monitoring, integrated pest management, piscicides, manual or mechanical removal of fish, research and development and two boat launches.

The project is anticipated to be constructed in three increments.

- Increment I includes site prep, channel excavation, bubble deterrent, acoustic deterrent, control building, upstream boat launch.
- Increment II includes electric deterrent, large acoustic deterrent, engineered channel wall, flushing lock, downstream boat launch, complete control building.
- Increment III includes completion of the engineered channel floor and walls.

The proposed project also includes compensatory mitigation to trap native fish downstream and transport them upstream, post-construction monitoring and adaptive management for a period of up to ten years to ensure project performance and focuses on success of physical construction that is within the control of the Corps, and annual operation and maintenance costs upon completion of the project.

T-1 EVALUATION OF FISH SORTING TECHNOLOGY TO PROMOTE INVASIVE CARP HARVEST AND NATIVE SPECIES PASSAGE

Lead Agency: Illinois DNR

Agency Collaborators: INHS, USGS, USACE

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$625,000	\$0

Project Summary:

This project will evaluate invasive carp attraction to and utilization of a mobile fish movement system/ladder with associated technology to support fish scanning and sorting capabilities in the Illinois River waterway in the State of Illinois. This project will result in implementation of a mobile pilot fish passage system that concurrently supports native fish passage and invasive carp harvest. This project will identify conditions necessary to promote invasive carp and native species utilization of the fish ladder. This project will support efforts to protect the Great Lakes by utilizing the fish ladder as a management tool to attract invasive carp and selectively remove them from the IWW while promoting the passage of native fishes at strategic locations (i.e., lock and dam bottlenecks, deterrent locations). Use of the new technology will ultimately help prevent the expansion and further establishment of invasive carp populations in the Illinois River waterway. FY 2022 funding will produce a mobile, pilot fish passage system that supports both native fish passage and invasive carp harvest and identifies conditions necessary to promote both invasive carp and native species utilization of the fish ladder. Secondary benefits will include scanning software to identify native and invasive fishes providing a species-selective system able to pass or constrain fish depending on their invasive status.

Project Description:

INHS and Illinois DNR will evaluate invasive carp attraction to and use of a mobile fish movement system/ladder with associated technology to support fish scanning and sorting capabilities. Deployment of a floating mobile platform to support the fish ladder will allow for the unit to be evaluated in multiple locations, as needed, helping to determine optimum positioning for effective use under different field-use scenarios. A flexible design will allow optimization of the fish ladder for invasive carp movement while also assessing the conditions necessary to selectively pass native fish species. As deterrents are configured to stop invasive carp, there is desire at some locations to selectively pass native fish while controlling invasive species. This technology could automate the process and increase hydrologic connectivity to native fish and mussels while concurrently supporting actions to constrain invasive fish at strategic barrier locations.

T-2 ACOUSTIC DETERRENTS FOR INVASIVE CARP

Lead Agency: USACE

Agency Collaborators: USFWS, USGS, Iowa DNR, Illinois DNR, University of Minnesota, Kentucky DFWR, Tennessee WRA, Western Kentucky University, University of Minnesota-Duluth, Purdue, University of Illinois, University of Wisconsin

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$1,469,700	\$0

Project Summary:

This project will further develop the use and efficacy of underwater acoustic deterrents at (1) Lock 19 on the Mississippi River (Keokuk, Iowa and Hamilton, Illinois); and (2) the Hanson Material Service, East Pit, Marseilles Pool on the Illinois River (Morris, Illinois). This project is further supported by laboratory work focused on testing more species, size ranges and signals to develop several signals for use depending on species and environment deployed. This project will result in efficacy of underwater acoustics as a method to prevent invasive carp from becoming established in the Great Lakes by generating a series of underwater signals that engages the lateral line and hearing sensory systems invasive carp, acting as a behavioral barrier to their movement. FY 2022 funding will produce (1) preliminary analyses from the Barkley Lock and Dam project, (2) preliminary analyses from the FY 2021 uADS deployment at Lock 19, (3) preliminary analyses of the uADS deployment at Morris, and (4) analyses of Black Carp and Grass Carp response to new engineered sounds deployed at Lock 19 as well as new engineered signals based on species-specific hearing ranges.

Project Description: *(This project is complementary to the USFWS project titled “T-3 Acoustic Deterrents for Invasive Carp” and the USGS project titled “T-4 Acoustic Deterrents for Invasive Carp”)*

Significant work has been done to identify biological and physical deterrent techniques that discourage the movement of invasive carp and common carp while allowing passage of native fish and recreational and commercial vessel passage to continue. Underwater acoustic deterrent systems have demonstrated effectiveness in laboratory and pond settings. Building off these studies and deploying large-scale experimental acoustic structures at critical passage points in the Ohio River and Upper Mississippi River basins will help managers understand the effectiveness of acoustic deterrents where invasive carp populations are established, with goal of informing potential opportunities for Great Lakes protection. For large-scale deployments, uADS will be installed at (1) bottlenecks in the river system, where invasive carp are only able to swim upstream through a lock chamber because the head height of the dam structure is impassable;

and (2) in soft bottom reaches where invasive carp populations already reside to examine the effectiveness and maintenance of underwater acoustics deterrent in systems that are less acoustically refractive than locks.

T-3 ACOUSTIC DETERRENENTS FOR INVASIVE CARP

Lead Agency: USFWS

Agency Collaborators: USGS, Kentucky DFWR, USACE-Nashville District, University of Minnesota

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$1,150,000	\$800,000

Project Summary:

This project will support implementation of a large-scale field study of the BAFF acoustic deterrent for invasive carp, including operations and maintenance of the BAFF system. The test is being conducted at the Barkley Lock and Dam on the Tennessee-Cumberland River in the State of Kentucky due to the physical characteristics of the dam (high-head dam with no overflow conditions), the presence of an existing monitoring infrastructure in place (telemetry receivers), and the presence of an established population of invasive carp. Upon completion of the study, final results will describe the effectiveness of the BAFF as a deterrent to invasive carp, informing potential opportunities for this technology to be transferred to other locations to protect the Great Lakes.

Project Description: *(This project is complementary to the USACE project titled “T-2 Acoustic Deterrents for Invasive Carp” and the USGS project titled “T-4 Acoustic Deterrents for Invasive Carp”)*

For this large-scale deployment, a BAFF – Fish Guidance Systems technology has been installed at the Barkley Lock and Dam approach channel on the Cumberland River in Kentucky. The system is being evaluated by an interagency research team for a total of three years. Silver Carp have been tagged and translocated each study year in the spring and the fall to track fish passage in a motivated state. Migration of fish is confined to a single passage point through the lock and will be monitored with the use of telemetry and hydroacoustic equipment around the BAFF. Funding through the Action Plan will be leveraged with base USFWS invasive carp funding to support continued operations and maintenance of the BAFF system.

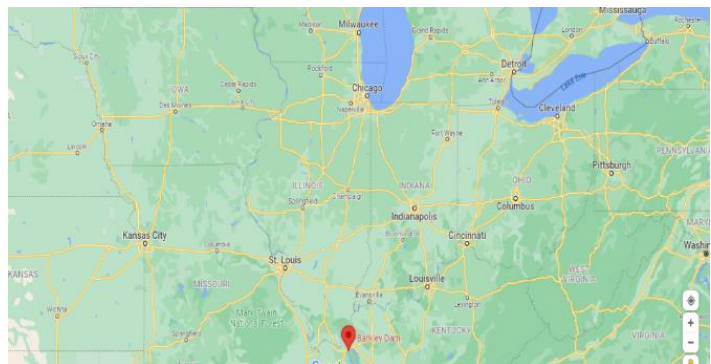


Figure 3. Map Showing Location of Barkley Dam

T-4 ACOUSTIC DETERRENTS FOR INVASIVE CARP

Lead Agency: USGS

Agency Collaborators: USFWS, USACE, Iowa DNR, Illinois DNR, Kentucky DFWR, Tennessee WRA, Missouri DC, Minnesota DNR, University of Minnesota-Duluth, University of Minnesota, Wisconsin DNR, Western Kentucky University

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$1,695,000	\$469,000

Project Summary:

This project will support research, deployment, and evaluation of acoustic deterrents in multiple locations, including the Cumberland River (BAFF at Barkley Lock); the Upper Mississippi River (uADS at Illinois/Iowa); and the Illinois River (testing engineered signals/playbacks in Illinois). This project will result in deployments and rigorous testing of experimental deterrents in rivers (specifically locks and dams) and prevent invasive carp from becoming established in the Great Lakes by discouraging upstream movement. FY 2022 funding will produce (1) quantitative measurements of fish movement at Barkley Lock and Dam in response to the BAFF; (2) continue evaluation of the uADS at Lock 19; and (3) continued evaluation of a small-scale acoustic deterrent in a backwater of the Illinois River to deter motivated fish and assess equipment performance. Efforts will complement ongoing design for the multi-deterrent engineered channel at the BRLD.

Project Description: *(This project is complementary to the USACE project titled “T-2 Acoustic Deterrents for Invasive Carp” and the USFWS project titled “T-3 Acoustic Deterrents for Invasive Carp”)*

Significant work has been done to identify potential biological and physical deterrent techniques that discourage the movement of invasive carp while allowing passage of native fish and shipping to continue. One candidate deterrent technique that has demonstrated effectiveness in laboratory and pond settings is underwater sound. Previous studies have documented both Bighead Carp and Silver Carp responding negatively to various underwater sound stimuli while many native fish species responded little to that same sound. Building off of these studies and deploying large-scale experimental acoustic structures at critical passage points in the Ohio River and Upper Mississippi River basins will help managers understand the effectiveness of acoustic deterrents where invasive carp populations are established and will evaluate potential for the technology to be transferred and deployed in other locations to prevent upstream migration to the Great Lakes. For this large-scale deployment, underwater sound equipment will be installed at bottlenecks in the river system where carp are only able to swim upstream through a lock

chamber because the head height of the dam structure is impassable. Migration of fish is then confined to a single passage point and can be monitored with the use of telemetry and hydroacoustic equipment.

In addition to field-testing of uADS, research efforts in the laboratory will continue to refine and optimize sound frequencies, sound pressure levels, and speaker designs to repel invasive carps while limiting or eliminating undesirable effects on native species. Future actions will focus on refining the sound characteristics that elicit the greatest response in these species in biologically motivated states (i.e., hunger, reproduction, etc.). The ultimate goal is to limit upstream passage of invasive carp, specifically in areas with access to the Great Lakes.

T-5 CARBON DIOXIDE DETERRENCE FOR INVASIVE CARP

Lead Agency: USACE

Agency Collaborators: USGS, USFWS, Illinois DNR, Illinois EPA

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$350,000	\$0

Project Summary:

This project will complete the planning for implementation of a CO₂ injection system in the CAWS as an additional carp deterrent at the EDDBS. This project will result in the engineering designs, estimated costs, and fluid dynamic models to assess the feasibility of CO₂ as a deterrent to prevent invasive carp from becoming established in the Great Lakes by clearing fish from the EDDBS after maintenance shutdowns. FY 2022 funding will produce field demonstration plans, identify permit and regulatory requirements associated with implementation, and develop contract documents.

Project Description: *(This project is complementary to the USGS project titled “T-7 Carbon Dioxide Deterrence for Invasive Carp”)*

The injection of CO₂ into water is being evaluated as a behavioral deterrent for invasive carps. In 2019, the USGS, USACE, and other partners demonstrated the temporary application of a CO₂ infusion system at a navigational lock in Wisconsin.

This project is focused on assessing the feasibility of CO₂ as a potential method to clear fish from the EDDBS within the CAWS. The EDDBS undergoes annual maintenance which could potentially present an opportunity for fish to move upstream towards Lake Michigan. This project will determine if CO₂ could be applied during or after maintenance to further reduce the risk of upstream expansion towards the Great Lakes. Additionally, if successful, the use of CO₂ could enhance general safety by eliminating the need to place boats within the electrified field of the EDDBS to manually remove fish.



Figure 4. Map of General Area for CO₂ (red box) Planning and Implementation. This area is adjacent to the current electric fish dispersal barrier in the CAWS.

T-6 IMPLEMENTATION AND PLANNING FOR A CARBON DIOXIDE DEPLOYMENT

Lead Agency: USGS

Agency Collaborators: USACE, USFWS, Illinois DNR, Illinois EPA

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$200,000	\$0

Project Summary:

This effort will complete the planning process for implementation of a CO₂ injection system in the CAWS. This project will result in the engineering designs, estimated costs, and fluid dynamic models to assess the feasibility of CO₂ as a deterrent to prevent invasive carp from becoming established in the Great Lakes by clearing fish from the electric dispersal barrier after maintenance shutdowns. FY 2022 funding will produce field demonstration plans, identify permit and regulatory requirements associated with implementation, and develop contract documents.

Project Description:

The injection of CO₂ into water is being evaluated as a behavioral deterrent for invasive carps. In 2019, the USGS, USACE, and other partners demonstrated the temporary application of a CO₂ infusion system at a navigational lock in Wisconsin. The next step to transfer this technology from research to management is to develop more permanent systems that can be utilized for management actions. More specifically, management agencies need well-defined startup costs and engineering designs for CO₂ infusion systems that can be deployed at key management points to keep invasive carps from moving into new areas.

This project is focused on assessing the feasibility of CO₂ as a potential method to clear fish from the electric EDDBS within the CAWS. The EDDBS undergoes annual maintenance, which could present an opportunity for fish to move upstream towards Lake Michigan. This project will determine if CO₂ could be applied during or after maintenance to further reduce the risk of upstream expansion towards the Great Lakes. Additionally, if successful, the use of CO₂ could enhance general safety by eliminating the need to place boats within the electrified field to manually remove fish.

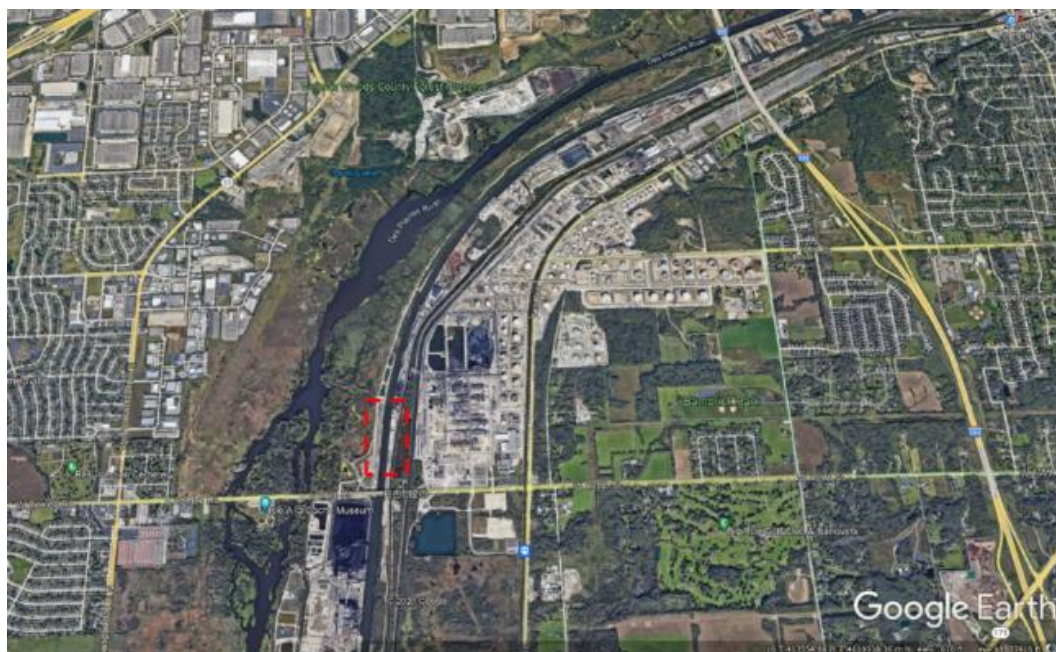


Figure 5. Map of General Area for CO₂ (red box) Planning and Implementation. This area is adjacent to the current electric fish dispersal barrier in the CAWS.

T-7 CARBON DIOXIDE DETERRENCE FOR INVASIVE CARP

Lead Agency: USGS

Agency Collaborators: USACE, USFWS

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$150,000	\$360,000

Project Summary:

This project will develop a control tool option for use by natural resource management agencies throughout the Great Lakes Basin. This project will result in efficacy, engineering, human health and regulatory compliance information for CO₂ as a deterrent barrier. This project will prevent invasive carp from becoming established in the Great Lakes by supporting management efforts through the use of CO₂ as a control tool. FY 2022 funding will produce deliverables that describe the effectiveness and regulatory compliance of CO₂ as a control tool for invasive carp.

Project Description: *(This project is complementary to the USACE project titled “T-5 Carbon Dioxide Deterrence for Invasive Carp”)*

CO₂ is being investigated as a potential deterrent to invasive carps. The concept is to introduce CO₂ into water to deter or prevent carps from moving upstream. Several published studies in laboratory, mesocosm and field settings have demonstrated that carps and other fishes are repelled from areas with elevated CO₂ concentrations. This avoidance mechanism could be useful for management agencies to restrict movement through key bottlenecks (e.g., navigational structures) and better control range expansion towards the Great Lakes and other large river basins.

T-8 EXPERIMENTAL FIELD TESTING OF LONGITUDINAL BUBBLER ARRAYS FOR BARGE ENTRAINMENT MITIGATION

Lead Agency: USACE, ERDC, Rock Island District

Agency Collaborators: USGS, USFWS, Illinois DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$1,600,000	\$0

Project Summary:

This project will field test the efficacy of bubbles in removing small invasive carp from the rake-box junction of commercial barges in the IWW in Illinois. This project will result in a means by which to mitigate the potential risk of barges inadvertently entraining small invasive carp and transporting them upstream and into the Great Lakes, thereby reducing the threat of introduction through this pathway. Results of this project will also help to address known vulnerabilities at the CAWS electrical barriers and assist in design of barriers at BRLD. FY 2022 funding will produce the analysis of field study data collected in the field trials in summer 2022 and a final technical report.

Project Description: *(This project is complementary to the USFWS project titled “T-9 Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation”)*

This project is a continuation of previous studies that investigated small fish entrainment, retainment, and upstream transport by commercial barge tows. The USACE and partner agencies have conducted several years of barge entrainment studies that demonstrate that small fish can become entrained and retained in the rake-to-box junction of commercial tows. These previous studies illustrate the needed mitigating technologies that can remove entrained small fish and, therefore, reduce the risk of upstream transport in the IWW.

Preliminary results from earlier experiments indicated that longitudinal bubbler arrays were the most effective of the configurations tested, with greater than 80% effectiveness at flushing particles from the box-rake junction. However, uncertainties remain regarding the translation of these scaled-laboratory tests to full-sized barges with live fish and navigation safety considerations.

In 2022, USACE collaborating with USFWS and USGS will carry out a full-size barge study to:

- Determine if the number of small invasive carp recaptured from the barge rake-to-box junction gap following fish stocking and transport into a lock is less for barge tows that pass over a longitudinal bubbler array compared to barge tows that do not pass over a bubbler array before entering the lock.
- Determine if the longitudinal bubbler has negligible effects on control and handling of commercial barges.

The interagency study team will conduct 30 treatment and 30 control trials then compare total fish recaptures (retainment) between the two trial types and determine the reaction of the barges to flows created by the longitudinal bubbler to assess safety. Treatment trials will consist of stocking 300-500 small invasive carp (marked with fin clips) directly into the barge tow junction gap then having the tow traverse 300m upstream passing over a 200-foot long longitudinal bubbler array immediately prior to entering Peoria Lock. Control trials will be identical with the exception that the longitudinal bubbler array will not be functional (i.e., not bubbling). In addition to netting, multibeam sonar videos of the junction gap will be recorded for the duration of each trial in order to provide a second measure of estimated fish retainment.

Invasive carp (Silver Carp) for the experimental trials will be collected in Peoria, LaGrange, and Alton pools as post-larva (8-10 millimeters total length) and transported to the Great Rivers Research and Education Center where they will be “grown out” in fish raceways until the experiment in August/September when the fishes will be approximately 40-50 millimeters total length. Conducting the field trials at Peoria Lock ensures that small invasive carp will not be transported upstream of their current range of distribution in the IWW.

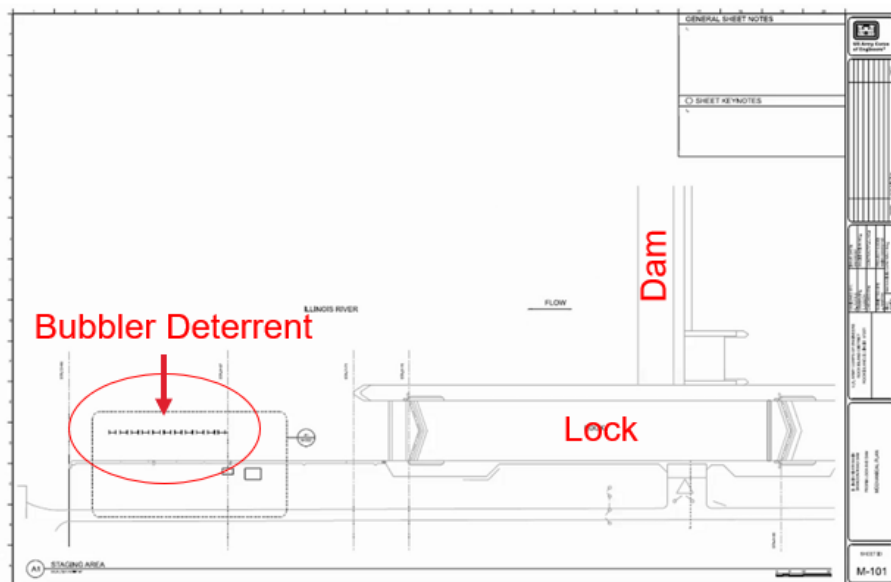


Figure 6. Location of Bubbler Deterrent at Peoria Lock and Dam, Illinois Waterway.

T-9 EXPERIMENTAL FIELD TESTING OF LONGITUDINAL BUBBLER ARRAYS FOR BARGE ENTRAINMENT MITIGATION

Lead Agency: USFWS

Agency Collaborators: USACE – Rock Island District, USGS, Illinois DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$250,000	\$0

Project Summary:

This project is part of a larger collaborative project, led by USACE, to field test the efficacy of bubbles in removing small invasive carp from the rake-to-box junction of commercial barges in the IWW in Illinois. This project will help inform the use of bubble technology as a means by which to mitigate the potential risk of barges inadvertently entraining small invasive carp and transporting them upstream and into the Great Lakes, thereby reducing the threat of introduction through this pathway.

Results of this project will also help to address known vulnerabilities at the CAWS electrical barriers and assist in design of barriers at BRLD. FY 2022 funding will enable the completion of field work for bubble deterrents including captive rearing invasive carp to be used during the field study.

Project Description: *(This project is complementary to the USACE project titled “T-8 Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation”)*

This project is a continuation of previous studies that investigated small fish entrainment, retainment, and upstream transport by commercial barge tows. The USFWS and partner agencies have conducted several years of barge entrainment studies that demonstrate that small fish can become entrained and retained in the box to rake junction of commercial tows. These previous studies illustrate the needed mitigating technologies that can remove entrained small fish and, therefore, reduce the risk of upstream transport in the IWW.

Preliminary results from earlier experiments indicated that longitudinal bubbler arrays were the most effective of the configurations tested with greater than 80% effectiveness at flushing particles from box-rake junction. However, it is unknown how these laboratory-scale trial results will translate to full-sized barges with live fish. Moreover, USACE is planning to conduct a full-scale safety test to ensure that the longitudinal bubble array is safe for commercial barge traffic.

In 2022, USFWS, collaborating with USACE and USGS, will carry out a full-size barge study to determine if the number of small invasive carp recaptured

from the barge rake-to-box- junction gap following fish stocking and transport into a lock is less for barge tows that pass over a longitudinal bubble array compared to barge tows that do not pass over a bubble array before entering the lock.

USFWS will conduct treatment and control trials and then compare total fish recaptures (retainment) between the two trial types. Treatment trials will consist of stocking 300-500 small invasive carp (marked with fin clips) directly into the barge tow junction gap then having the tow traverse 300 meters upstream passing over a longitudinal bubble array immediately prior to entering Peoria Lock. Control trials will be identical with the exception that the longitudinal bubble array will not be functional (i.e., not bubbling). In both the treatment and control trials, once the tow enters the lock and the chamber doors close, nets will be used to attempt to recapture any retained fishes. In addition to netting, videos of the junction gap will be recorded for the duration of each trail in order to provide a second measure of estimated fish retainment. Conducting the field trials at Peoria Lock ensures that small invasive carp will not be transported upstream of their current distribution in the IWW.

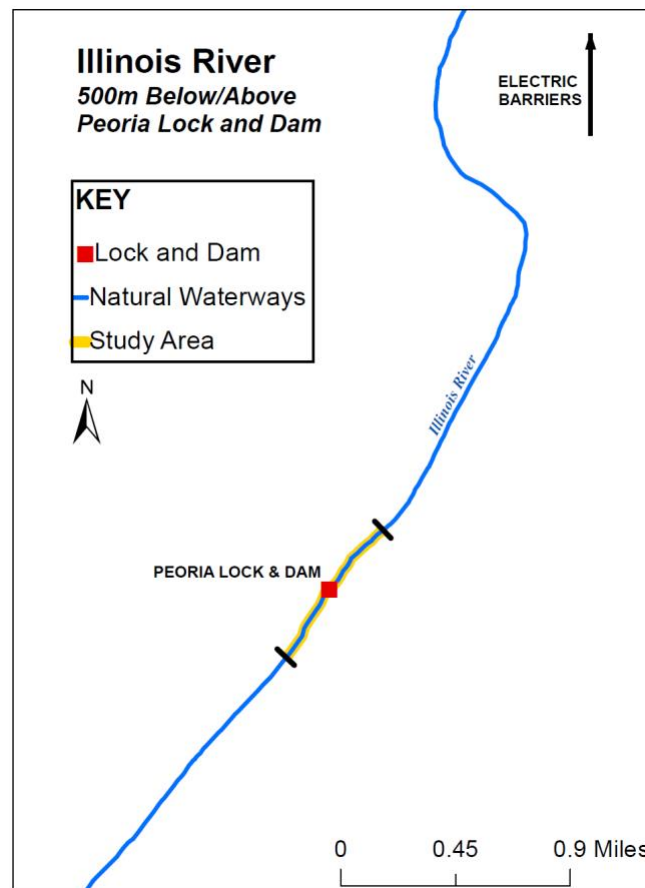


Figure 7. Map of Study Location – Peoria Lock and Dam, Illinois River

T-10 PREVENTION OF BARGE-INDUCED TRANSPORT OF AQUATIC NUISANCE SPECIES

Lead Agency: USGS

Agency Collaborators: USFWS, USACE

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$100,000	\$0

Project Summary:

This project will support the development and testing of mitigation technologies for preventing barge-induced upstream movement of invasive carp through navigation locks and electric barriers in the IWW of the State of Illinois. This project will result in the evaluation of bubbler arrays and other mitigation technologies on barges for fish clearing and prevent invasive carp from becoming established in the Great Lakes by reducing or preventing the barge-induced transport of invasive carp through locks and electric barriers. FY 2022 funding will produce a large-scale field study to test whether longitudinal bubbler arrays are effective at clearing fish away from barges, a data release of USGS data collected during the field study, and a final project report summarizing results of the field study.

Project Description:

This project is a continuation of previous interagency studies that investigated small fish entrainment, retainment, and upstream transport by commercial tows. This project covers USGS activities related to the interaction of commercial tow traffic with aquatic nuisance species such as invasive carps.

The USGS will continue efforts with USACE and USFWS collaborators in FY 2022 to develop ideas for preventing barge-induced fish passages at BRLD and the EDBS and plan out-year data collection efforts.

The project will also identify if there are locations and/or periods of time in which there is an increased risk of tows entraining bigheaded carp eggs or larvae and transporting them upstream in the IWW. The study entails a combined analysis of commercial vessel shiptrack data from the Nationwide Automatic Identification System with results from FluEgg model runs for six spawning events in the Illinois River in 2015.



Figure 8. Map of the Illinois River Showing the Locations of Lock and Dam Structures (Source: USACE web page). FY 2022 proposed work will take place at Peoria Lock and Dam.

T-11 SCIENCE SUPPORT FOR CONTROL EFFORTS IN THE ILLINOIS WATERWAY AND OTHER PRIORITY SITES

Lead Agency: USGS

Agency Collaborators: Illinois DNR, INHS, USACE, USFWS, Tennessee Valley Authority, NOAA

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$100,000	\$75,000

Project Summary:

This project will assess the influence of river hydraulics and water-quality on the population range, movement, and spawning/recruitment success of invasive carp in the IWW in Illinois. This project will result in monitoring data and evaluations of the consistency of spawning locations in relation to environmental conditions over several years and prevent invasive carp from becoming established in the Great Lakes by providing critical information that can be used to inform the design and evaluation of barrier technologies and guide control efforts. FY 2022 funding will produce real-time and synoptic data in the IWW to support specific partner needs, an assessment of seasonal variation in invasive carp spawning locations in the IWW, and FluEgg modeling support and training for state and federal partners.

Project Description:

This project investigates the influence of habitat stimuli, such as river hydraulics and water-quality, on the population range, movement, and spawning and recruitment success of invasive carp in the IWW and other priority sites identified by the ICRCC. Documenting and understanding how invasive carp interact with the hydraulics and water quality of a river informs efforts to deter invasive carp using novel barrier technologies and control invasive carp through commercial fishing, mass harvest techniques, and management of habitat factors. A large part of this project is providing a wide range of science support to other USGS centers and federal and state partners on invasive carp technology development projects and control efforts.

Proposed actions for FY 2022 include:

- Support of the operation and maintenance of two real-time, continuous water-quality monitoring stations in the Marseilles Pool of the IWW (one in the main channel and one in a backwater)
- Continue ongoing work using the reverse-time particle tracking capabilities of FluEgg v4.1.1 to estimate the most-likely spawning locations for eggs and larvae sampled in the IWW by the INHS in the summers of 2015 and 2018.

- FluEgg analyses to identify probable spawning locations of larvae captured in the Starved Rock and Marseilles pools in 2020 and 2021.

Additional work proposed for FY 2022 includes collaboration with NOAA on writing up the results of their IBM for the IWW. USGS provided a library of 240 FluEgg simulations for this modeling effort and will contribute to the interpretive journal article led by colleagues at NOAA.

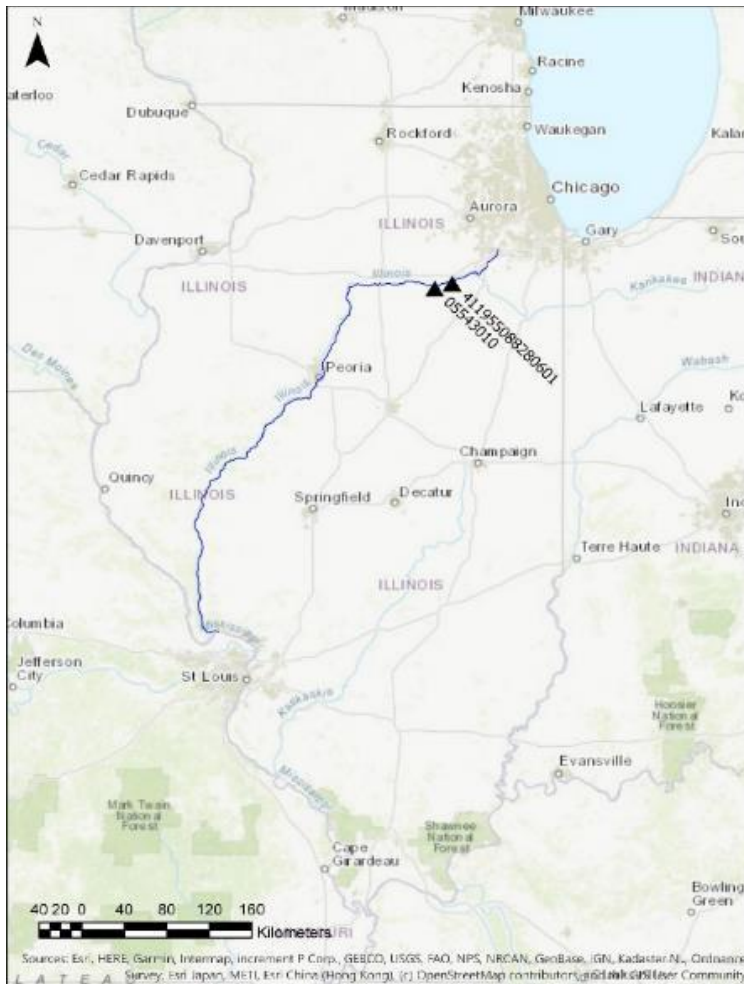


Figure 9. Map of Study Area – Illinois Waterway. The blue line is the centerline of the Illinois River. The two black triangles show two real-time, continuous water-quality monitoring stations in the Marseilles Pool of the IWW.

T-12 TECHNOLOGY REGISTRATION AND ENVIRONMENTAL REVIEW

Lead Agency: USFWS

Agency Collaborators: USGS, USACE, USEPA, University of Wisconsin Platteville, University of Illinois, Kentucky DFWR, Iowa DNR, Illinois DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$40,000	\$15,000

Project Summary:

This project will support multiple ongoing invasive carp deterrent and control technology projects submitted by USFWS and USGS. These include acoustic deterrent projects (Barkley Lock and Dam in Grand Rivers, Kentucky and Lock and Dam 19 in Keokuk, Iowa/Hamilton County, Illinois); CO₂-Carp; and Antimycin A. This project provides support to address the regulatory permitting and environmental reviews required for scaled-up field deployment of deterrent research projects to prevent the establishment of invasive carp within the Great Lakes. This project will result in deterrent technology projects fulfilling USEPA registration requirements and environmental review for field studies, including scale-up studies investigating engineering and design feasibility for invasive carp deterrent technologies. FY 2022 funding will continue the development and launch of an Online Program Management System for CO₂-Carp where resource managers can request the CO₂-Carp product label and administer all requests with associated records management and reports online.

Project Description:

This project supports the development, registration, and use of various emerging technologies to control invasive carp, including carbon dioxide (CO₂; now USEPA-registered as Carbon Dioxide-Carp), Antimycin-A, and acoustic deterrents.

For FY 2022, the proposed actions include the launch and maintenance of a USFWS-hosted online permit system so state and federal partners can register to use CO₂-Carp and request a label for the specific applications approved by the USEPA. USFWS and USGS will administer this system to provide and track the label to applicators, ensure state registrations and other necessary permits (for example, NPDES permits) are obtained prior to receiving the label, and collect data to report back to USEPA in order to maintain product registration.

T-13 USGS MULTI-DETERRENT EFFICACY AND OPERATIONS

Lead Agency: USGS

Agency Collaborators: USACE, USFWS, USBR, Arkansas GFC, Iowa DNR, Illinois DNR, Indiana DNR, Kentucky DFWR, Michigan DNR, Minnesota DNR, Missouri DC, Mississippi DWF&P, Tennessee WRA, Auburn University, Purdue University, University of Illinois, Western Kentucky University, University of Minnesota-Twin Cities, University of Minnesota-Duluth

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$50,000	\$0

Project Summary:

This project will further develop the planning, efficacy, and operations of multiple deterrents currently considered for potential installation at BRLD on the Des Plaines River at Joliet, Illinois. This project will result in the development of planning models for design, deployment, and operation of multiple deterrents in new locations to prevent invasive carp from becoming established in the Great Lakes. Project objectives include identifying methodologies and strategies for generating complex stimuli that actively engages more than one sensory system of invasive carp (such as hearing, lateral line, visual, and chemoreception cues). FY 2022 funding will produce (1) a stakeholder developed science plan for prioritizing deterrents testing that would include the physical attributes and interactions of the deterrents and fish behavior; (2) establishing an adequate data sharing portal for the participating agencies; and (3) choosing, designing, and developing several laboratory and field test locations for controlled studies to inform field designs and deployments.

Project Description: *(This project is complementary to the USACE project titled “T-14 USACE Multi-Deterrent Efficacy and Operations”)*

Significant work has been done to identify biological and physical deterrent techniques that discourage the movement of invasive carp while allowing native fish and recreational and commercial vessel passage to continue. In recent years, several other deterrents – Acoustics, CO₂, and Longitudinal Bubble Barrier – have been in development and may be safer for humans and navigation, and as effective in deterring invasive species. While potentially more effective, these deterrents may also reduce the impacts on native biota. Evaluation of these technologies tend to place additional emphases on (1) the effects on the environment, (2) effects of humans and human safety, (3) impacts to navigation, and (4) efficiency of the deterrents. These efforts do not formally include a plan for design and operations, estimating costs for installation, and operation/maintenance beyond the specific prototype meso- and mega-scale in field deployments.

USGS, in collaboration with federal, state, university, and private collaborators and stakeholders, will work with USACE to initiate a new FY 2022 effort to evaluate multi-deterrents. FY 2022 activities through this project include:

- I. Development of a science team of researchers and managers to:
 - Explore the multi-deterrent options (i.e., perpendicular air bubble, longitudinal air bubble, underwater acoustics, electrical, CO₂, resistance weirs, cavitation, and flushing lock) known strengths and weakness, share lessons learned, and conduct a gap assessment to develop a science plan and approach.



Figure 10. (Left) Location of the Brandon Road Lock and Dam, Joliet, Illinois. (Right) Diagram of Multiple Deterrents Under Consideration for BRLD Interbasin Project Deployment (Photo from www.usace.army.mil/Media/News/NewsSearch/Article/2465911/glmris-brandon-road).

- Prioritize multiple combinations of multi-deterrent testing for the physical interactions (i.e., how one deterrent impacts the functioning of another deterrent).
 - Prioritize multiple combinations of multi-deterrent testing for the efficacy (i.e., did two or three deterrents increase the desire response).
 - Choose meso-scale test beds (two to three) for further development and testing.
- II. Design and maintain a knowledge and data sharing portal to facilitate between federal agency data exchange and archiving.
- III. Undertake the design and construction of laboratory (for physics-based interaction model development) and meso-scale test beds including adequate holding or access to several species and sizes of invasive carp.

T-14 USACE MULTI-DETERRENT EFFICACY AND OPERATIONS

Lead Agency: USACE

Agency Collaborators: USACE, USFWS, USBR, USGS, Arkansas GFC, Iowa DNR, Illinois DNR, Indiana DNR, Kentucky DFWR, Michigan DNR, Minnesota DNR, Missouri DC, Mississippi DWF&P, Tennessee WRA, Auburn University, Purdue University, University of Illinois, Western Kentucky University, University of Minnesota-Twin Cities, University of Minnesota-Duluth

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$527,900	\$0

Project Summary:

This project will further develop the planning, efficacy and operations of multiple deterrents currently under consideration for potential installation at BRLD on the Des Plaines River (Joliet, Illinois). This project will result in develop planning models for design, deployment, and operation of multi-deterrents in new locations to prevent invasive carp from becoming established in the Great Lakes by generating complex stimuli that actively engages more than one sensory system (such as hearing, lateral line, visual, and chemoreception cues). FY 2022 funding will produce (1) a stakeholder developed science plan for prioritizing deterrents testing that would include the physical attributes and interactions of the deterrents and fish behavior; (2) establishing an adequate data sharing portal for the participating agencies; and (3) choosing, designing, and developing several laboratory and field test beds for controlled studies to inform field designs and deployments.

Project Description: *(This project is complementary to the USGS project titled “T-13 USGS Multi-Deterrent Efficacy and Operations”)*

The electrical barrier is the only deterrent with 10+ years of RDT&E investment from GRLI and USACE. In recent years, several other deterrents – Acoustics, CO₂, Longitudinal Bubble Barrier – are working towards developing deterrents that are safer for humans and navigation, as effective in deterring invasive species, yet reduce the impacts on native biota. These technologies tend to place additional emphases on (1) the effects on the environment, (2) effects of humans and human safety, (3) impacts to navigation, and (4) efficiency of the deterrent. Regrettably, these efforts do not formally include a plan for design and operations, estimating costs for I/O&M beyond the specific prototype meso- and mega-scale in field deployments. In addition, the current efforts, much like the electric barrier, have strengths, weakness, and of course, gaps in knowledge and applications.

USACE, in collaboration with federal, state, university, and private collaborators and stakeholders, will undertake a new effort for multi-deterrents RDT&E. This effort will development of a science team of researchers and managers to:

- Explore the multi-deterrent options (i.e., perpendicular air bubble, longitudinal air bubble, underwater acoustics, electrical, CO₂, resistance weirs, cavitation, and flushing lock) known strengths and weakness, share lessons learned, conduct a gap assessment to develop a science plan and approach for RDT&E.
- Prioritize multiple combinations of multi-deterrent testing for the physical interactions (i.e., how one deterrent impacts the functioning of another deterrent).
- Prioritize multiple combinations of multi-deterrent testing for the efficacy (i.e., did two or three deterrents increase the desire response).
- Choose two or three meso-scale test beds for further development and testing.
- Design and maintain a knowledge and data sharing portal to facilitate between federal agency data exchange and archiving.
- Undertake the design and construction of laboratory (for physics-based interaction model development) and meso-scale test beds including adequate holding or access to several species and sizes of invasive carp.



Figure 11. (Left) Location of the Brandon Road Lock and Dam, Joliet, Illinois. (Right) Diagram of Multiple Deterrents Under Consideration for BRLD Interbasin Project Deployment (Photo from www.usace.army.mil/Media/News/NewsSearch/Article/2465911/glmris-brandon-road).

M-1 ILLINOIS WATERWAY DETECTION, MANAGEMENT AND CONTROL, AND CONTINGENCY PLANNING FOR INVASIVE CARP

Lead Agency: Illinois DNR

Agency Collaborators: USACE, INHS, USGS, USFWS, USCG

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$3,973,800	\$0

Project Summary:

This project will maintain an active MRP for the State of Illinois in the IWW and CAWS developed in coordination with ICRCC partners through an adaptive process. This project will prevent invasive carp from becoming established in the Great Lakes through the implementation of Action Plan and MRP activities. FY 2022 funding will produce a written plan describing and coordinating partner agency efforts conducted in the IWW and CAWS in 2022 to achieve the goal of preventing invasive carp from arriving in the Great Lakes. The plan will detail field efforts, coordination, communication, and implementation of efforts to partners, as prudent.

Project Description:

The general purpose of this project is to prevent the establishment of invasive carp in the Great Lakes by precluding their movement via the CAWS through a variety of Illinois DNR-led actions supported and outlined in the ICRCC MRP. A rigorous detection protocol is in place, based on active roles in these waters to ensure invasive carp are not present nor thriving in waters between the EDDBS and Lake Michigan, as well as through additional strategic actions conducted further downstream. SIM has been identified as a robust process to inform managers of invasive carp status in the waters of the CAWS. Another key component of management and control of invasive carp in the upper IWW has been harvest/removal by contracted commercial fishing. Reduced invasive carp populations in the upper IWW reduces the chances of invasive carp gaining access to waters near the EDDBS. Informed by modeling outputs and observations, this adaptive process has shown success as the observed decline in densities in Dresden Island Pool has been reduced by as much as 96% since 2012 as noted by hydroacoustic surveys and correlative data.

FY 2022 detection actions supported by Illinois DNR under this project will include:

- Staffing, coordinating, and implementation of SIM in the CAWS.
- Contracting commercial fishers and staff to implement activities in CAWS and pools directly below EDDBS.

- Fish surveillance and suppression in support of maintenance to the EDBS.

A key component of management and control of invasive carp in the upper IWW has been removal by contracted commercial fishing. Reduced invasive carp populations in the upper IWW have been observed demonstrating lower propagule pressure and reducing the chances of invasive carp gaining access to waters near the EDBS. Primary areas fished include the Dresden Island, Marseilles, and Starved Rock pools. FY 2022 management and control actions under this project will include:

- Fixed and random site monitoring upstream of the EDBS
- Standardized monitoring downstream of the EDBS (fixed sites, where prudent) integrating young-of-year and juvenile monitoring into plan
- Removal of Bighead Carp and Silver Carp from connected or identified waters (e.g., lagoons, ponds, lakes when identified or warranted)

Contingency planning for response activities, including related communications, are identified in the annual MRP. The CRP is included as a component of the MRP. This planning supports more coordinated and effective interagency responses in the event of invasive carp detection in a new location. Annual tabletop exercises have proven to be helpful and allow for evaluation of the CRP, helping to identify any needed updates and clarification by utilizing both agency staff and other interested partners, as necessary. While the hope is that the CRP should not be used, ensuring that a robust and comprehensive plan is in place and ready for implementation, if needed, remains an ICRCC priority. A tabletop exercise will be planned for 2022.

M-2 ASSESSMENT OF INVASIVE CARP REPRODUCTION AND ECOSYSTEM RESPONSE IN THE ILLINOIS WATERWAY

Lead Agency: Illinois DNR

Agency Collaborators: INHS, Eastern Illinois University, SIUC, USGS Central Midwest Water Science Center

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$462,000	\$0

Project Summary:

This project will monitor for invasive carp reproduction in the IWW and select tributaries (Fox River, Kankakee River, Vermilion River, Sangamon River, Mackinaw River, and Spoon River), and quantify the relationship between zooplankton abundance and invasive carp density in a subset of navigation pools in the Illinois River. This project will prevent invasive carp from becoming established in the Great Lakes by providing rapid detection of invasive carp spawning in the IWW, guidance for targeted responses to disrupt invasive carp reproduction, and (in combination with harvest and removal efforts in the IWW) assessments of removal levels that will diminish the invasive carp population growth rate. Actions will slow expansion of the invasion front towards the Great Lakes via the IWW. FY 2022 funding will produce: (1) rapid detection of any invasive carp reproduction in the IWW, which will be reported through regular progress reports as well as rapid communication of detected reproduction to the MRWG group; (2) detection of any Black Carp reproduction in the IWW; (3) a quantified relationship between reproductive productivity, recruitment, and adult density to inform invasive carp removal efforts; and (4) a zooplankton-based assessment metric for evaluating ecosystem response to invasive carp removal.

Project Description:

Ichthyoplankton sampling is conducted to monitor for the eggs and larvae of invasive carp species, informing assessments of the extent, location, and timing of invasive carp reproduction in the IWW. Samples are collected with an ichthyoplankton push net at weekly intervals during April through June and bi-weekly from July through October, with more frequent sampling during periods when temperature and flow conditions are thought to be optimal for invasive carp spawning. Samples will be screened for the presence of species-specific DNA, which indicates possible invasive carp eggs and larvae. Microscopy will then be used to quantify number of invasive carp eggs and larvae in samples. These data are used as an early detection system for monitoring the upstream expansion or contraction of invasive carp populations in the IWW, and

potential reproduction by the newly expanding Black Carp population in Illinois. Data will also be used to quantify the relationship between invasive carp stock abundance, reproductive output, and subsequent recruitment to assess the level of removal needed to degrade the ability of invasive carp to establish self-sustaining populations. Vertically integrated zooplankton samples will be collected bi-weekly between April and October. Illinois DNR will also collect data on environmental factors known to influence zooplankton communities in large rivers, such as turbidity, chlorophyll *a*, total phosphorus, and discharge. Targets for ecosystem response to invasive carp removals will be developed by using monitoring data from the pre-assessment time period to model zooplankton indicators as a function of invasive carp abundance and the seasonal environmental variation driving their spatiotemporal dynamics (e.g., discharge, temperature, total phosphorus, chlorophyll *a*).

The threat of invasive carp reproduction in the upper navigation pools of the IWW is particularly acute because of the risks this poses for expansion of the invasion front towards Lake Michigan and subsequent increased potential for these species to challenge the electric dispersal barrier. The level of spawning occurring in the upper Illinois River affects recruitment occurring downstream; therefore, quantifying the relationship between adult density, reproductive productivity, and recruitment will allow for the establishment of levels of invasive carp harvest in the navigation pools of the upper river that will degrade reproductive productivity sufficiently to diminish population growth rate in downstream navigation pools, ultimately reducing the number of fish moving upstream and further contributing to declines in densities in the upper Illinois River.



Figure 12. Map of Sampling Locations (dark circles within Illinois Waterway and select tributaries).

M-3 INVASIVE CARP STOCK ASSESSMENT IN THE ILLINOIS RIVER

Lead Agency: Illinois DNR

Agency Collaborators: SIU, USACE, USGS, INHS

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$550,000	\$0

Project Summary:

This project will involve hydroacoustic sampling, implanting invasive carp with acoustic transmitters, and maintaining an acoustic receiver array in Illinois, specifically the Alton - Dresden Island pools of the Illinois River. This project will result in the identification of high-density locations of invasive carp, a long-term assessment of population trends, and quantification of upstream movements. This project will prevent invasive carp from becoming established in the Great Lakes by directing harvest to high-density locations near the invasion front, aiding decisions on current levels and locations of removal and deterrents in support of MRWG goals and will inform managers of potential invasive carp movement into upstream pools to determine whether contingency response actions are necessary. FY 2022 funding will produce invasive carp density maps every other month in the Marseilles and Dresden Island pools, illustrating locations where densities are highest. This project will also produce pool-wide density estimates from Alton to Dresden Island pools, the number of tagged invasive carp at-large in each pool, the number moving into other pools through lock and dams, and probability estimates of invasive carp moving among pools.

Project Description:

This project uses several approaches to assess the invasive carp populations to aid removal and response efforts. Hydroacoustic sampling will occur in the upper Illinois River throughout the Marseilles and Dresden Island pools every other month from February to October to identify locations of high invasive carp densities. The resulting density heatmaps (illustrating locations where densities are highest) will be provided to MRWG members so that removal efforts can be targeted as fish aggregations within each pool change throughout the year. The same sampling approach and density heatmap generation will also occur for each Unified Method mass removal event that takes place in the upper Illinois River. Hydroacoustic sampling will also occur in Alton to Dresden Island pools in October to quantify pool-wide invasive carp densities for comparison to long-term data collected since 2012. These trends through time will help determine whether the relative abundance of invasive carp is changing from recent years, possibly as a result of management actions, and whether relative abundances in lower river pools

suddenly increase and warrant additional actions to prevent an upstream surge. Monitoring of acoustically tagged invasive carp will continue from Alton to Dresden Island pools across an array of 70 stationary receivers. Seventy-five invasive carp will be implanted with acoustic transmitters in Alton Pool; 75 in LaGrange Pool; 50 in Starved Rock Pool; and 50 in Marseilles Pool to supplement the existing number of acoustically tagged individuals at large in these pools. The Telemetry Work Group goal is to maintain at least 50 active transmitters per pool in the upper Illinois River and 150 tags per pool in the lower Illinois River. The resulting movement data will be used to identify pool-to-pool movement rates (including dam versus lock passage routes) for inclusion into the SEICarP model and to assess potential changes in upstream movements by comparing the number of tagged fish at-large in each pool to data from past years. Maintaining a high number of tagged fish in the lower Illinois River also allows for the identification of potential upstream movements via detection on real-time receivers that could determine whether a contingency response action is necessary.

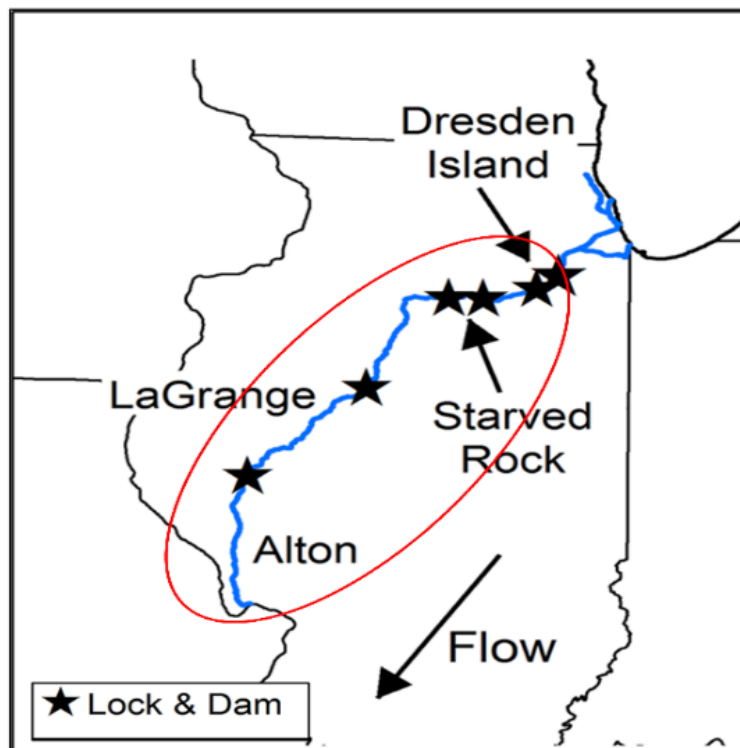


Figure 13. Project Location Throughout the Illinois River, including Dresden Island, Marseilles, Starved Rock, Peoria, LaGrange, and Alton Pools.

M-4 GREAT LAKES EARLY DETECTION, MONITORING, AND EVALUATION

Lead Agency: USFWS

Agency Collaborators: Michigan DNR, Illinois DNR, Indiana DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$350,000	\$1,400,000

Project Summary:

This project will implement a comprehensive early detection surveillance program for invasive carp species in the Great Lakes at high-risk locations in southern Lake Michigan (Calumet River, Burns Harbor, and Burns Ditch) and western Lake Erie. USFWS biologists will utilize an array of traditional and novel gears to sample all potential life stages of invasive carp species to maximize detection probability, if present. This program complements the eDNA monitoring program implemented by the USFWS and partners.

Project Description:

USFWS will continue to implement a comprehensive early detection surveillance program for Bighead Carp, Silver Carp, Grass Carp, and Black Carp in and near the Great Lakes. This program complements the invasive carp eDNA monitoring programs implemented by the USFWS and partners. Sampling will primarily target areas of high concern in the Great Lakes (e.g., nearshore areas in southern Lake Michigan and western Lake Erie, specific locations with past positive eDNA results, etc.), and use a wide array of traditional and novel gears to sample all potential life stages of invasive carp species.

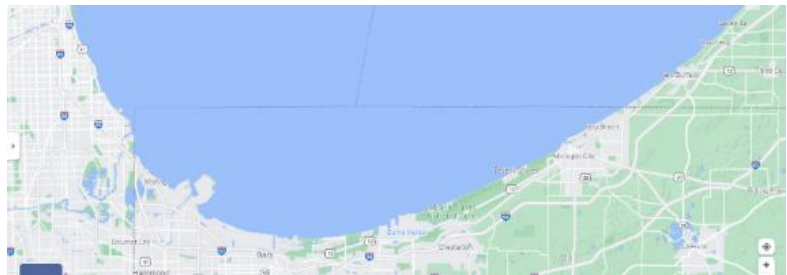


Figure 14. Project Area: Chicago – Southern Lake Michigan

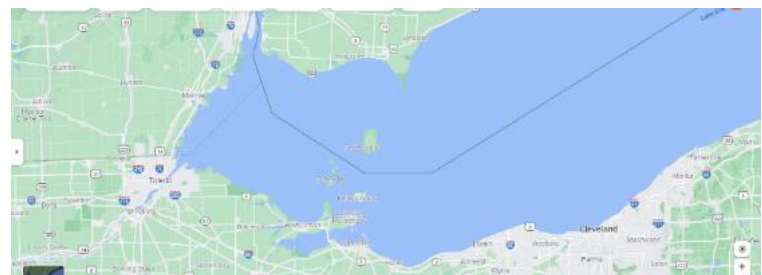


Figure 15. Project Area: Western Lake Erie

M-5 INVASIVE CARP DEMOGRAPHICS

Lead Agency: USFWS

Agency Collaborators: INHS, Illinois DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$240,000	\$120,000

Project Summary:

This project would build on an existing multi-year age dataset for invasive carp using standardized aging protocols and methods. The data will inform MRWG-supported population models (i.e., SEICarP, statistical catch-age-age stock assessment models) used to scientifically-inform efforts to prevent invasive carp from becoming established in the Great Lakes. FY 2022 funding will be used to produce age and growth data from age analyses on approximately 1,200 Silver Carp in the lower six pools of the Illinois River (i.e., Alton, LaGrange, Peoria, Starved Rock, Marseilles, Dresden Island).

Project Description:

This project will process invasive carp age structures (i.e., lapilli otoliths) from fish collected through the MAM Program in the lower six pools of the Illinois River. These age structures will be analyzed in the USFWS fish aging laboratory. After ages are assigned to all samples, age and growth data will be provided to the MRWG Modeling Work Group to inform invasive carp population models in the Illinois River. Such models will be used to evaluate the relative importance of fishing mortality, fish movement, and natural mortality to observed declines in Silver Carp abundance; thereby informing intensive invasive carp harvest efforts and other management in the Illinois River. Furthermore, working collaboratively with MAM and the MRWG Modeling Work Group, USFWS will provide additional age structure collection support where necessary in the fall period of MAM collections.



Figure 16. Map Showing the Lower Six Pools in the Illinois River. Source: https://www.ifishillinois.org/images/illinois_river.gif

M-6 DES PLAINES RIVER OVERFLOW MONITORING

Lead Agency: USFWS

Agency Collaborators: USACE Chicago District, Illinois DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$15,000	\$0

Project Summary:

This project will continue a monitoring effort focused on the early detection of invasive carp in the Des Plaines River, Illinois. This project will prevent invasive carp from becoming established in the Great Lakes through detection of invasive carp potentially bypassing the EDBS by moving between the Des Plaines River and the CSSC, especially during high water events. FY 2022 funding will produce data about any potential invasive carp breaches as well as an annual Interim Summary Report detailing the results of the sampling.

Project Description:

Routine targeted early detection monitoring increases the likelihood of detecting and removing invasive carp that may have migrated into the Des Plaines River prior to the occurrence of overflow events, thereby reducing the risk of subsequent invasive carp transfer into the CSSC in the vicinity of the EDBS. Through this project, fixed sites will be sampled three times throughout the field season for invasive carp. Additional sampling will be scheduled if: (1) invasive carp population status in Brandon Road Pool significantly increases; or (2) there are credible reports of invasive carp sightings in the upper Des Plaines River. Overflow monitoring will occur each time an overflow event occurs.

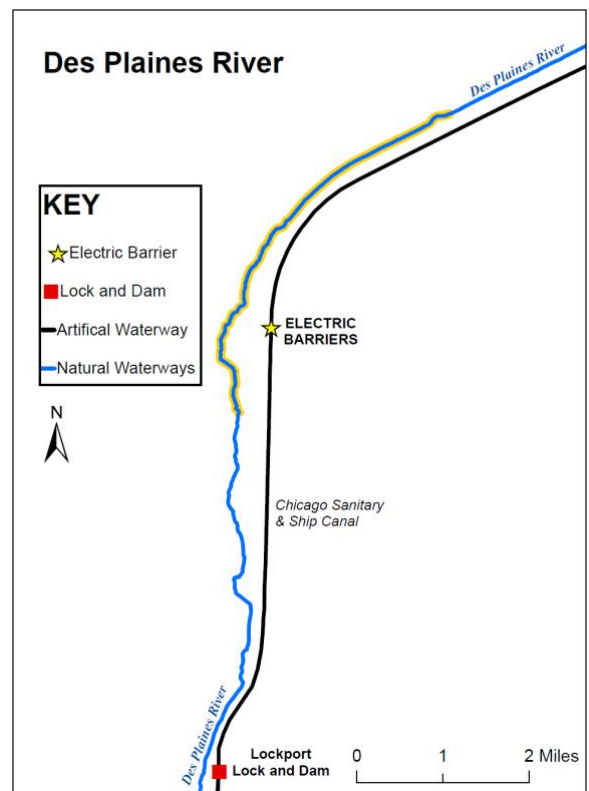


Figure 17. Map of Study Area – Des Plaines River

M-7 ILLINOIS RIVER MONITORING AND RESPONSE TEAM SUPPORT

Lead Agency: USFWS

Agency Collaborators: Illinois DNR, USACE Chicago District, SIU

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$70,000	\$275,000

Project Summary:

This project will provide for USFWS field support of SIM, Unified Method, and contingency response efforts in the upper IWW. This project will prevent invasive carp from becoming established in the Great Lakes by providing field support for actions focused on early detection upstream of the EDBS, population control downstream of the EDBS, and contingency response. FY 2022 funding will support monitoring and response activities and produce summarized data provided to Illinois DNR for all sampling events.

Project Description:

USFWS will assist the Illinois DNR-led SIM during two events in 2022 (April/May and October). USFWS assists with the Unified Method as planned by the Illinois DNR each year. The SIM supports invasive carp early detecting in the CAWS upstream of the EDBS, thereby aiding the prevention of invasive carp population establishment upstream of the EDBS. The USFWS is on call if a contingency response action is requested by the ICRCC. Unified Method controls invasive carp population abundance in the downstream vicinity of the EDBS, further reducing propagule pressure on the system. Contingency response actions are aimed to minimizing threats of invasive carp establishment through rapid deployment in the event of a new detection.



Figure 18. Map of Study Area - CAWS.

M-8 MIDWEST REGION FISHERIES PROGRAM CAPACITY FOR EDNA SAMPLING AND EDNA PROCESSING

Lead Agency: USFWS

Agency Collaborators: States, Tribes of Great Lakes, Upper Mississippi River, Ohio River

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$0	\$2,400,0000

Project Summary:

This project will monitor for the presence of invasive carp eDNA in the Great Lakes, Upper Mississippi River, and Ohio River basins. USFWS will process water samples collected by field staff, in collaboration with state and tribal agency partners, to detect the presence of invasive carp DNA in Great Lakes tributaries of concern to help monitor for the potential presence of these invasive carp species. FY 2022 funding will produce results for 8,000 to 9,000 collected and analyzed water samples.

Project Description:

The USFWS applies the science of eDNA as an early detection and monitoring tool in support of the ICRCC strategic approach for protecting the Great Lakes from invasive carp. This work includes the continued refinement and development of state-of-the-art tools, field sampling and laboratory protocols, and expanded analytical capacity to support a robust eDNA monitoring program for efficiently sampling high-priority locations for the presence of invasive carp. USFWS has identified the need to maintain program capacity for eDNA surveillance in the Great Lakes, Upper Mississippi, and Ohio River basins. Building upon work that has been completed for Bighead Carp and Silver Carp marker improvements, field collection and extraction protocols, USFWS will continue support for invasive carp surveillance for Great Lakes protection as part of this monitoring program.

Use of eDNA as a monitoring tool for invasive carps and other AIS has been successfully implemented since 2013, coordinated through the USFWS Midwest Fisheries Center - Whitney Genetics Lab. Improvements through research efforts within federal agencies and academic institutions has resulted in realized efficiencies in field and laboratory techniques and processes allowing for analytical capacity to expand each year. Higher throughput has been realized with modifications to current procedures and methods, all of which have been tested and validated in three labs in order to be adopted into the Quality Assurance Project Plan.

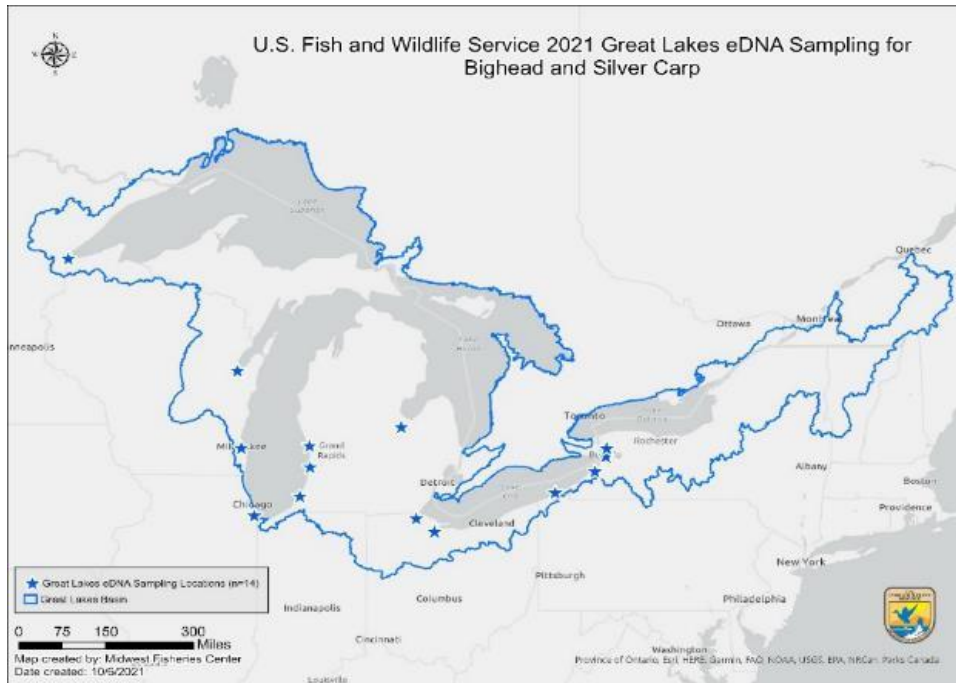


Figure 19. Map Identifying Locations for eDNA Sampling for Bighead Carp and Silver Carp.

M-9 TELEMETRY IN THE UPPER ILLINOIS RIVER

Lead Agency: USACE

Agency Collaborators: USFWS, USGS, SIUC, Illinois DNR, Illinois NHS

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$0	\$200,000

Project Summary:

This project will track and monitor the movement of invasive carp and surrogate species in the upper Illinois River from Dresden Island Lock and Dam to the confluence of the CSSC and Sal-Sag Channel in Illinois. This project will result in a greater understanding of surrogate fish movements and interactions with locks and dams and the electric dispersal barrier and prevent invasive carp from becoming established in the Great Lakes by monitoring the adult population front in Dresden Island and identify locations for targeted removal. FY 2022 funding will produce monthly summaries and a year-end analysis of telemetry data to be included with the 2022 MRWG Interim Summary Report.

Project Description:

Telemetry in the upper Illinois river has three major goals that consist of tracking and monitoring fish from Dresden Island to the confluence of the CSSC and the Cal Sag. The major goals consist of: (1) Monitor the EDDBS for upstream passage of large fishes and assess risk of Bighead Carp and Silver Carp presence (Barrier Efficacy); (2) Identify lock operations and vessel characteristics that may contribute to the passage of Bighead Carp and Silver Carp and surrogate species through navigation locks in the Upper IWW; and (3) Evaluate temporal and spatial patterns of habitat use at the leading edge of the Bighead and Silver Carp invasion front. This funding request is to continue the work in assessing the efficacy of Barriers IIA and IIB, and permanent Barrier I. Future work will combine the historical acoustic telemetry monitoring with alternative monitoring systems at the barrier site such as hydroacoustics in cooperation with partner agencies. Additionally, continual refinement of the stationary receiver network will occur which increases efficiency and coverage within the system. Further downstream, the combined receiver array established by USACE, and the receiver arrays established by SIUC and USFWS have been able to monitor long term movement of invasive carp in the entire IWW, including localized movements through lock structures and at the area of the population’s leading edge. Future downstream activities have focused on inter-pool movement across the BRLD and finer scale movement detection of invasive carp within the Dresden Island Pool.

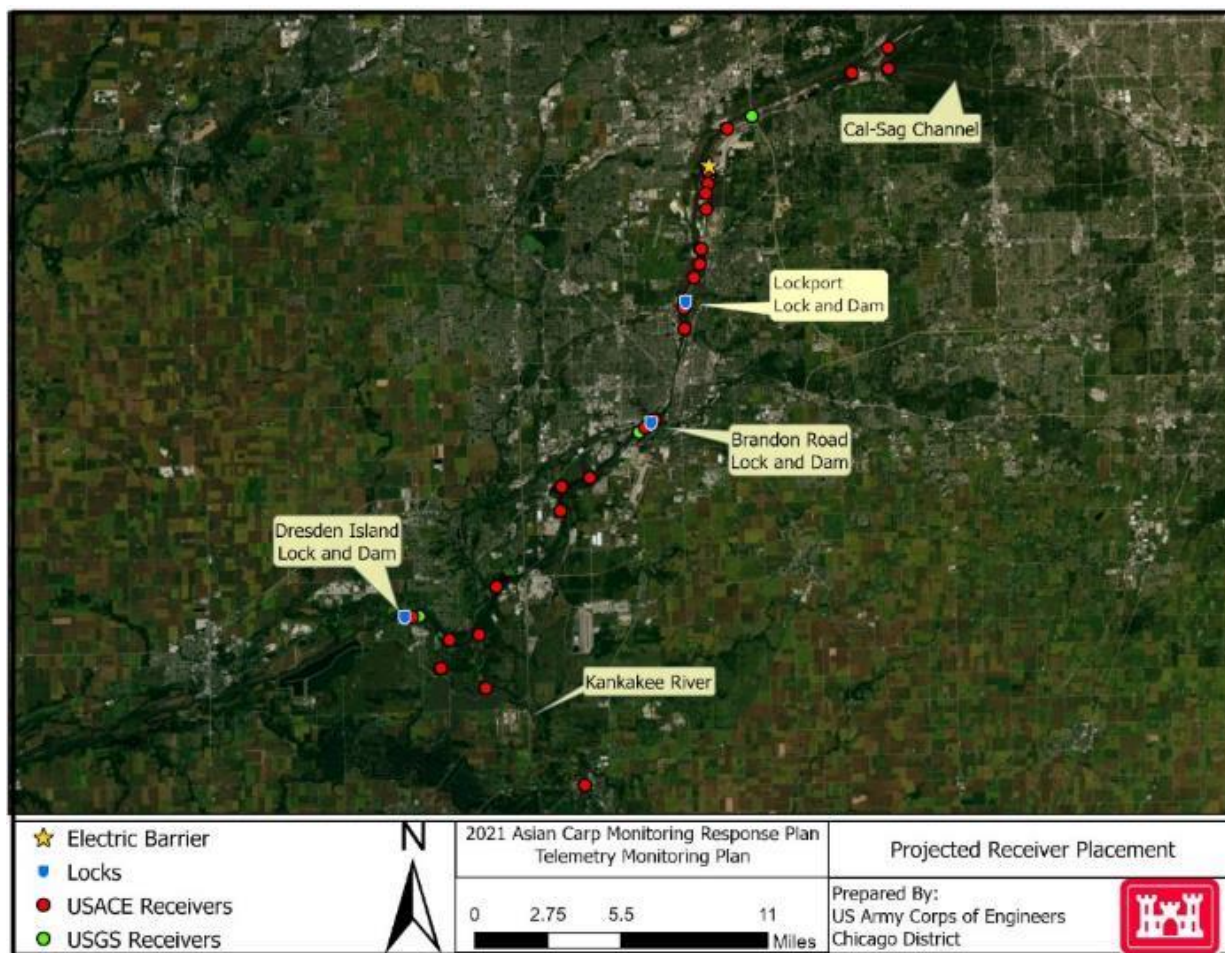


Figure 20. Telemetry Project Area Map.

M-10 TELEMETRY SUPPORT FOR THE SPATIALLY EXPLICIT INVASIVE CARP POPULATION MODEL (SEICARP)

Lead Agency: USFWS

Agency Collaborators: SIU, USACE Chicago District, USGS

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$110,000	\$250,000

Project Summary:

This project will provide telemetry support for the SEICarP model that estimates invasive carp population status in the IWW. This project will result in estimates of the frequency of pool-to-pool invasive carp movement and prevent invasive carp from becoming established in the Great Lakes by improving the accuracy of SEICarP model predictions. FY 2022 funding will produce data on the movement of telemetered invasive carp in the IWW that will be used to parameterize the SEICarP model.

Project Description:

In 2022, in support of parameterizing the movement component of the SEICarP model, USFWS crews will tag an additional 150 Silver Carp and Bighead Carp in and around the Peoria Pool and Starved Rock Pool with acoustic transmitters. Tagging locations and target lengths will be informed by consultation the MRWG Telemetry Work Group. This large-scale tagging of invasive carp will provide more information for the model to better estimate current levels of exploitation and to bolster estimates of large-scale pool-to-pool movement. Fish will be tracked using the current acoustic array within the IWW. Additional receivers will be placed in areas with reduced coverage and the MRWG Telemetry Work Group will be consulted prior to deployment. This work is collaborative with both the MRWG Telemetry Work Group and the MRWG Modeling Work Group. All information from individual telemetered invasive carp will be shared with the working groups and uploaded to FishTracks. FY 2022 funding will be used to purchase acoustic transmitters and surgery supplies and will as support operational costs associated with SEICarP telemetry fieldwork (fish tagging and maintaining/downloading acoustic hydrophones deployed in the IWW).

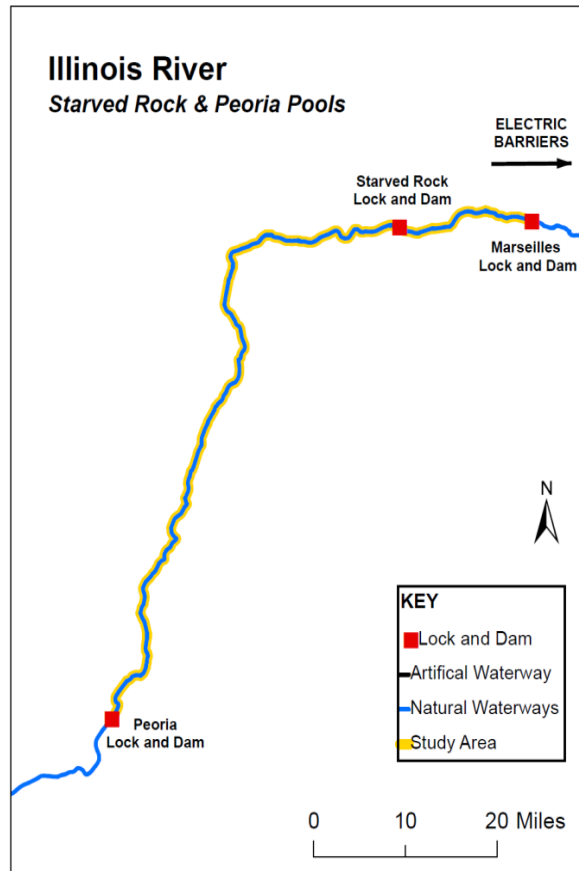


Figure 21. Map of Study Area – Starved Rock and Peoria Pools.

M-11 ILLINOIS RIVER HYDROACOUSTICS

Lead Agency: USFWS

Agency Collaborators: SIU, USACE Chicago District

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$125,000	\$0

Project Summary:

This project will provide hydroacoustic estimates of large fish abundance and distribution in pools of the Upper IWW and in the vicinity of the EDBS. This project will result in risk assessment data that informs management actions to invasive carp from becoming established in the Great Lakes by ensuring that abundances of large fish upstream of the invasion front in the Dresden Island Pool are monitored, and that changes to operation of the EDBS are informed by information about current fish presence at that location. FY 2022 funding will produce bi-weekly reports about fish abundance and distribution near the EDBS, bi-monthly reports on fish abundance and distribution in the Upper IWW, and rapid communications to the ICRCC on moderate or substantial changes in fish community species composition or fish behavioral observations near the EDBS.

Project Description:

Side-looking split beam hydroacoustic and side scan sonar surveys will be conducted above and below the CSSC EDBS to assess fish abundance and distribution patterns near the EDBS on a fine temporal scale. Surveys at the EDBS will take place on a bi-weekly (barrier surveys) to bi-monthly (pool surveys) beginning in January 2022. The purpose of the barrier surveys is to aid in assessing the risk of large fish, potentially Bighead Carp or Silver Carp, passing through the EDBS during barrier operational changes and/or maintenance. The purpose of the pool surveys is to provide early detection of an increase in the abundance of fishes greater than 12 inches in length, potentially being Bighead Carp or Silver Carp; and to inform risk of increased propagule pressure on the EDBS. The hydroacoustic survey equipment utilized for these surveys consists of two Biosonics® split-beam transducers as well as an ultra-high resolution side scan unit (side scan employed during barrier surveys only). This approach, using both systems, will allow a large portion of the water column to be ensonified by the survey vessel during each survey. These surveys will provide information on abundance of fish targets larger than 12 inches, as well as spatial distribution information. Results of surveys will be communicated to partners as changes in fish abundance or behavioral status are detected.

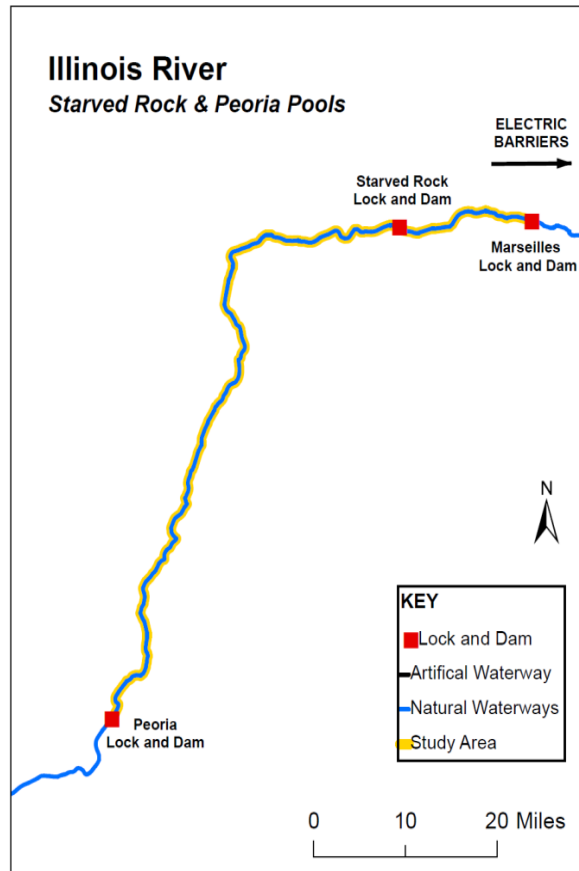


Figure 22. Map of Study Area – Starved Rock and Peoria Pools.

M-12 REAL-TIME TELEMETRY AND MULTI-STATE MODELING

Lead Agency: USGS

Agency Collaborators: Illinois DNR, GLFC, SIUC, USACE, USFWS

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$105,000	\$104,000

Project Summary:

This project will result in real-time data and other invasive carp movement information to inform real-time management decisions and refine the SEICarP model. FY 2022 funding will produce final transition probability estimates from the newly-developed Bayesian multi-state model, continue the maintenance of real-time telemetry to inform contingency actions, and produce a study plan to refine fishing mortality estimates using telemetry data.

Project Description:

USGS will work with MRWG Telemetry Work Group and Modeling Work Group in support of the SEICarP model. USGS will finalize and publish the results of a Bayesian multi-state model for estimating transition (movement between pools) probabilities from telemetry data coming from a multi-agency network of acoustic receivers in the Illinois River and associated waterways. The analyses will also inform the level of tagging and number of receivers needed to provide useful transition estimates. The telemetry data used in the analysis is being stored in a multi-agency, centralized database (FishTracks) developed and previously maintained by the USGS as part of this project.

USGS, in coordination with the MRWG Modeling Work Group, will develop a study plan to use existing telemetry data and mark-recapture data from the Starved Rock and Marseilles pools of the Illinois River to refine fishing mortality and population estimates of invasive carp in the upper Illinois River. Such estimates are critical parameters for the SEICarP model, and refined estimates could improve the predictions of that model. USGS, in coordination with the developers of the SEICarP model, will explore additional parameters and predictor variables into a comprehensive invasive carp movement model. USGS will work with partners via the MRWG Telemetry Work Group to inform decisions on contingency actions for invasive carp by deploying real-time acoustic receivers at strategic locations, and serving those data via the internet, text messaging, and email. Specific products include one real-time acoustic receiver network with seven receivers with remote data serving and alert options.

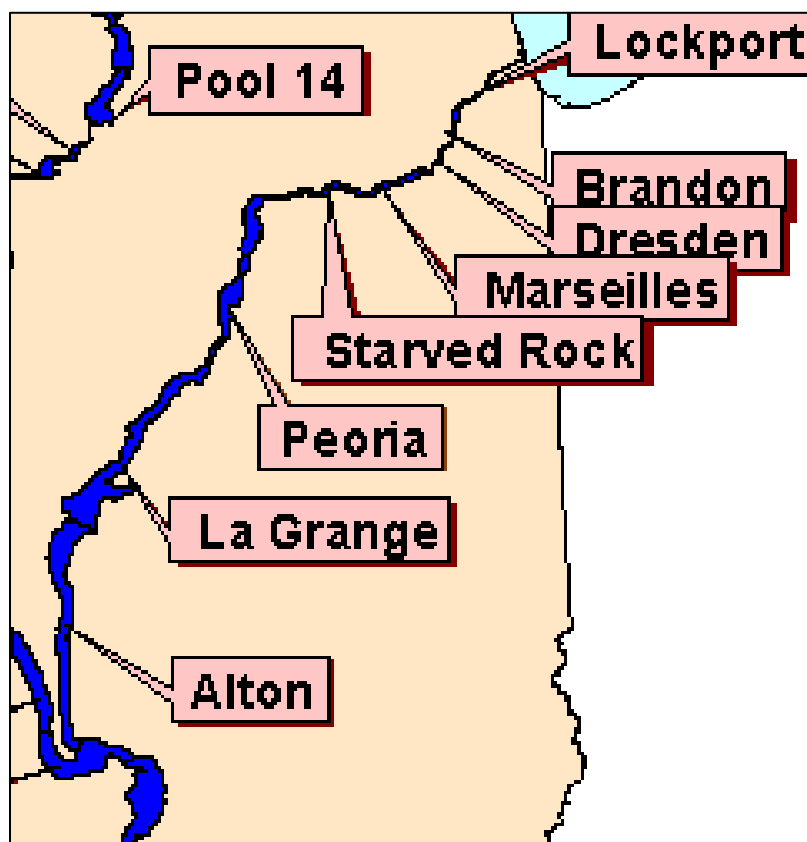


Figure 23. Map of Study Locations Including the Pools of the Illinois River in the red rectangle (Dresden Island, Brandon Road, and Lockport)

M-13 EARLY DETECTION OF INVASIVE CARP IN THE UPPER ILLINOIS WATERWAY

Lead Agency: USFWS

Agency Collaborators: USACE Chicago District, INHS, Illinois DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$350,000	\$600,000

Project Summary:

This project will increase targeted monitoring for detection of invasive carp in the uppermost pools of the IWW. This project will increase monitoring conducted above BRLD thereby increasing the likelihood of detecting any potential invasive carp range expansion at the earliest possible time, when they are in low in abundance. Planned activities in FY 2022 are additive to ongoing partner monitoring efforts and all activities are being planned and closely coordinated with MRWG and its Detection Work Group. FY 2022 funding will support targeted monitoring for small and large invasive carp using multiple fishery gears and produce information and reports on the spatial distribution of invasive carp in the upper IWW.

Project Description:

This project aims to increase targeted early detection sampling of small (less than or equal to 153 millimeters total length) and large (greater than 153 millimeters total length) Silver Carp and Bighead Carp in the upper IWW. These additional detection efforts provide further targeted sampling, increasing the likelihood that invasive carp are detected if present at lower abundances above the BRLD. The information provided by this invasive carp-focused sampling will aid ICRCC and MRWG agencies in evaluating the current invasion risk of invasive carp to the Great Lake via the CAWS. Data will help inform the Upper IWW CRP an - Invasive Carp Response Decision Matrix and related management and control actions focused on preventing invasive carp establishment in the Great Lakes.

Early, pre-spawn, sampling will focus on targeted detection of large invasive carp as small invasive carp are unlikely to be present in the system until spawning produces young of year individuals. Post-spawn sampling will focus on targeted detection of both large and small life stages. Early detection sampling in the upper IWW will be conducted via a combination of both fixed and random site sampling. Sampling effort will consist of approximately one crew week of effort per gear per pool per month. Site selection will target habitat types and areas that are known to be occupied by invasive carp in other areas of the IWW. Sampling targeted towards large invasive carp will include daytime boat electrofishing and electrified dozer trawling. Sampling targeted towards small invasive carp will include electrified dozer trawling and mini-

fyke netting. Dozer trawling will be used to sample invasive carp habitats in depths greater than approximately 1.5 meters and mini-fyke nets will be used to sample shallower habitats.

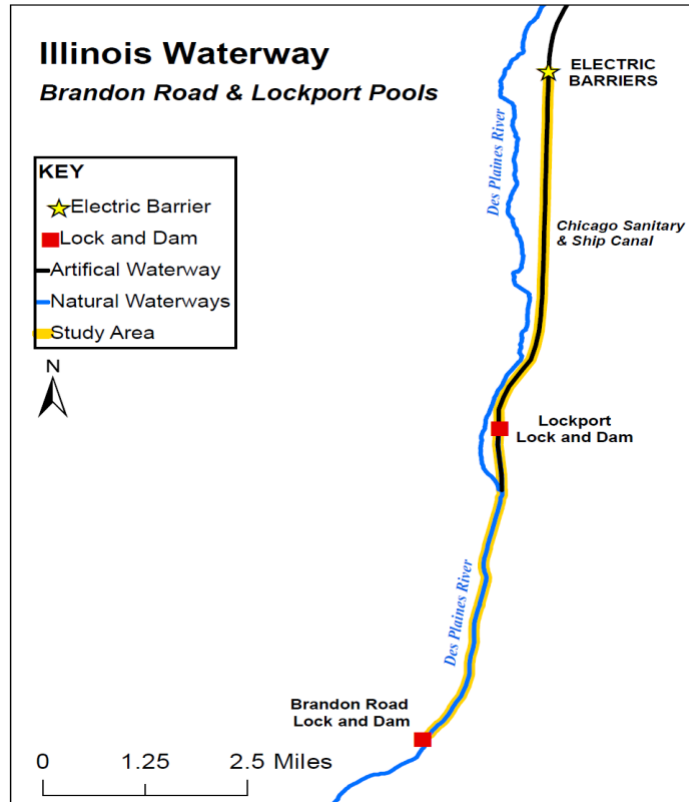


Figure 24. Map of Study Area – Brandon Road and Lockport Pools.

M-14 UPPER ILLINOIS WATERWAY SMALL INVASIVE CARP DISTRIBUTION MONITORING

Lead Agency: USFWS

Agency Collaborators: USACE Chicago District, INHS, Illinois DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$150,000	\$200,000

Project Summary:

This project will increase targeted effort for detection of small (less than 6 inch total length) invasive carp in the area believed to be the current invasion front for the less than 6 inch life stage within the IWW. In FY 2021, one invasive carp larva was collected in the Marseilles Pool and several small fish were collected in the upper portion of Starved Rock Pool (Starved Rock Yacht Club). This increased targeted sampling effort seeks to support the Contingency Response Plan by adding additional confirmation about the distribution of small invasive carp above Marseilles Lock and Dam. Planned activities in FY 2022 are additive to ongoing partner monitoring efforts and all activities are being planned and closely coordinated with MRWG and its Detection Work Group.

Project Description:

Small Silver Carp and Bighead Carp pose a unique threat to invading the Great Lakes because of the potential limitations of the EDDBS at immobilizing fish less than 6 inches in total length (\leq 153 millimeters total length). This project aims to increase targeted surveillance of small Silver Carp and Bighead Carp in the upper IWW for the purpose of increasing certainty in the derived species distributions by reducing the potential for a false negative-based conclusion that small carp are absent when they are actually present. Currently, monitoring for small carp in Marseilles Pool is conducted as a component of the fish assemblage-based MAM Program for decision making project which includes a total of 96 electrofishing samples and 72 mini-fyke sets collected between June and October each year. The MAM sampling is conducted for all life stages of invasive carp and for native fish species.

This new project in FY 2022 will provide additional intensive monitoring using a variety of traditional fish sampling gear at both targeted and random-stratified sites within Marseilles and Dresden Island pools throughout the year, with the goal of detecting potential shifts in the distribution of small Silver Carp and Bighead Carp. This project supplements (more than triples) targeted sampling for small invasive carp in Marseilles and Dresden Island pools by adding 120 electrofishing samples, 120 electrified dozer trawl samples, and 90 mini-fyke samples per pool

annually. Results from this project will aid ICRCC and MRWG agencies in evaluating the risk of Bighead Carp and Silver Carp invasion to the Great Lake via the CAWS.

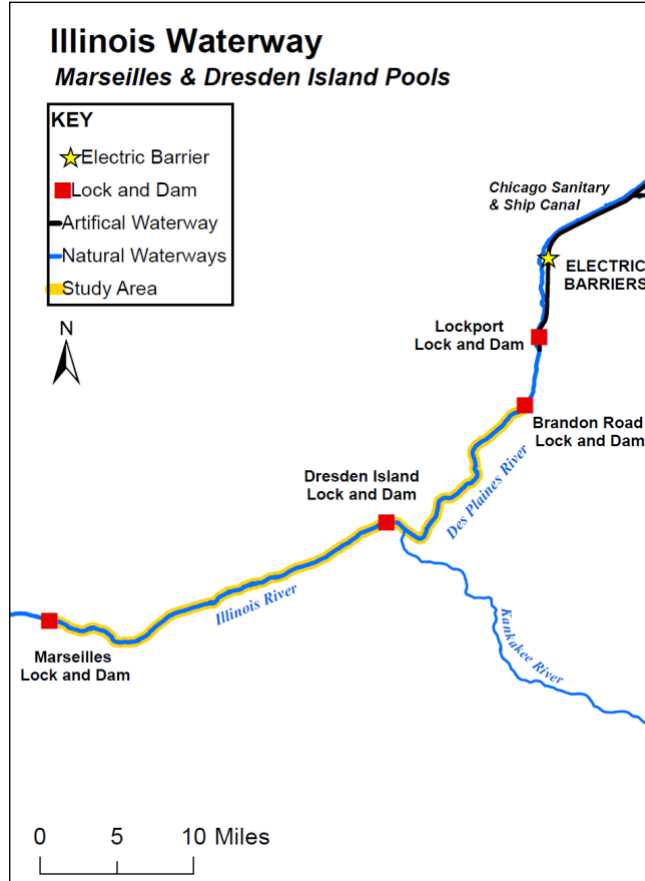


Figure 25. Map of Study Area – Marseilles and Dresden Island Pools.

C-1 CONTRACT FISHING FOR INVASIVE CARP DETECTION AND REMOVAL

Lead Agency: Illinois DNR

Agency Collaborators: None

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$1,600,000	\$0

Project Summary:

The goal of this project is to prevent invasive carp from getting into the Great Lakes by removal of at least 1 million pounds in the in the Starved Rock and Marseilles pools of the upper IWW and to continually evaluate removal efforts.

Project Description:

This project uses contracted commercial fishing on an ongoing basis to reduce the numbers of invasive carp in the upper Illinois and lower Des Plaines rivers downstream of the EDBS. Commercial fishers will be contracted to harvest as many invasive carp as possible in the Starved Rock and Marseilles pools. Disposal arrangements are managed by Illinois DNR which may include private industry for collection and disposal for purposes other than human consumption.

Illinois DNR biologists assigned to commercial fishers will gather information on harvested invasive carp to inform population abundance and movement assessments in the IWW downstream of the EDBS as a supplement to fixed site monitoring by contracted netters. In the CAWS (seasonally) and from the EDBS downstream through Lockport pool, Brandon Island pool, and Dresden Island pool (bi-weekly), many of the same contracted netters will work in teams of two or more to detect and remove invasive carp.

A third set of contracted fishers fulfill a contract with Illinois DNR as rapid responders. These fishers can be called up on short notice with the widest subset of gears available (including seines) for scheduled work or in response to information that requires investigation or harvest.

Contractual language does allow utilization of these fishers throughout the region if a need and additional funding is identified for such work. This project allows for contracting with commercial fishers and any necessary contracts for fish removal.

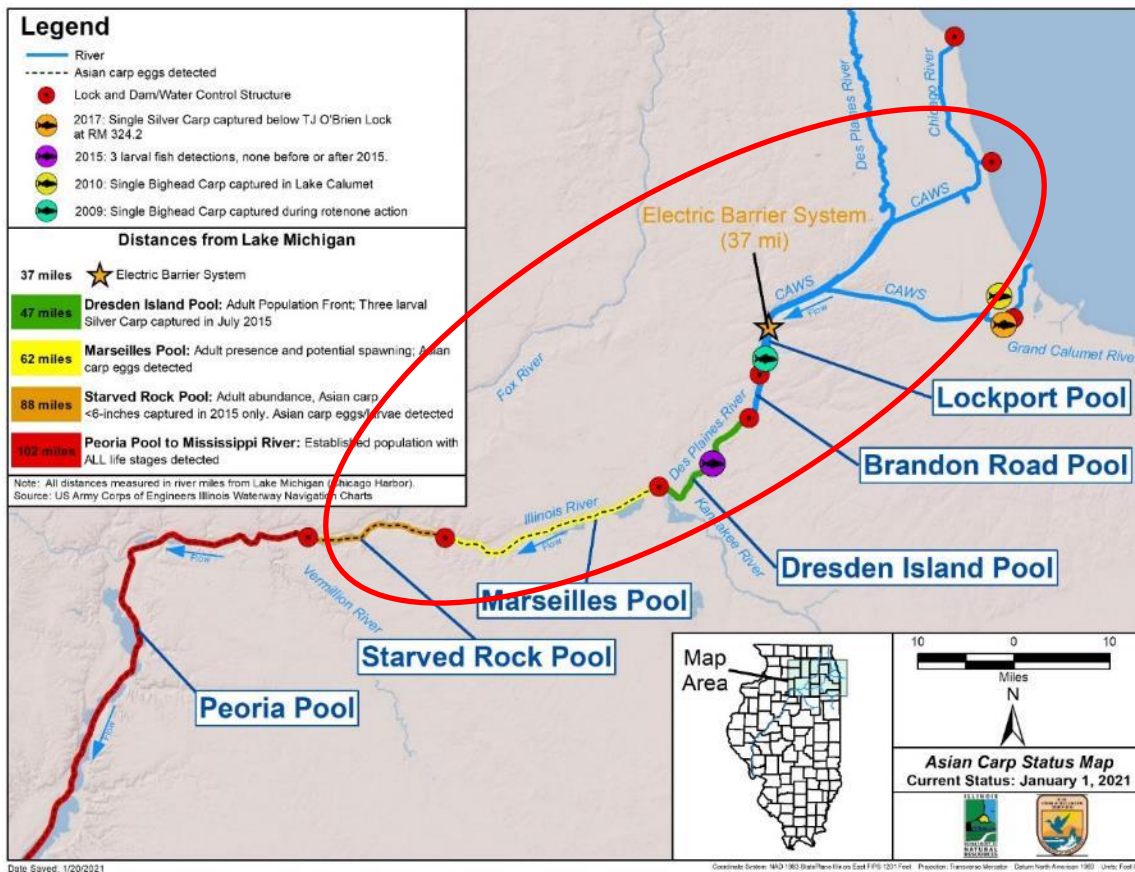


Figure 26. Map Identifying Approximate Coverage of Contract Fishing (in red oval), from Starved Rock Up Through the CAWS.

C-2 INVASIVE CARP ENHANCED CONTRACT REMOVAL

Lead Agency: Illinois DNR

Agency Collaborators: SIUC

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$885,300	\$0

Project Summary:

This project will continue the Enhanced Contract Fishing Program in Illinois in the Alton, LaGrange, and Peoria pools of the Illinois River. This project will result in the significant removal of invasive carp from these areas and prevent invasive carp from becoming established in the Great Lakes by reducing the number of individual fish reaching the upper Illinois River. FY 2022 funding will support removal of 8 to 10 million pounds of invasive carp, supported by processor purchase of 1.9 million pounds of invasive carp waterside or within 10 miles of designated waters.

Project Description:

Control of invasive carp via harvest is a viable technique in the upper Illinois River. SEICarP modeling suggests that removal of invasive carp in the lower Illinois River may reduce the migration of fish upstream, further reducing the possibility of invasion into the Great Lakes. This project is a collaborative and adaptive control effort that will inform the development of management strategies for enhanced removal through harvest. Program implementation of regional-scale harvest on a pool-by-pool basis will continue in FY 2022 through contracting with commercial fishers to increase overall removal, first in the Peoria Pool, then in Alton and La Grange pools in coordination with agency managers (Figure 26). Assistance will also be provided to processors who pick up or are located near the Peoria Pool or other designated waters to facilitate transportation and removal efforts of the harvested invasive carp.

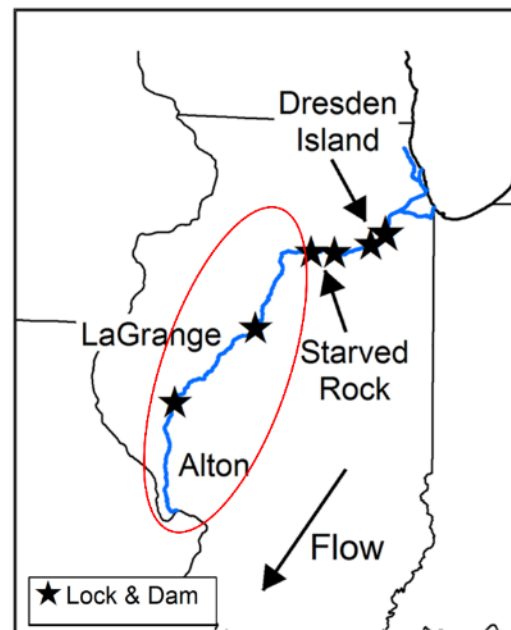


Figure 27. Project Location Throughout the Lower Illinois River.

C-3 INVASIVE CARP REMOVAL, BRAND IMPLEMENTATION, AND MARKETING

Lead Agency: Illinois DNR

Agency Collaborators: SIUC

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$100,000	\$0

Project Summary:

This project will promote the sale of harvested invasive carp caught in the IWW and other areas where invasive carp are found. This project will result in significant removal of invasive carp from the Alton, LaGrange, and Peoria pools of the Illinois River and prevent invasive carp from becoming established in the Great Lakes by reducing the number of fish reaching the upper Illinois River. FY 2022 efforts will produce a national launch of a brand for harvested invasive carp to enhance a market for fishers and processors being supported through the enhanced contract removal and marketing program. This project will support collaborative management goals to implement targeted intensive harvest as a strategy for reducing invasive carp populations, and the risk of upstream migration toward the Great Lakes.

Project Description:

This project builds on baseline work to develop and implement a new positive brand for invasive carp and to promote the use of harvested carp by industries and consumers. This effort will include extensive analysis, surveys and research to devise a new name and logo, and creation of a marketing plan and user guide for implementation and launch of the brand. The marketing plan consists of identification of a self-generated industry group to carry brand implementation forward, web design, social media strategy, video, creation of a national-scale launch event and supporting print and other promotional collateral. Communication surrounding the brand involves a theme of “Eat Well, Do Good”, emphasizing ecological benefits in support of protection of the Great Lakes.

The brand is planned to be launched in 2022 preceded by an effort to identify potential markets for harvested invasive carp using the new brand name, followed by an effort to support and foster promotion of the use of invasive carp followed by an effort to expand the number of outlets that will sell harvested invasive carp product. These include restaurants, fish markets, grocery stores, large institutional buyers and national distribution channels. FY 2022 funding will support efforts to continue to expand markets and foster growth among existing producers and cultivation of new ones. Support will include connection of processors with sales outlets through continued support to defray the cost of product promotion and preparation of product samples through the Market Value Program.

FY 2022 funding will also support attendance at one to three major seafood shows, production of collateral and sales materials, continued website maintenance and social media presence.

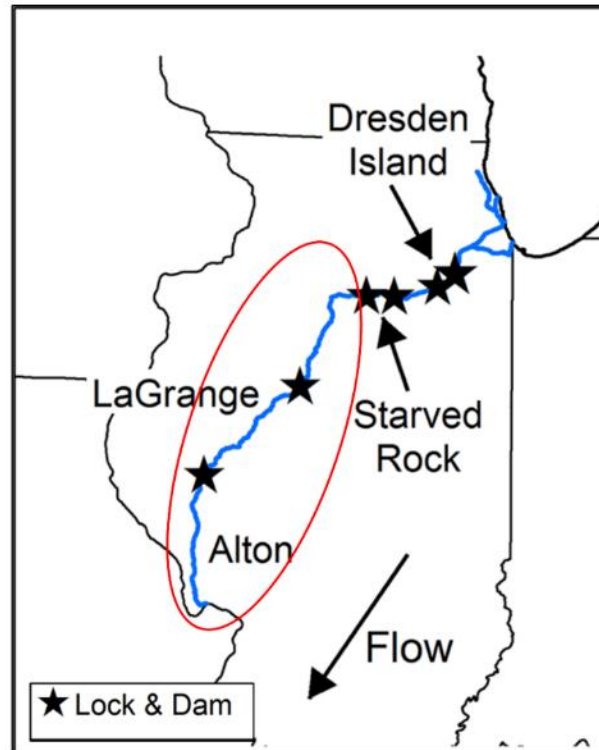


Figure 28. Project Location in the Lower Illinois River.

R-1 ICRCC CONTINGENCY ACTIONS IN THE UPPER ILLINOIS RIVER

Lead Agency: USFWS, USACE, Illinois DNR

Agency Collaborators: GLFC, USGS, USCG, MWRD

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$0	\$0

Project Summary:

This project will ensure response to changes in invasive carp populations in the Upper Illinois River and the continued development and refinement of the CRP through additional response planning and training. This project will result in a response-ready effort and will prevent invasive carp from becoming established in the Great Lakes by ensuring coordinated and targeted response actions when the CRP indicated a response is necessary. No funding is requested.

Project Description:

The CRP was formally adopted into the annual MRP in 2016 with alternative response actions identified in previous plans which only covered the CAWS upstream of the EDDBS. Illinois DNR and the ICRCC announced the finding of one Silver Carp in the IWW below T.J. O’Brien Lock and Dam, approximately nine miles away from Lake Michigan on June 26, 2017. The Silver Carp capture triggered two additional weeks of intensive sampling in the area, as outlined in the ICRCC’s 2017 CRP. In addition, multiple positive eDNA water samples in the CAWS triggered two weeks of intensive monitoring actions in 2019.

The MRWG continues to refine and improve the CRP through annual table-top exercises with response agencies and stakeholders. These exercises review the existing CRP and work through hypothetical scenarios that would likely trigger a response action. This allows the MRWG to elicit feedback on appropriate response actions and potential impacts.

The purpose of the CRP is to outline the process and procedures the MRWG and the ICRCC member agencies will follow in response to the change in invasive carp conditions in any given pool of the upper IWW. In the event a change is detected indicating an increase in risk level, the plan will be implemented to carry out response actions. The interagency MRWG has maintained a robust and comprehensive invasive carp monitoring program in the CRP area and will continue these efforts as the foundation for early detection capability in the IWW.

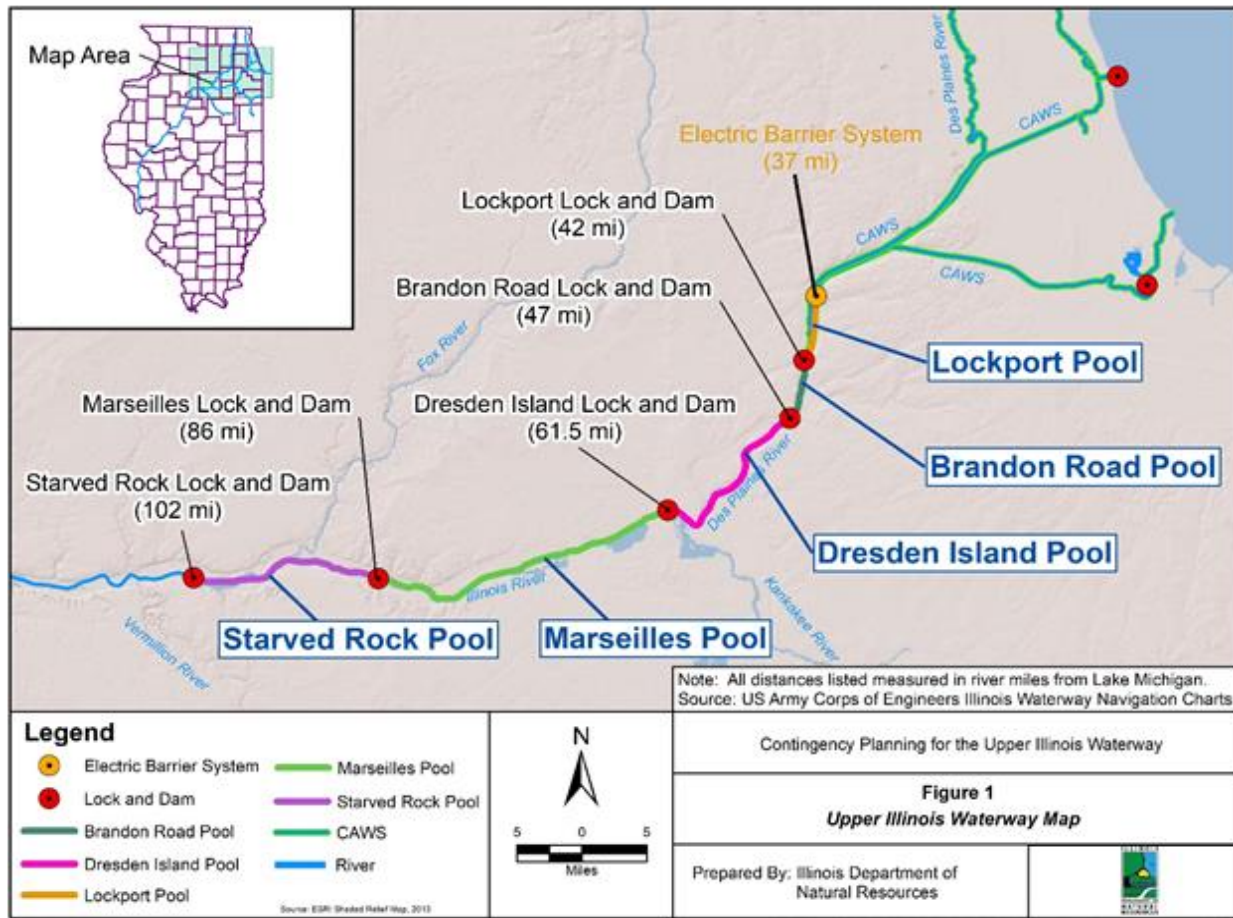


Figure 29. Map of the Project Area.

GC-1 ADAPTIVE MANAGEMENT FRAMEWORK FOR GRASS CARP IN LAKE ERIE

Lead Agency: Ohio DNR

Agency Collaborators: University of Toledo, GLFC, Michigan DNR, USGS

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$600,000	\$0

Project Summary:

U.S. and Canadian resource agencies in the Lake Erie basin have identified the growing threat of invasive Grass Carp as a high priority requiring focused and aggressive monitoring and control actions targeting locations of known spawning in the Sandusky and Maumee Rivers. Member agencies have developed a suite of proposed actions for implementation, building off existing efforts within the Lake Erie basin. Planning for continued Grass Carp actions is being conducted in collaboration with the GLFC, Council of Great Lakes Fishery Agencies Lake Erie Invasive Fishes Committee, and the Council of Lake Committees Lake Erie Committee.

Project Description:

The project goals are to remove 390 diploid Grass Carp annually from Lake Erie and determine the feasibility of a seasonal barrier on the Sandusky River to disrupt their spawning potential. Both goals were identified through the SDM process facilitated by Michigan State University. This project will result in suppression of the Grass Carp population in Lake Erie and prevent this member of the invasive carp family from becoming established in the Great Lakes following the recommendations of the Lake Erie Grass Carp Response Strategy (Ohio DNR 2019 – 2023).

GC-2 IMPLEMENTATION OF AN ADAPTIVE MANAGEMENT FRAMEWORK FOR GRASS CARP IN LAKE ERIE

Lead Agency: Michigan DNR

Agency Collaborators: Ohio DNR, USFWS, USGS

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$325,000	\$150,000

Project Summary:

This project will implement Grass Carp response actions in Michigan and Ohio waters of Lake Erie and connecting waters. This project will result in removal of adult Grass Carp and reduce the risk of spread and establishment in the Great Lakes by reducing the number of spawning fish while collecting information to inform future adaptive response actions. FY 2022 funding will provide the support to staff a Michigan DNR field crew that will implement response efforts in the western basin of Lake Erie.

Project Description:

Michigan DNR will implement response actions for Grass Carp in Lake Erie, based on the 5-year adaptive response strategy (2019-2023) developed by the LEC and informed by an SDM process facilitated by Michigan State University in 2016-2017. The three objectives of the response strategy include: (1) improve the collective understanding of Grass Carp population dynamics, behavior, and impacts in Lake Erie to inform effective management actions; (2) implement controls to minimize population expansion, by removing fish and/or blocking access to preferred habitats; and (3) minimize the likelihood of introduction and establishment of new breeding populations of Grass Carp in the tributaries and nearshore areas of Lake Erie and Lake St. Clair. This project funding will be used to support one Michigan Grass Carp response team that will implement the following actions:

- Implement targeted removal efforts during presumed spawning events.
- Conduct sustained response efforts to track population trends over time.
- Conduct surveillance efforts to evaluate potential spread to new locations.
- Maintain telemetry arrays, tag fish, and use telemetry detections to inform removal efforts.
- Implement and evaluate innovative methods (e.g., bait and attractants) with partners around the basin to increase Grass Carp capture rates.
- Partner with commercial fishing operations to enhance Grass Carp removal efforts.
- Outreach with bow-fishers to promote removal and reporting.

- Participate in the population modeling, telemetry, and other sub-work groups under the Lake Erie Grass Carp Working Group.
- Represent Michigan during regional and international invasive species meetings to communicate Grass Carp control efforts to interested partners and stakeholders.



Figure 30. Map of the Five Grass Carp Response Locations in Michigan Waters of Lake Erie. Trenton Channel (1), Hot Ponds (2), North Maumee Bay (3), Pointe Mouillee (4), LaPlaisance Bay (5).

GC-3 IMPLEMENTATION OF AN ADAPTIVE MANAGEMENT FRAMEWORK FOR GRASS CARP IN THE GREAT LAKES

Lead Agency: USFWS

Agency Collaborators: Fisheries and Oceans Canada, GLFC, Michigan DNR, Ohio DNR, New York DEC, Pennsylvania Fish and Boat Commission, USGS

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$1,160,000	\$650,000

Project Summary:

This project provides support for additional capacity needed to expand enhanced Grass Carp surveillance and capture effort in Lake Erie and additional lake basins in which Grass Carp detections are increasing. This project will result in the capture and removal of diploid (fertile) and triploid (sterile) Grass Carp. These actions will reduce the threat of diploid Grass Carp establishing self-sustaining populations in the Great Lakes by suppressing reproductive success. FY 2022 funding will support the needed capacity to implement Grass Carp monitoring and response actions at targeted locations in U.S. waters of the Great Lakes.

Project Description:

The following USFWS locations will support the Grass Carp surveillance and capture efforts in the additional lake basins in the Great Lakes.

USFWS Alpena FWCO - Lake Huron, Lake Erie Western and Central Basins

- The Alpena FWCO will provide field crews, vessel support, and laboratory assistance to project partners working to implement State-led Grass Carp response actions in Lake Erie and connecting waters. USFWS will support research/management needs of the Lake Erie Committee, identified by the Lake Erie Grass Carp Working Group, described in the Lake Erie Grass Carp Response Strategy (2019-2023).
- Response priorities will be to: (1) maintain support for two existing Grass Carp field crews from the Alpena FWCO, (2) implement and evaluate innovative control actions for Grass Carp, (3) use real-time telemetry detections of Grass Carp to inform planning and implementation of response actions, and (4) contribute to efforts to remove 390 Grass Carp annually from the Lake Erie basin.
- Research priorities will be to: (1) maintain support for the modeling/telemetry (GLATOS) project, (2) maintain support for the otolith microchemistry/stable isotope analysis project, (3) maintain support for USFWS ploidy analysis of Grass Carp blood samples, (4) continue to assist with implementation of USGS Grass Carp bait/attractant aggregation study, (5)

continue to assist with implementation of mobile VPS array study to track fine-scale movements of Grass Carp during response actions, (6) continue to serve as a second reader to verify Grass Carp age estimates, and (7) provide representation, as needed, at relevant regional or national conferences and meetings to support coordination and information-sharing related to Grass Carp management.

USFWS Lower Great Lakes FWCO - Lake Erie Eastern Basin, Lake Ontario

- The Lower Great Lakes FWCO will provide field crews and vessel support to project partners implementing State-led Grass Carp response actions in Lake Erie and connecting waters. The Lower Great Lakes FWCO will support research/management needs of the Lake Erie Committee, identified by the Lake Erie Grass Carp Working Group, described in the Lake Erie Grass Carp Response Strategy (2019-2023). Additionally, capacity will be added to support Grass Carp monitoring and response, as needed, in Lake Ontario.
- Response priorities will be to: (1) support a dedicated Grass Carp field crew, (2) support implementation and evaluation of innovative control actions for Grass Carp, (3) use real-time telemetry detections of Grass Carp to inform planning/implementation of response actions, and (4) remove all Grass Carp collected.

USFWS Green Bay FWCO - Lake Michigan

- In response to a request from the State of Michigan, the Great Lakes Fishery Commission and the Lake Michigan Committee, the Green Bay FWCO will establish a strike team to support a new effort to implement detected Grass Carp response actions in Lake Michigan.
- Response priorities will be to: (1) support a dedicated Grass Carp field crew and vessel, (2) support implementation and evaluation of innovative control actions for Grass Carp, and (3) remove all Grass Carp collected and process for ploidy.

USFWS Whitney Genetics Lab (WGL) – Lake Michigan, Huron, Erie, Ontario

- Whitney Genetics Lab staff will work with Michigan DNR and USGS to use eDNA detection data collected in the Sandusky River in 2021 to develop a Grass Carp eDNA occupancy model. This model will guide future Grass Carp eDNA monitoring efforts to maximize probability of detection in preparation for implementation of a basinwide surveillance program in collaboration with state partners.
- WGL staff will work with partners to prepare a peer-reviewed manuscript outlining occupancy model results for publication.

GC-4 USGS SPAWNCast – A GRASS CARP SPAWNING EVENT PREDICTION TOOL

Lead Agency: USGS

Agency Collaborators: Ohio DNR, University of Toledo

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$90,000	\$0

Project Summary:

This project will provide a web-based decision support tool (USGS-SpawnCast) with 5-10 day forecasts of potential Grass Carp spawning events in select tributaries to the western basin of Lake Erie. This project will result in forecasts of potential Grass Carp spawning events and prevent invasive carp from becoming established in the Great Lakes by providing advanced warning of spawning events and identifying events and locations where strike teams can have the greatest impact on Grass Carp populations in western Lake Erie. FY 2022 funding will be used to produce a refined USGS SpawnCast webpage and forecast dashboard for the Sandusky River (developed and beta tested in FY 2021) and build similar Grass Carp spawning forecast dashboards for the Maumee and Cuyahoga rivers.

Project Description:

In FY 2021, the USGS consulted agency response coordinators regarding the need for a decision support tool to facilitate the planning, coordination, and mobilization of resources for rapid response to Grass Carp spawning events in tributaries to Lake Erie. There was broad support for a web- and mobile-accessible decision support tool capable of forecasting Grass Carp spawning events up to 5-days in advance to enable resource management agencies time to mobilize and deploy Grass Carp strike teams and sampling crews effectively and efficiently. It was emphasized that such a tool should utilize real-time USGS gaging station data (water level, temperature, velocity, discharge), National Weather Service river and weather forecasts, necessary river physiographic characteristics (drainage area, undammed river length, bedslope, substrate, etc.), and known Grass Carp spawning times, areas, and habitat requirements. In May 2021, USGS SpawnCast, a Grass Carp spawning prediction tool, went live for beta testing by agency response coordinators.

USGS SpawnCast uses observed and forecast discharge and water-quality data combined with species-specific spawning requirements to forecast spawning probability for species of interest in select rivers and tributaries to the Great Lakes. Initially developed in 2021 for forecasting Grass Carp spawning in the Sandusky River, pilot testing by Grass Carp strike teams and ichthyoplankton sampling crews during the 2021 spawning season demonstrated the utility of the

tool for planning and mobilization of resources in advance of high-probability Grass Carp spawning events. Feedback from users and managers will be used to refine this tool to meet the current and future needs of the Great Lakes Grass Carp Advisory Committee and the broader community battling invasive carp. It is envisioned that this tool may eventually also help forecast spawning of native, threatened, and endangered species to help promote successful reproduction of beneficial species. In response to requests from agency response coordinators, Grass Carp spawning forecast dashboards for the Maumee and Cuyahoga rivers will be added to USGS SpawnCast prior to the 2022 spawning season. The techniques and methods employed by this tool will undergo peer review in Ohio and approval for public dissemination will be sought.



Figure 31. Map of the Study Area Showing the Maumee, Sandusky, and Cuyahoga Rivers.

GC-5 IDENTIFICATION OF OPTIMAL RIVER CONDITIONS FOR SPAWNING AND RECRUITMENT OF GRASS CARP IN TRIBUTARIES OF THE WESTERN BASIN OF LAKE ERIE

Lead Agency: USGS

Agency Collaborators: NOAA GLERL, Ohio DNR, University of Toledo

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$85,000	\$0

Project Summary:

This project will simulate the drift of Grass Carp eggs and larvae in tributaries to the Great Lakes, specifically the Maumee River and the Sandusky River. This project will result in the identification of optimal river conditions for spawning and recruitment of Grass Carp and prevent invasive carp from becoming established in the Great Lakes by providing information about the conditions that promote recruitment and population growth to better inform future management efforts. FY 2022 funding will produce a suite of FluEgg model simulations that, in addition to supporting NOAA bioenergetics modeling efforts, will be used to evaluate in-river hatching rates and larval retention rates. This work will identify specific river conditions and spawning areas which have the greatest potential for Grass Carp reproduction and allow prioritization of targeted control efforts by state and federal partners.

Project Description:

The tributaries of WLE are the focus of intensive egg sampling efforts aimed at assessing Grass Carp recruitment risk in rivers with both confirmed and hypothesized spawning. Identifying the river conditions (flow and temperature) and spawning sites that have the greatest potential for Grass Carp recruitment is necessary to allow management agencies to prioritize events for response actions and allocate their limited resources effectively and efficiently. Therefore, USGS proposes to use existing hydraulic and FluEgg models and high-efficiency, batch processing capabilities to build a library of spawning simulations in the WLE tributaries for a range of water temperatures and discharges (steady flow conditions). The simulations will be used to evaluate optimal spawning conditions using in-river hatching rates and larval retention rates. A hindcasting approach will be used to evaluate historic ichthyoplankton data and year-class estimates from adult captures in the context of the simulations leading to better understanding of Grass Carp recruitment variability in the WLE.

Proposed new work for FY 2022 includes batch simulations of Grass Carp egg/larval drift in the Sandusky River. Additionally, FY 2022 funding will support a collaboration with NOAA on a peer-reviewed journal article examining the results of their IBM of the Maumee River. The resulting publication will examine invasive carp reproductive success, recruitment, population growth, and food web effects in the Maumee River and WLE.



Figure 32. Map of the Study Area Showing the Maumee, Sandusky, and Cuyahoga Rivers.

GC-6 EVALUATION OF BAIT AND ATTRACTANTS TO INCREASE AGGREGATION AND HARVEST OF GRASS CARP IN THE LAKE ERIE BASIN

Lead Agency: USGS

Agency Collaborators: Michigan DNR, Ohio DNR, USFWS, University of Toledo, Sandusky River Watershed Coalition

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$175,000	\$1,075,687

Project Summary:

This project will test the usage of Grass Carp bait and algal attractant for enhancing removal efforts in the Sandusky River, Ohio and Plum Creek, Michigan. This project will test the ability of bait and algae to increase harvest of Grass Carp and prevent invasive carp from becoming established in the Great Lakes by supporting the reduction of population size. FY 2022 funding will expand the scope and duration of work (increased trial duration to greater than 10 days, greater, volume of attractant released per feeding platform to areas of higher concentration of Grass Carp. USGS will increase bait and algae deployment duration to concentrate fish densities and numbers near harvest locations targeted by state management strike teams.

Project Description:

This collaborative project will continue to examine new technological control tools such as attractants and baits for enhanced Grass Carp removal in the Great Lakes basin. Different attractant classifications, such as spawning-related chemicals (pheromones) and food-based attractants, aim to support resource managers using integrated pest management strategies for invasive fishes. Research efforts related to the proposed project will focus on the use of bait and algal attractant to increase aggregations of Grass Carp, which selectively feed on aquatic vegetation, to enhance removal efforts in Lake Erie tributaries. Previous research has identified glutamine to elicit an involuntary feeding response in the lab by keeping olfactory neuroreceptors open. Subsequently, the reported glutamine research has gained interest in its applicability as a food enhancer to increase the efficacy of the Grass Carp bait. USGS proposes to use glutamine with the algae pellets to increase the response of Grass Carp to the feeding platforms. The deployment of these complementary control tools (i.e., baits and algae) is essential to establish multiple mechanisms for combating the spread of Grass Carp.

The original bait formulation, created from duckweed, was successfully used for the oral delivery of a chemical control agent to Grass Carp. Recent assessment of six bait formulations have identified a combination of corn and rapeseed as a palatable and attractive bait for Grass Carp. Preliminary data also suggest that this bait is species selective. Although a

commercial manufacturer was identified in 2020, further refinement of the base bait formulation is in progress to facilitate mass-production.

Once a successful base bait has been designed, the addition of an attractant, as mentioned above, aims to further increase its selectivity, palatability, and efficacy for target species removal. To monitor the effectiveness of the algal attractant and bait in the field, USGS will use eDNA, radio telemetry, side-scan sonar, and traditional passive and active harvest methods to track changes in relative abundance of Grass Carp around baiting stations.

The goal is to continue field deployment of bait and algal attractant to determine if increased Grass Carp harvest rates can be achieved during seasonal removal operations currently employed by state management agencies in Michigan and Ohio. Key differences between year one and two:

- Increased trial duration.
- Greater volume of attractant released per feeding platform.
- Incorporate Grass Carp conspecific feeding sound at platforms (dependent upon results from laboratory trials in fall/winter 2021-2022).
- Add platforms to upstream portion of Sandusky River.
- Adjust timing of Plum Creek platform deployment to winter months.

GC-7 EFFICACY OF AN OBLIQUE BUBBLE SCREEN SYSTEM AS A TWO-WAY DISPERSAL BARRIER FOR INVASIVE CARP

Lead Agency: USGS

Agency Collaborators: University of Illinois at Urbana-Champaign, Ohio DNR, GLFC, Michigan DNR, University of Toledo

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$205,000	\$205,000

Project Summary:

This effort will assess and optimize the efficacy of an OBS system as a two-way, seasonally operated dispersal barrier to disrupt spawning and recruitment of invasive carp in known spawning tributaries to the Great Lakes. This project will result in an alternative (or modification) to existing barrier technologies and prevent invasive carp from becoming established in the Great Lakes by developing an OBS system capable of redirecting and capturing more than 50% of downstream-drifting invasive carp eggs and larvae, while concurrently deterring the passage of upstream-swimming adult carp with at least 50% efficacy. FY 2022 funding will produce the design of such a barrier for flow conditions typical of Grass Carp spawning events and a two-way efficacy of at least 50% in both directions to allow scaling-up for near field scale testing in subsequent years.

Project Description:

The primary objective of this project is to develop a two-way invasive carp dispersal barrier that uses an OBS system to both entrain and inhibit downstream dispersal of eggs and larvae and deter the upstream movement of adult carp attempting to reach spawning areas. OBS are deployed across a channel at an angle to the flow to redirect particulates in the water column to the downstream-most bank where they can be collected (actively or passively). This emerging technology is well-suited for application to trapping of drifting eggs and larvae. Recently, a feasibility study initiated by the GLFC identified the BAFF, a system that includes oblique bubble screens in addition to lights and sound, as one of two potential options for a seasonal barrier on the Sandusky River to limit Grass Carp upstream migration and reproduction and increase harvest of mature adults. This work will directly inform the design of such a barrier and potentially allow it to act as a two-way dispersal barrier. Furthermore, results could be applicable to all invasive carp based on similar egg and larvae characteristics and proven response to bubble screens. Potential impacts on native species with spawning and/or drift periods that overlap with invasive carp will be identified and assessed.

An effective OBS system will let managers deploy a single barrier to target two different life stages, thereby simultaneously reducing recruitment and supporting the harvest of mature adults before they spawn. The proposed UIUC-USGS collaboration, together with input from state and federal partners

(Ohio DNR, Michigan DNR, GLFC) will allow transition from the laboratory to the field to test the experimental findings in natural settings. Upon successful field testing, technology transfer will provide optimal designs for use by international, federal, and state agencies and their private-sector partners.



Figure 33. Map Including the Location of the University of Illinois at Urbana.

GC-8 IMPROVED CONTROL EFFICIENCY THROUGH BETTER UNDERSTANDING OF GRASS CARP MOVEMENTS AND HABITAT USE

Lead Agency: USGS

Agency Collaborators: Michigan DNR, Ohio DNR, NY DEC, Pennsylvania Fish and Boat Commission, Michigan State University

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$200,000	\$630,395

Project Summary:

This project will address the threat of invasive Grass Carp by developing a comprehensive understanding of seasonal movements and habitat use to determine when and where control efforts would be most effective in Ohio, Michigan, Pennsylvania, and New York within Lakes Erie/Huron and tributaries to these lakes. This project will result in detailed observations of Grass Carp spawning, feeding, and overwinter behavior and prevent invasive carp from becoming established in the Great Lakes by determining when and where control efforts would be most effective. FY 2022 funding will produce a summary of the seasonal movements and locations of Grass Carp in lake and tributary habitats and the abiotic cues that may predict when and where these behaviors will occur.

Project Description:

The goal of this project is to address the threat of invasive Grass Carp by developing a comprehensive understanding of seasonal movements and habitat use to determine when and where control efforts would be most effective. The work will be accomplished with acoustic telemetry, leveraging the GLATOS in a basin-wide interagency collaboration. The goal of this project directly addresses a top priority of the Council of Great Lakes Fishery Agencies. This research objective was developed through a series of SDM workshops involving USGS partners of the JSP for Great Lakes Fishery Management (<http://www.glfca.org/joint-strategic-plan-committees.php>).

Behavioral information on Grass Carp spawning, feeding, and overwinter behavior is highly sought by managers to inform the development of control strategies and efforts. Detailed observations of the location and timing of Grass Carp behaviors will also be compared to abiotic conditions to explore potential cues to these observed movement patterns. Initial telemetry results have indicated the need to expand the telemetry network into nearshore areas of Lake Erie to fill critical gaps in knowledge of Grass Carp habitat use. The objective is to continue developing the GLATOS network in nearshore waters of Lake Erie and tributaries and contribute a more robust analysis of seasonal habitats, fine-scale tributary habitat use, and grass carp survival for use by decision-makers.

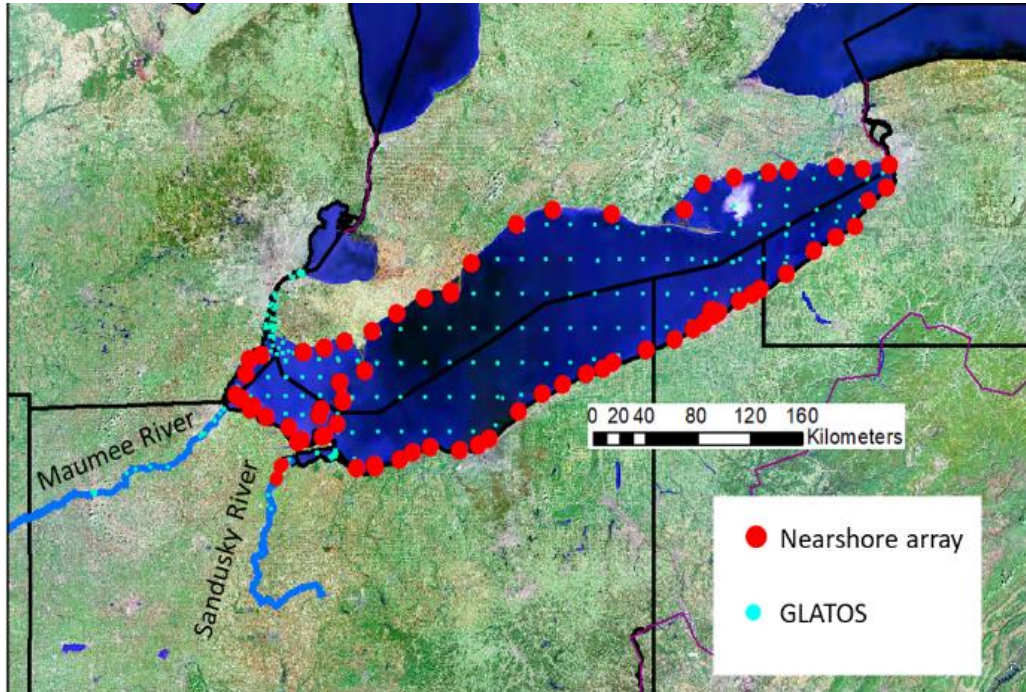


Figure 34. Lake Erie and the Location of Grass Carp Nearshore Acoustic Receiver Array. The Grass Carp receivers and arrays are shown in red and other existing strategically located GLATOS receivers are shown in blue.

GC-9 IDENTIFYING SPAWNING TRIBUTARIES AND SPECIFIC SPAWNING AREAS OF GRASS CARP

Lead Agency: USGS

Agency Collaborators: Michigan DNR, Ohio DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$200,000	\$485,067

Project Summary:

This project will monitor Grass Carp spawning in tributaries of Lake Erie, Lake Huron. This project will improve understanding of Grass Carp spawning and distribution and prevent their establishment in the Great Lakes by identifying areas where successful reproduction is occurring. This information will be used by resource managers to inform prioritization of control efforts. FY 2022 funding will produce an updated database of sampling events and input data for modeling of spawning locations when eggs or larvae are collected.

Project Description:

This project will sample for Grass Carp early life history stages (eggs and larvae) in tributaries to the Great Lakes. USGS will use ichthyoplankton nets in several tributaries where Grass Carp are either known to spawn, have been identified as high risk of Grass Carp spawning, or have had recent collections of adult Grass Carp. Suspected Grass Carp eggs and larvae will be examined for developmental stage, and all collection data and developmental stages of eggs and larvae will be entered into a database. USGS uses data from eggs and larvae in models that identify specific spawning locations. This information will be provided to managers to inform their efforts to remove and eradicate Grass Carp from the Great Lakes. This project prevents the establishment of Grass Carp in two ways. First, it helps managers target adult Grass Carp removal efforts during spawning. To date, this tactic has produced high catches of adult Grass Carp. Second, it has identified new spawning rivers and locations within rivers, which directed where control efforts were targeted, further reducing the overall population and risk of establishment. This goal was identified by the Great Lakes Grass Carp Advisory Committee and is a top priority of the Council of Great Lakes Fishery Agencies, the Lake Erie Committee, and partners of the JSP for Great Lakes Fishery Management.

GC-10 CHARACTERIZATION OF HYDROLOGY AND SEDIMENT MOBILITY TO INFORM DESIGN OF A SEASONAL BARRIER IN THE SANDUSKY RIVER

Lead Agency: USGS

Agency Collaborators: GLFC, Ohio DNR, University of Toledo

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$280,000	\$0

Project Summary:

This project will characterize relevant hydraulic properties and sediment dynamics required for the design, installation, and operation of an invasive carp barrier in the Sandusky River, near Brady’s Island, Ohio. Products from this project will help to inform aspects of barrier evaluation and design critical to the success of potential barriers to limit Grass Carp reproduction and recruitment in the Sandusky River. Funding for FY 2022 will produce high-quality, continuous hydraulic and water-quality data at the proposed barrier site (water surface elevation, discharge, stream velocity, and basic water-quality parameters) as well as an assessment of sediment dynamics and streambed morphology (high-resolution bathymetry, streambed mobility and evolution, and suspended sediment).

Project Description:

Using a combination of continuous monitoring and synoptic surveys, the USGS will collect and report information that will inform the USACE and Ohio DNR in the design and later the installation and operation of an invasive carp barrier on the Sandusky River near Brady’s Island. The proposed investigation will monitor characteristics to report the variability of discharge, in-stream velocity, water-surface elevation, bathymetry, and suspended sediment at and around the proposed location of an invasive Grass Carp barrier. Each major product provides necessary data to inform an effective design of a behavioral barrier to disrupt Grass Carp reproduction. The following will be collected:

- A stream gage will be established at the proposed barrier site to continuously monitor and report water surface elevation and the sensor velocity.
- High-resolution bathymetry, bed mobility, and bed morphology.
- Water quality and sediment transport.

All data will be collected, reviewed, and quality-assured using standard USGS techniques and methods. All time-series data from the stream gage will be made publicly available on the USGS’s National Water Information System website at <https://waterdata.usgs.gov/nwis/gw>.

GC-11 DEVELOPMENT AND TESTING OF DETERRENT TECHNOLOGIES FOR GRASS CARP

Lead Agency: USGS

Agency Collaborators: Kentucky DFWR, USFWS, GLFC, Ohio DNR, Michigan DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$195,000	\$0

Project Summary:

This project will evaluate Grass Carp response to an experimental BAFF at Barkley Lock and Dam in the Cumberland River near Grand Rivers, Kentucky. This project will result in fine-scale assessment of Grass Carp behavioral response to a BAFF deterrent system and prevent invasive carp from becoming established in the Great Lakes by providing data and information to the Sandusky River Grass Carp Barrier Team to inform the design of a deterrent system for the Sandusky River. FY 2022 funding will produce an assessment of effectiveness of an experimental BAFF to limit the upstream movement of Grass Carp.

Project Description:

The Lake Erie Grass Carp Adaptive Response Strategy (2019-2023) identified the objective of minimizing the likelihood of introduction and establishment of new breeding populations of Grass Carp in the tributaries of Lake Erie with the use of barriers to block movements to potential spawning areas. Behavioral deterrents have not been directly evaluated for Grass Carp and there is a need for additional research to evaluate the effectiveness of deterrent technologies for limiting Grass Carp population expansion. Barkley Lock and Dam on the Cumberland River is a key population bottleneck where invasive carp must pass through the lock chamber to move upstream; this location was selected for testing an experimental BAFF. As demonstrated in the laboratory, a BAFF holds promise as being more specific to invasive carp because they have more sensitive hearing than many native species. Laboratory and limited field tests demonstrated the potentially selective deterrence of invasive carp. Initial research on the hearing abilities of Grass Carp in experimental laboratory tanks has identified that Grass Carp have a similar range of detectable frequencies (i.e., 0.2 to 4 kHz) to those of invasive carp. Understanding Grass Carp response to a BAFF in a real-world, large-river setting will permit evaluating the applicability of this technology for Grass Carp control in other large river locations, including tributaries of the Great Lakes, and has been identified broadly as a research need by state and federal partners. This project would leverage an existing, ongoing large-scale pilot field study (deployment of the BAFF and efficacy study for invasive carp) for a rare opportunity to gain additional information to inform a Sandusky River deterrent for Grass Carp. USGS will use acoustic telemetry arrays

(VEMCO and HTI) to 1) evaluate the effectiveness of the BAFF at preventing upstream passage of Grass Carp into the lock chamber of Barkley Lock and Dam under varying environmental and operating conditions, and 2) assess the behavior (e.g., swim direction, speed, tortuosity, depth) of Grass Carp in the lock approach near the BAFF at Barkley Lock and Dam. These data will be used to inform the applicability of using a BAFF as a component of a Grass Carp control program in the Sandusky River and other tributaries of the Great Lakes.



Figure 35. Barkley Lock and Dam on the Cumberland River near Grand Rivers, Kentucky

GC-12 GRASS CARP PLOIDY ANALYSIS TO ASSESS REPRODUCTIVE RISK OF DETECTED POPULATIONS

Lead Agency: USFWS

Agency Collaborators: USGS, SIUC, University of Toledo, Department of Fisheries and Oceans-Canada, Ohio DNR, Michigan, DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$65,000	\$110,590

Project Summary:

This project will support laboratory and additional analyses to determine the ploidy status (reproductive diploid or non-reproductive triploid) of captured Grass Carp in Great Lakes waters of Illinois, Wisconsin, Michigan, Indiana, Ohio, Pennsylvania, and New York. The project leverages agency funding for analysis of Grass Carp from the upper Mississippi River and Ohio River sub-basins. This project will result in reproductive potential determination for detected Grass Carp populations and inform efforts to prevent Grass Carp from becoming established in the Great Lakes. Reproductive potential, or ploidy status, is determined by flow cytometry analysis of samples from captured fish. Ploidy results are provided to partners for risk assessment and management planning.

Project Description:

The USFWS, USGS, DFO and Great Lakes state management agencies collect Grass Carp samples during targeted removal and research efforts in the Great Lakes. Ploidy analysis for chromosomal content of the sampled fish can help determine if captured Grass Carp were escaped triploids produced through aquaculture (no threat of reproduction) or reproductive diploids (threat of reproduction in the wild). Results can help managers focus removal and control efforts on areas where reproductive diploids have been found, with the goal of preventing establishment of a breeding population. The technology using flow cytometry to determine the ploidy status of invasive carps was developed by USGS researchers and is performed at USFWS laboratories. Ploidy results, along with capture data and images, are submitted to the USGS-Nonindigenous Aquatic Species Database (<https://nas.er.usgs.gov/>) for searchable information managers and researchers can use to control and manage Grass Carp in the Great Lakes Basin.

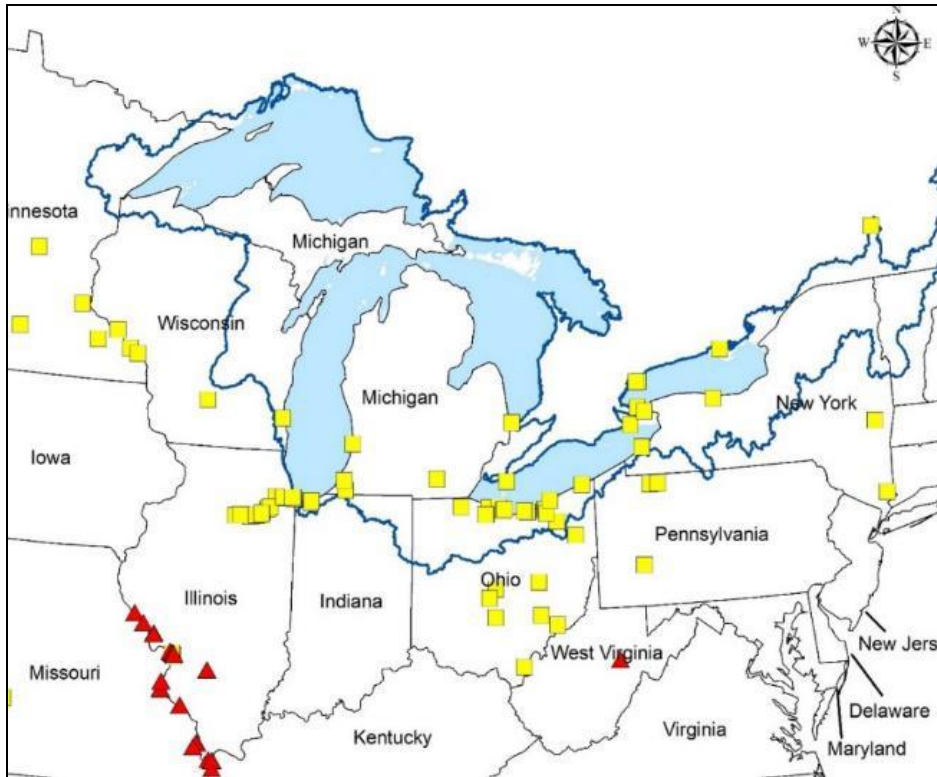


Figure 36. Map Indicating Grass Carp Captures (yellow squares) and Black Carp Captures (red triangles).

GC-13 SANDUSKY RIVER GRASS CARP BARRIER

Lead Agency: USACE

Agency Collaborators: Ohio DNR, GLFC, USGS, Michigan DNR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$250,000	\$0

Project Summary:

This project will result in the evaluation, selection, design, and construction of a barrier designed to impede upstream movement of Grass Carp to known spawning grounds in the Sandusky River, Ohio. This project is part of an adaptive response strategy endorsed by the Lake Erie Committee (Lake Erie Grass Carp Adaptive Response Strategy, 2019-2023) to control and possibly prevent establishment of Grass Carp in the Great Lakes by limiting access to 11,000 acres of spawning habitat through employment of one or more barrier technologies, to include behavioral barrier systems and physical-hydraulic barrier systems. The feasibility study will evaluate a suite of alternatives based on project objectives. The barrier will be designed and operated to minimize disturbance to native migratory fish species that also use the Sandusky River for spawning. The barrier will also be designed to minimize impacts to recreational navigation. FY 2022 funding will produce a Federal Interest Determination Document, a Project Management Plan for a feasibility study and a draft Feasibility Cost-Share Agreement to guide negotiation with the non-federal sponsor. The Ohio DNR, with funding from the GLFC, completed a report “*Feasibility Study, Grass Carp Barrier Alternatives, Sandusky River, OH*” recommending a BAFF-style barrier as a potential option at the proposed location.

Project Description:

Grass Carp is an invasive ANS and has been identified in Lake Erie in the Sandusky River. Grass Carp are highly adaptable and pose a threat to the fishery if population expansion and population growth are not effectively controlled. Currently, state and federal agencies are pursuing control of Grass Carp through targeted removals as part of the Lake Erie Committee’s Adaptive Response Strategy, but a bi-national SDM process identified that a seasonal barrier in the Sandusky River would improve the control effort. If left unmanaged, Grass Carp can have broad ecologic impacts including habitat alteration and disruption of the food web.

Potential locations for a behavioral and/or a physical-hydraulic Grass Carp barrier have been identified at the downstream extent of Brady’s Island and downstream of State Street Bridge in the Sandusky River at Fremont, Ohio.

Construction of a barrier focused on impeding upstream movement of Grass Carp to suitable spawning habitat in the river and tributaries will have benefits that outweigh the negative impacts

of Grass Carp. Based on previous work by others, the FID will focus on locations in the Sandusky River. The FID will include consideration the following alternatives: (1) no action, (2) behavioral barrier systems, and (3) physical-hydraulic barrier systems.

Project benefits would consist of prevention of Grass Carp from accessing 11,826 acres of spawning habitat in the Sandusky River watershed, thereby reducing Grass Carp populations in Lake Erie and in turn reducing impacts on habitat and native species. Barriers would reduce Grass Carp impacts, while maintaining river connectivity and not impairing native migratory fish species or current recreational use of the water body.



Figure 37. Sandusky River Map.

BC-1 ENHANCED DETECTION OF BLACK CARP IN THE LOWER ILLINOIS RIVER

Lead Agency: Illinois DNR

Agency Collaborators: USGS, INHS, SIUC

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$188,000	\$0

Project Summary:

Illinois DNR will continue monitoring the range expansion of Black Carp up the Illinois River, despite limited catches reported to date. Black Carp have invaded the Illinois River system and have been recently captured in the Alton, La Grange, and Peoria reaches of the lower Illinois River. Currently, the invasion of Black Carp is represented by only a few reported individual Black Carp and little is known about the size of the population or potential scope of ecosystem changes that may result from the invasion.

Project Description:

Critical to any inferences made about the range expansion of Black Carp is better knowledge of their population levels in invaded reaches. The limited number of Black Carp reported have been from incidental catches by commercial fishers while targeting other species (e.g., Bighead Carp, Silver Carp, common carp, Grass Carp, buffalo spp., catfish spp.). More robust estimates of the current population levels are essential to management and potential control of Black Carp in the Illinois River.

Illinois DNR will continue sampling using hoop nets baited with experimental baits to assess the population of Black Carp in the lower Illinois River and efficacy of different baits to collect them. The bait of choice to be used in Illinois River monitoring will hopefully be guided by targeted efforts of known Black Carp populations (Horseshoe Lake and Mississippi River) where bait comparisons can be evaluated during intensive sampling. In the La Grange Reach of the Illinois River, Illinois DNR will expand upon the existing LTRM standardized hoop netting efforts and make direct comparisons using experimentally baited hoop nets to target Black Carp to better detect their presence, abundance, and expansion up the lower Illinois River. While LTRM hoop netting uses a soybean-based bait, this proposed expansion will include the use of clam-based and cottonseed-based baits deployed in paired hoop net sets each in main- and side-channel habitats of the La Grange Reach. Expanded hoop netting efforts will be randomly fished in main- and side-channel border habitats in three time periods (June 15-July 31; August 1-September 15; and September 16-October 31).

BC-2 BLACK CARP MANAGEMENT AND CONTROL – COORDINATION AND SUPPORT

Lead Agency: USFWS

Agency Collaborators: USGS, Illinois DNR, BCWG

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$68,500	\$61,000

Project Summary:

This project will utilize a contractor to complete development of a an SDM process to identify and prioritize activities most effective for the management and control of Black Carp. In addition, this project will continue genetic identification of suspect Black Carp eggs/larvae, determine ploidy of captured Black Carp, and develop an outreach strategy to increase awareness of Black Carp and the related bounty program in waters leading to the Great Lakes. This project will identify priority actions for Black Carp management, increase our understanding of reproduction and distribution, and maximize the public contribution to distribution. This project will prevent Black Carp from becoming established in the Great Lakes by informing the agencies’ understanding of risk, and by identifying the best actions to address that risk. FY 2022 funding will produce a revised Black Carp Management Strategy, Black Carp Outreach Plan, and identification/ploidy of suspected Black Carp captures.

Project Description:

USFWS proposes to utilize the expertise of SDM subject matter experts with developing data-informed processes to support complex prioritization exercises. These objective experts will work with the BCWG, utilizing the latest information on Black Carp, to identify highest priority containment and control actions or identify information gaps preventing implementation of the highest priority actions. The output of this SDM process will lead to tools and techniques that can be used to assess and reduce the risk of Black Carp approaching and potentially entering the Great Lakes. Numerous partners have been engaged to date, with increased collaboration anticipated once the SDM process is initiated. Decisions will likely be focused on determining:

- Effectiveness of current and potential future barriers/deterrents to Black Carp migration.
- Most promising Black Carp attractants to pursue.
- Most promising Black Carp control tools to pursue.
- Optimal methodologies to improve sampling techniques.
- Risk of movement of Black Carp into new areas via non-swimming pathways.

Currently, detection of Black Carp is accomplished primarily through public reporting of captured fish under Illinois DNR's Black Carp Bounty Program. This program supports the collection of key distribution and demographics information from each reported capture (e.g., early life history, genetics, diet, and population demographics). An updated "Keep, Cool, Call" brochure was previously developed and posted to invasivecarp.us. USFWS proposes to develop a strategy to leverage the brochure messaging, including the identification of Black Carp, by producing and distributing associated outreach products in collaboration with state and federal partners.

USFWS will continue to provide genetics analysis capability, as needed, to partners to inform young-of-year fish identification, supporting assessments of potential Black Carp range expansion. Also, USFWS will continue to consult with the USACE Engineer Research and Development Center geneticists on potential opportunities to improve Black Carp eDNA sampling protocols, detection sensitivity, assay validation, and development of a Standard Operating Procedure for Black Carp eDNA monitoring. Finally, USFWS staff will continue to provide ploidy analysis support.

BC-3 BLACK CARP MONITORING, ASSESSMENT, AND CONTROL

Lead Agency: USGS

Agency Collaborators: USFWS, USACE-ERDC, INHS, Illinois DNR, SIUC, MDC, KDFWR

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$450,000	\$120,000

Project Summary: This effort will assess the life history, ecology, behavior, and detectability of Black Carp and work toward development of species-specific management actions and controls in the Mississippi River basin. This project will result in assessments of Black Carp life history, ecology, behavior, detectability, and research to support the development of potential prevention and control methods to preclude the introduction and establishment of this species in the Great Lakes. Results from this project will be used to inform the consideration of management actions and controls for potential use within the range of occurrence of Black Carp. FY 2022 funding will be used to summarize initial bait development, status, and sources of recruitment; present results from diet, capture, and species status; and allow continuation of research into the dispersal, habitat use, and movement behavior of wild Black Carp, diet composition, reproductive development, population demographics, larval development. This project will also support state and federal collaborators with the collection and distribution of samples and data needed for research and development of management actions.

Project Description:

This project includes the following objectives related to understanding life history, status, and behavioral characterization required for the development of management actions and controls for Black Carp::

- Continued assistance with the Illinois DNR Black Carp bounty program through coordination and receipt of fish carcasses and to process samples for a variety of research objectives directed at understanding the ecology of Black Carp throughout their range.
- Further research to describe habitat use and movements of tagged Black Carp through active relocation and passive detections when possible and report the occurrence and incidence of long-range movements to inform and describe dispersal mechanisms.
- Habitat modeling of capture locations and the available habitat within the upper and middle Mississippi River

Development of a single-dose species specific piscicide bait for the control of wild Black Carp and protection of high-value mussel populations is underway. One manuscript titled “Ingested toxicity of antimycin A to Grass Carp and Black Carp in two carriers” is in review. An additional

manuscript titled “Development of an oral piscicide delivery method for Black Carp” is in preparation.

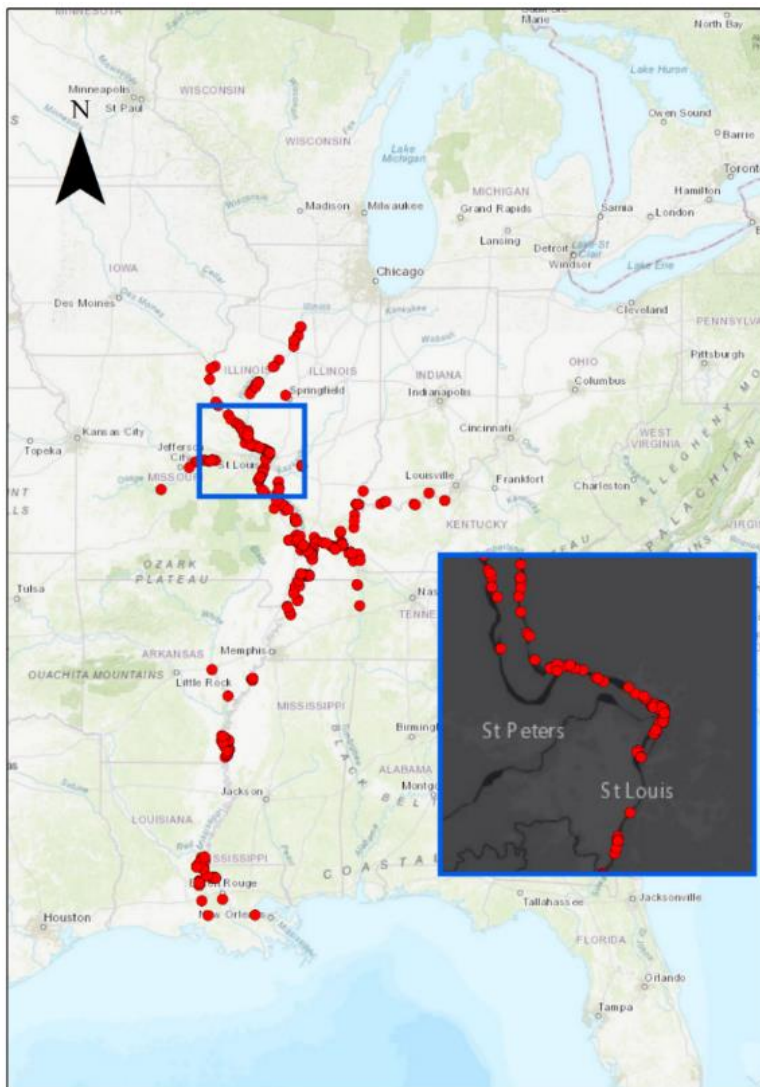


Figure 38. Map of Black Carp Distribution and Focused Study Area.

DS-1 INVASIVE CARP ENHANCED CONTRACT REMOVAL, MARKETING, ASSESSMENT, AND MANAGEMENT

Lead Agency: Illinois DNR

Agency Collaborators: SIUC, Tetra Tech

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$188,600	\$0

Project Summary:

This effort will assess the success of enhanced contract removal efforts and aid directed harvest of invasive carp in the lower Illinois River in the State of Illinois. This project will result in information about the success of harvest and prevent invasive carp from becoming established in the Great Lakes by reducing the number of fish moving upstream into the upper Illinois River as predicted by SEICarP modeling. FY 2022 funding will provide ‘heat maps’ (graphical visualizations) and trends in density and size distributions of invasive carp in the lower Illinois River to aid contracted harvest and assess the effect of harvest on densities of invasive carp.

Project Description:

Control of invasive carp via harvest is a viable technique in the upper Illinois River. SEICarP modeling using telemetry and demographics data predicts that removal of invasive carp in the lower Illinois River may reduce the migration of fish upstream, further reducing the possibility of invasion into the Great Lakes. This project will evaluate effects of harvest by assessing changes in invasive carp spatial distributions (hotspots), densities, and population demographics in the lower Illinois River to develop management strategies for enhanced removal through harvest. These efforts are required to provide detailed and comprehensive analyses about efficacy of removal, status of populations, and recommendations for future removal efforts to meet management goals.

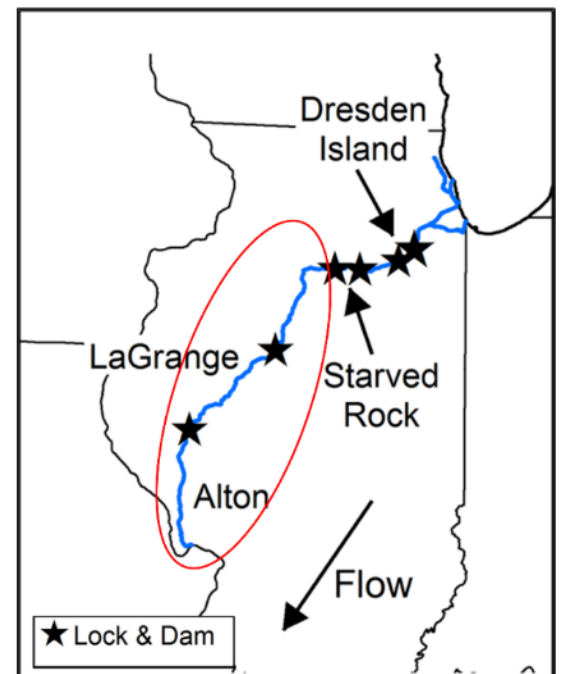


Figure 39. Map of Study Area.

DS-2 MODELING POTENTIAL INVASIVE CARP RECRUITMENT, POPULATION GROWTH, AND FOOD WEB EFFECTS IN GREAT LAKES TRIBUTARIES

Lead Agency: NOAA GLERL

Agency Collaborators: USGS, Brenton Consulting, Eureka Aquatic Research

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$110,800	\$60,000

Project Summary:

This project will summarize and report results of collaborative modeling efforts by NOAA and USGS to predict establishment, recruitment, population growth, and food web effects of invasive carp species in the Illinois River and the WLE, including the Maumee River estuary. This project will result in an improved understanding of recruitment mechanisms of invasive carp and evaluate current and alternative harvest scenarios proposed to control invasive carp in the IWW. FY 2022 efforts will produce three peer-reviewed journal manuscripts, including two on results of the coupled FluEgg and NOAA individual-based bioenergetics models for invasive carp in the Illinois River and Maumee River/WLE, and one on establishment and food web effects of invasive carp in the Illinois River.

Project Description:

In rivers and lakes of North America, Asia, and Europe, the introduction of invasive carp has resulted in the decline of many native fish species, with planktivorous larval, juvenile, or adult fish being particularly affected. NOAA’s previous food web model results of potential risk of invasive carp to Great Lakes habitats and the Illinois River suggest that if the invasive carp reach a high biomass, there could be consequences to important fishery species. Establishment and growth of invasive carp species are driven by variable habitat conditions for spawning and recruitment, and variation in productivity and structure of food webs, thus creating uncertainty in predicting population sizes and food web effects among and within Great Lakes habitats.

To help inform risk of establishment and food web effects of invasive carp species in the Great Lakes, NOAA collaborated with food web modelers at Brenton Consulting and Eureka Aquatic Research to develop and calibrate multi-species food web models of invasive carp and selected resident fishes for Saginaw Bay and invasive carp for the Illinois River and Maumee River estuary. The IBM used temperature and river stage height as environmental variables and tracked bioenergetic growth and predator-prey interactions of individual invasive carp with select ecologically and economically important fish species and their prey in riverine habitats or lake nearshore and offshore zones. To project invasive carp effects on the Illinois River and Maumee

River food web, NOAA collaborated with the USGS FluEgg team to use simulated outputs of fish egg and larval drift as inputs into the IBM, then modeled the rest of the fish life cycle to project reproductive success and recruitment variability of invasive carp and native fish species. Using these linked models, NOAA was able to simulate recruitments, population trends, and food web effects of invasive carp in the Illinois River that mimicked agency observations and are currently developing model runs for simulations of invasive carp in the Maumee and WLE.

In FY 2022, the NOAA food web team will collaborate with the USGS FluEgg team to write up the coupled modeling work on invasive carp reproductive success, recruitment, population growth, and food web effects in the Illinois River, and Maumee River and WLE. The proposed project will help prevent the introduction and establishment of invasive carp in the Great Lakes by informing in what types of habitats invasive carp may successfully recruit, and what harvest and size levels are needed to prevent establishment and population growth.

DS-3 INVASIVE CARP POPULATION MODELING TO SUPPORT AN ADAPTIVE MANAGEMENT FRAMEWORK

Lead Agency: USFWS

Agency Collaborators: USGS, Illinois DNR, SIU, MSU

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$200,000	\$100,000

Project Summary:

This effort will develop objective, data-driven models to inform decisions concerning invasive carp control efforts in the Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island pools of the Illinois River, Illinois. This project will result in quantitative population models designed to help prevent invasive carp from becoming established in the Great Lakes by identifying management recommendations that minimize the number of invasive carp challenging the EDBS. FY 2022 funding will produce advancements to existing decision-support tools leading to more accurate long-term management outcomes and will support development of novel models to address emerging management questions.

Project Description: *(This project is complementary to the USGS project titled “DS-4 Invasive Carp Population Modeling to Support an Adaptive Management Framework”)*

The goal of this project is to develop objective, data-driven tools in support of the adaptive management process and invasive carp control efforts focused on Great Lakes protection from invasive cap. To accomplish this goal, this project will continue ongoing efforts to develop and implement the SEICarP model and develop novel tools to address emerging management questions. The SEICarP model is a simulation-based mathematical representation of Silver Carp and Bighead Carp population dynamics. The model is being used to inform management in the Illinois River in two primary ways. First, the model is being used to provide management recommendations concerning required levels and spatial allocations of mortality (e.g., removal of invasive carp through harvest) and upstream movement deterrence to minimize propagule pressure in the vicinity of the EDBS. Second, critical model assumptions and results from sensitivity analyses are being used to provide management recommendations concerning data collections and research in the Illinois River and guide ongoing model development aimed at extending model capabilities and reducing model uncertainty.

Due to limitations associated with movement estimates, model-based mortality recommendations are provided on a relatively course spatial resolution (i.e., pools above versus below Starved Rock Lock and Dam) rather than on an individual pool level. To address these limitations, this project will coordinate with the MRWG Telemetry Work Group to deliver an updated movement model

with greater spatial coverage and finer spatial resolution. In addition, this project will support the recoding of the SEICarP model, as needed, to accept the updated movement model.

Development of an invasive carp stock-recruitment relationship represents an additional area of ongoing model development. The stock-recruitment relationship is fundamental to the management of invasive carp in the Illinois River waterway as it determines how recruitment rates will respond to control-induced reductions in biomass of adult invasive carp.

Also, the SEICarP model will be developed to estimate the rate at which individuals in a given pool contribute to pools located above Starved Rock Lock and Dam. The goal of this ‘per-capita’ contribution modeling effort is to assist managers by providing a tool that would prioritize harvest locations (i.e., pools) as a function of individual fish contributions to subpopulations at the leading edge of the invasive carp distribution in the Illinois River.

In addition to ongoing development of the SEICarP model, this project will include a feasibility study to determine how successfully statistical catch-at-age or statistical catch-at-length models could be completed using currently available Illinois River data. Statistical catch-at-age or -length modeling will provide insights into the contract commercial harvest program by estimating fishing mortality rates. Lastly, this project will prepare a final report and manuscript based on results from the current version of the SEICarP model.

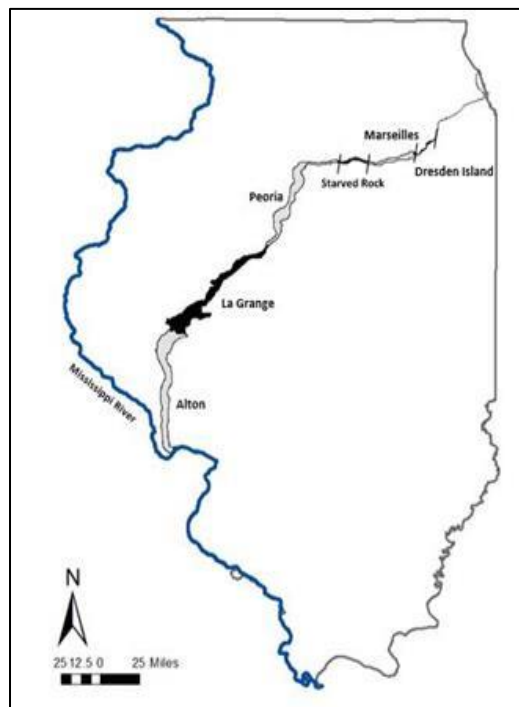


Figure 40. Modeling Covers the Entire Illinois River.

DS-4 INVASIVE CARP POPULATION MODELING TO SUPPORT AN ADAPTIVE MANAGEMENT FRAMEWORK

Lead Agency: USGS

Agency Collaborators: USGS, Illinois DNR, SIUC, Michigan State University

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$100,000	\$270,000

Project Summary:

This project will develop objective, data-driven models to inform decisions concerning invasive carp control efforts in the Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island pools of the Illinois River, Illinois. This project will result in quantitative population models designed to help prevent invasive carp from becoming established in the Great Lakes by identifying management recommendations that minimize the number of invasive carp challenging the electrical dispersal barriers. FY 2022 funding will produce advancements to existing decision-support tools leading to better long-term management outcomes and develop novel models to address emerging management questions.

Project Description: *(This project is complementary to the USFWS project titled “DS-3 Invasive Carp Population Modeling to Support an Adaptive Management Framework”)*

The goal of this project is to develop objective, data-driven tools in support of the adaptive management process and invasive carp control efforts. To accomplish this goal, this project will continue ongoing efforts to develop and implement the SEICarP model and develop novel tools to address emerging management questions.

The SEICarP model is a simulation-based mathematical representation of Silver Carp and Bighead Carp population dynamics. The model is being used to inform management in the Illinois River in two primary ways. First, the model is being used to provide management recommendations concerning required levels and spatial allocations of mortality and upstream movement deterrence to minimize propagule pressure in the vicinity of the electrical dispersal barriers. Second, critical model assumptions and results from sensitivity analyses are being used to provide management recommendations concerning data collections and research in the Illinois River and guide ongoing model development aimed at extending model capabilities and reducing model uncertainty.

The FY 2022 effort will coordinate with the MRWG Telemetry Work Group to deliver an updated movement model with greater spatial coverage and finer spatial resolution. In addition, this project would recode the SEICarP model as needed to accept the updated movement model.

The stock-recruitment relationship is fundamental to the management of invasive carp in the Illinois River waterway, because it determines how recruitment rates will respond to control-induced reductions in adult biomass. FY 2022 activities would address this limitation by leveraging data from the MRWG Hydroacoustics Work Group as well as age-structure data from field collections to develop an invasive carp stock-recruitment relationship.

The model will be developed to estimate the rate at which individuals in a given pool contribute to pools located above Starved Rock Lock and Dam. The goal of this per capita contribution modeling effort is to assist managers by providing a tool that would prioritize harvest locations (i.e., pools) as a function of individual fish contributions to subpopulations at the leading edge of the invasive carp distribution.

In addition, this project will conduct a feasibility study to determine how successfully statistical catch-at-age or statistical catch-at-length models could be completed using currently available Illinois River data. Statistical catch-at-age or -length modeling will provide insights into the contract commercial harvest program by estimating fishing mortality rates. Lastly, this project will prepare a final report and manuscript based on results from the current version of the SEICarP model.

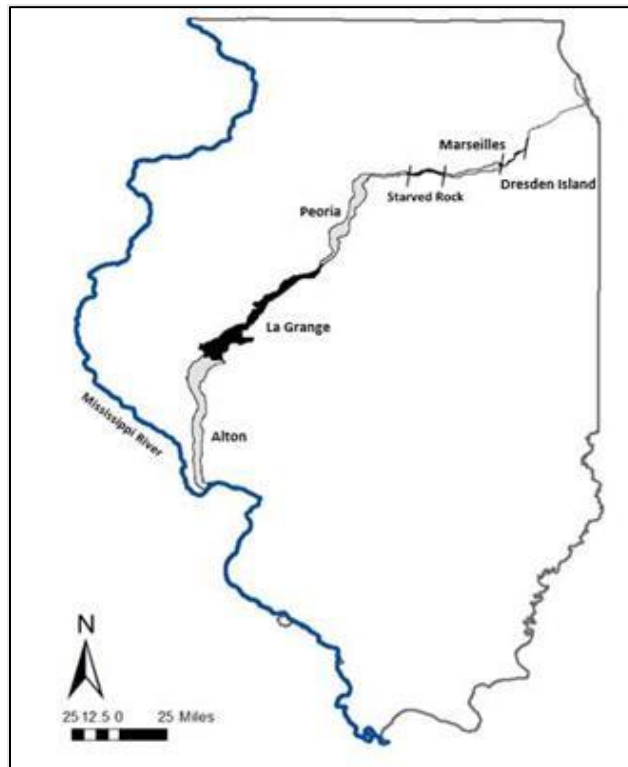


Figure 41. Modeling Covers the Entire Illinois River.

DS-5 INVASIVE CARP DATABASE MANAGEMENT AND INTEGRATION SUPPORT

Lead Agency: USGS

Agency Collaborators: Illinois DNR, USFWS, USACE, SIU, INHS, Missouri DC

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$82,000	\$378,000

Project Summary:

This project will inform modeling efforts and adaptive management actions and prevent invasive carp from becoming established in the Great Lakes by providing researchers and managers with tools to integrate, analyze, visualize, and understand invasive carp data. This project will provide unified, multi-agency data management and integration support for existing data sets of invasive carp-related data throughout the Upper Mississippi (including the Illinois River) and Ohio River sub-basins. FY 2022 funding will provide continued data management, integration, and analysis of invasive carp data within the Upper Mississippi and Ohio River sub-basins via the FishTracks Telemetry Database and associated decision support tools. The project will focus on data for the Illinois River (within the Upper Mississippi River sub-basin) to support agency efforts to protect the Great Lakes.

Project Description:

The overarching goal of this project is to provide data management, informational products, and decision support tools to aid and inform the management and removal of invasive carp in the Upper Mississippi and Ohio River sub-basins. Integrating and transforming invasive carp-related data sets into actionable information includes the following objectives:

1. Continued maintenance and improvement of the FishTracks Telemetry Database to facilitate data compilation, management, and summarization.
2. Furthering understanding of invasive carp life history and other factors that might influence the efficacy and efficiency of contract removal or other control approaches (e.g., deterrents) and facilitate risk assessment.
3. Incorporating understandings from Objective 2 into analyses, informational products, and decision support tools to inform modeling efforts and management decisions to control invasive carp.

Specific products resulting from these objectives include:

1. Development of a database for demographics-related data being collected by the partnership (beginning with the Upper Mississippi River, as supported by agency funding) to facilitate population modeling efforts and risk assessments.
2. Decision support tools (i.e., web mapping and geoprocessing services for existing invasive carp-related data layers and tools collected and developed by the partnership) to provide an online, centralized location and end-user interface for invasive carp-related data sets, database applications, and analytical tools to inform risk assessment, control, removal, and other management actions.



Figure 42. Project Location Map.

COMM-1 CRCC STRATEGIC COMMUNICATIONS

Lead Agency: USFWS

Agency Collaborators: All agencies with an active member of the Communication Work Group

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$200,000	\$ 100,000

Project Summary:

This project will support strategic communication for the ICRCC, led by the USFWS as co-chair of the CWG. This project will result in enhanced communication between the ICRCC, its member agencies, the public, and key stakeholders. This project will prevent invasive carp from becoming established in the Great Lakes by ensuring that key information is shared efficiently between the ICRCC, and other entities involved in invasive carp control efforts. This year’s funding will create new efficiencies in the ICRCC’s communication efforts and enable the development of new products that amplify the critically needed messaging identified by ICRCC members. USFWS and Illinois DNR serve as co-chairs of the CWG.

Project Description:

Requested funding will be used by the USFWS to lead the implementation of targeted ICRCC communication efforts. Work includes: (1) management of the ICRCC website, InvasiveCarp.us; (2) facilitating monthly communications meetings between ICRCC member agencies; (3) targeted media outreach; (4) coordinating partner responses to public, congressional, and media inquiries; (5) refinement of ICRCC early detection notification protocols; (6) creating ICRCC branded communication products; (7) enhancing the ICRCC’s image library; and (8) ultimately increasing the reach of ICRCC messaging. Communications work will contribute to key audiences having a greater understanding and appreciation for the ICRCC’s purpose, function, current actions, and successes.

PO-1 ICRCC PARTNERSHIP OPERATIONS ASSISTANCE

Lead Agency: USFWS

Agency Collaborators: USEPA

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$41,000	\$41,000

Project Summary:

This project will support critical capacity to provide key coordination, communication, and outreach among the ICRCC and to other invasive carp partners. The effort increases efficiency in ICRCC communication and facilitates prompt and accurate ICRCC deliverables on behalf of the Co-Chairs and the participating agencies. This project supports coordinated and strategic bi-national (U.S. and Canada), interagency efforts to protect the Great Lakes from invasive carp. The ICRCC program support provides staff assistance through the proposed actions listed below.

Project Description:

Proposed Actions for FY 2022 include:

- Work with the ICRCC and other stakeholders both in the Great Lakes and in the Mississippi River basins to address invasive carp management needs.
- Assist in ensuring bi-national coordination in sharing of invasive carp control information, including efforts under the national invasive carp control plans.
- Develop the annual Invasive Carp Action Plan, including interagency and intergovernmental coordination, and communication and outreach.
- Provide general support to the ICRCC co-chairs to support the activities of the ICRCC.
- Assist in convening ICRCC meetings to discuss agency input.
- Assist in preparation for Congressional briefings, as needed, in coordination with co-chairs.
- Assist in convening public updates with agencies and stakeholders across the Great Lakes.
- Assist the MRWG in the development and release of the MRP and work with the MRWG to help coordinate the extensive monitoring under the MRP for the CAWS and the Illinois River.

PO-2 COORDINATION AND FACILITATION FOR THE CHICAGO AREA WATERWAY SYSTEM AQUATIC INVASIVE SPECIES STAKEHOLDER GROUP

Lead Agency: Northwestern Indiana Regional Planning Commission

Agency Collaborators: ICRCC

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding
\$54,000	\$0

Project Summary:

This project will coordinate and facilitate communication and meetings for the Chicago Area Waterway System Aquatic Invasive Species (CAWS-AIS) Stakeholder Group. The CAWS-AIS Stakeholder Group includes representatives of local governments, non-governmental organizations, and various waterway user groups concerned about the system’s impact as an AIS pathway between basins. This project will continue support for maintenance of an established and diverse group of informed stakeholders engaging on AIS control projects geographically focused on the CAWS, including invasive carp protection efforts. FY 2022 funding will produce monthly CAWS-AIS Stakeholder Group Steering Committee meetings, two to four face-to-face meetings (or virtual depending on COVID-related travel restrictions), distribution of related notes and correspondence.

Project Description:

Proposed Actions for FY 2022 include:

- Continue tracking progress of the Planning, Engineering, and Design between the USACE and the State of Illinois pertaining to the planned control project at the BRLD as well as monitoring budgetary commitments to the project by federal and state partners,
- Continue receiving and discussing agency reports on the results of agency invasive carp surveillance and control measures,
- Continue to review and discuss the results of cost and effectiveness research into additional invasive carp control measures,
- Continue to observe progress on maintaining and updating the GLMRIS Report, and
- Continue to serve as a forum for exchanging information and receiving updates from the USACE, USFWS, the State of Illinois, and other federal and state agencies.

PO-3 GLMRIS PROGRAM MANAGEMENT

Lead Agency: USACE

Agency Collaborators: None

FY 2022 Lead Agency Project Funding:

GLRI Funding	Agency Funding*
\$0	*

* The FY 2022 President’s Budget includes funding for this activity under the Coordination with Other Water Resource Agencies Remaining Item in the Investigations Account.

Project Summary:

This project supports USACE coordination and communication with the ICRCC and the CAWS-AIS stakeholder group as efforts continue to prevent the spread of aquatic nuisance species in either direction between the Great Lakes and Mississippi River basins through the CSSC, and other aquatic pathways.

Project Description:

Proposed Actions for FY 2022 include:

- Internal coordination, coordination with other agencies, coordination among and support to project elements within the geographical boundaries of the GLMRIS study area (see map below).
- Budget development and defense.
- Public outreach and stakeholder engagement.
- Response to Congressional and media inquiries.

