2025 INTERIM SUMMARY REPORT

Invasive Carp Monitoring and Response Plan

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ACRONYMS AND ABBREVIATIONS LIST

Acronym and Abbreviation	Definition
2DKS	2-Dimensional Kolmogorov-Smirnov
AICc	Akaike Information Criteria Corrected
AIS	Aquatic Invasive Species
C	Celsius
Cal-Sag	Calumet-Saganashkee
CarpDAT	Invasive Carp Database
CAWS	Chicago Area Waterway System
CENPP	Constellation Energy Nuclear Power Plant
CERC	Columbia Environmental Research Center
CO2	Carbon Dioxide
CPO	Conservation Police Officer
CPUE	Catch per Unit Effort
CRP	Contingency Response Plan
CSSC	Chicago Sanitary and Ship Canal
DC	Direct Current
DNA	Deoxyribonucleic Acid
DNR	Department of Natural Resources
EDBS	Electric Dispersal Barrier System
EDM	Early detection and monitoring
eDNA	Environmental Deoxyribonucleic Acid
EF	Electrofishing
FAQ	Frequently Asked Questions
ft	feet
FWCO	Fish and Wildlife Conservation Office
GLFC	Great Lakes Fishery Commission
ICRCC	Invasive Carp Regional Coordinating Committee
ILDNR	Illinois Department of Natural Resources
ILRCdb	Illinois River Catch Database
in	inch
INHS	Illinois Natural History Survey
ISR	Interim Status Report

Acronym and Abbreviation	Definition
ISU	Invasive Species Unit
IWW	Illinois Waterway
KDFWR	Kentucky Department of Fish & Wildlife Resources
kHz	Kilohertz
L&D	Lock and Dam
LTEF	Long Term Illinois River Fish Population Monitoring Program
LTRM	Long-term Resource Monitoring
LTRMP	Long term Resource Monitoring Program
m^3	Cubic Meter
m	Meter
MAM	Multi-Agency Monitoring
MDC	Missouri Department of Conservation
mm	Millimeter
MOU	Memorandum of Understanding
MRP	Monitoring and Response Plan
MRWG	Monitoring and Response Work Group
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
OTN	Ocean Tracking Network
QA/QC	Quality Assurance/Quality Control
qPCR	Quantitative Polymerase Chain Reaction
RAFT	Riverine Acoustic Fish Telemetry Network
RM	River Mile
SCAA	Statistical Catch-at-Age
SEICarP	Spatially Explicit Invasive Carp Population
SIM	Seasonal Intensive Monitoring
SIU	Southern Illinois University
spp.	Species
TL	Total length
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency

Acronym and Abbreviation	Definition
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UMESC	Upper Midwest Environmental Sciences Center
yds	Yards
YOY	Young-of-Year

EXECUTIVE SUMMARY

This Invasive Carp Interim Summary Report (ISR) was prepared by the Monitoring and Response Work Group (MRWG) and released by the Invasive Carp Regional Coordinating Committee (ICRCC). It is intended to act as an update to previous ISRs and present the most up-to-date results and analysis for a host of projects dedicated to preventing invasive carp from establishing populations in the Chicago Area Waterway System (CAWS) and Lake Michigan. Specifically, this document is a compilation of the results of 19 projects, each of which plays an important role in preventing the expansion of the range of invasive carp and furthering the understanding of invasive carp location, population dynamics, behavior, and the efficacy of control and capture methods. The MRWG has also completed a companion document, the 2025 Invasive Carp Monitoring and Response Plan (MRP) for the Illinois Waterway (IWW).

> The term "invasive carp" generally refers to four species of carp native to central and eastern Asia that were introduced to the waters of the United States and have become highly invasive. The four species generally referred to by the "invasive carp" moniker are:
>
> - **Bighead Carp** (*Hypophthalmicthys nobilis*)
> - **Silver Carp** (*Hypophthalmicthys molitrix*)
> - **Grass Carp** (*Ctenopharyngodon idella*)
> - **Black Carp** (*Mylopharyngodon piceus*)

The 2025 results for 19 projects are summarized in this ISR. Also included in this ISR is an update to Appendix A: Zooplankton as Dynamic Assessment Targets for Invasive Carp Removal. The Upper Illinois Waterway Continency Response Plan (CRP) is an important component of the effort to prevent invasive carp from establishing a presence in the IWW; therefore, the CRP is also identified in the project location crosswalk included in the ISR, but the CRP is a separate document that can be found on https://icrcc.fws.gov. The summaries in the ISR document the purpose, objectives, and methods for each project, in addition to providing an analysis of results and recommendations for future actions. The projects are grouped into three general categories:

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

Presented below are project highlights by category, which provide a brief snapshot of project accomplishments during 2025. A link to the corresponding project is provided at the end of each highlight.

HIGHLIGHTS OF 2025 EFFORTS

Detection Projects

- Led by Illinois Department of Natural Resources (ILDNR), MRWG agencies completed two 2-week Seasonal Intensive Monitoring (SIM) events with conventional gears in the CAWS upstream of the Electric Dispersal Barrier System (EDBS) in 2025; no live Silver Carp or Bighead Carp were captured or observed during 2025 SIM events (see: SEASONAL INTENSIVE MONITORING IN THE CAWS).
- Staff supporting the 2025 spring SIM event captured and removed two Grass Carp, one from Lake Calumet and one from the Little Calumet River (see: SUPPORT FOR EARLY DETECTION OF INVASIVE CARP IN THE UPPER ILLINOIS WATERWAY).
- No invasive carp were detected upstream of Brandon Road Lock and Dam (see: SUPPORT FOR EARLY DETECTION IN THE UPPER ILLINOIS WATERWAY).
- No small invasive carp were captured in Lockport, Brandon Road, Dresden Island, Marseilles, or Starved Rock pools (see: SUPPORT FOR EARLY DETECTION IN THE UPPER ILLINOIS WATERWAY).
- The U.S. Fish and Wildlife Service (USFWS) captured and removed two large Bighead Carp, 490 large Silver Carp, and 10 large Grass Carp from Marseilles Pool, Dresden Island Pool, and the lower Kankakee River in 2025. No Black Carp were encountered during sampling (see: SUPPORT FOR EARLY DETECTION OF INVASIVE CARP IN THE UPPER ILLINOIS WATERWAY).
- From April to early October 2025, Illinois Natural History Survey (INHS) staff conducted ichthyoplankton sampling from Brandon Road to Alton navigation pools of the IWW. The sampling results indicate that overall invasive carp reproductive productivity in 2025 was low (see: ASSESSMENT OF INVASIVE CARP REPRODUCTION IN THE ILLINOIS WATERWAY).
- In 2025, INHS and Eastern Illinois University collected invasive carp eggs and larvae samples from all pools in and downstream of the Marseilles Pool. Despite widespread regional drought, several precipitation events caused moderate rises in discharge that triggered multiple low-magnitude spawning events in the IWW main channel from April to August. No evidence of invasive carp reproduction was observed upstream of Dresden Island Lock and Dam (see: ASSESSMENT OF INVASIVE CARP REPRODUCTION IN THE ILLINOIS WATERWAY).
- USFWS staff collected 1,040 environmental deoxyribonucleic acid (eDNA) samples upstream of the EDBS and 110 eDNA samples in Powderhorn Lake (control site); positive detections were few and consistent with previous sampling years (see: INVASIVE CARP eDNA SAMPLING AND PROCESSING).
- The enforcement phase of the Law Committee's *Least Wanted Aquatic Invasive Species* project took place in 2025. Despite prior regulatory notice, 10 businesses nationwide illegally sold prohibited species to undercover officers, resulting in criminal charges and $2,250 in fines. The project also led many pond and aquarium suppliers to implement purchase restrictions and

update websites with state-specific prohibited species lists (see: ALTERNATE PATHWAY SURVEILLANCE IN ILLINOIS – LAW ENFORCEMENT).

Management and Control Projects

- From 2018 to 2025, USFWS collected and processed over 6,100 otolith aging structures from six pools of the Illinois River, which provided pool-specific age-structure metrics (see: INVASIVE CARP DEMOGRAPHICS IN THE ILLINOIS WATERWAY).
- During the 2025 multiple agency monitoring (MAM) sampling event, 1,657 small Silver Carp (less than 6 inches or 152.4 millimeters) were captured in the lower three pools of the Illinois River. This represents a significant increase in spawning over 2023 and 2024 but is still a relatively minor spawning pulse in the historical context of longer-term La Grange Pool sampling (see: MULTI-AGENCY MONITORING OF THE ILLINOIS RIVER FOR DECISION MAKING).
- In 2025, 299,176 fish were captured, representing 101 species, 6 hybrid species, and 12 unknown species from family groups (e.g., small individuals from Cyprinidae, Catostomidae, Centrarchidae, etc.). Zero invasive carp (large or small) were captured in Lockport or Brandon Road pools in 2025 (see: MULTI-AGENCY MONITORING OF THE ILLINOIS RIVER FOR DECISION MAKING).
- Led by Southern Illinois University (SIU), the 14th year of standardized monitoring of bigheaded carp (i.e., Bighead Carp and Silver Carp) densities was completed in 2025 from Alton to Dresden Island pools. This data allows for long-term assessments and comparisons of density trends across space and through time (see: INVASIVE CARP STOCK ASSESSMENT IN THE ILLINOIS RIVER).
- In 2025, historical barrier scan data was reviewed and reprocessed to enable year-to-year comparisons and population trend analysis, revealing that large target densities from mobile hydroacoustic surveys in Lockport, Brandon Road, and Dresden Island pools were lower than the previous year (see: ILLINOIS WATERWAY HYDROACOUSTICS).
- SIU maintained the stationary acoustic telemetry receiver array throughout the Illinois River, ensuring sufficient surveillance efforts occurred to detect adult movements among pools and toward the invasion front (see: SIU LONGITUDINAL RECEIVER ARRAY AND TAGGING).
- No known live tagged fish have crossed the EDBS in the upstream direction (see: ACOUSTIC TELEMETRY MONITORING NEAR THE INVASION FRONT AND EDBS).
- In April 2025, USFWS implanted 150 V-9 acoustic transmitters inside invasive carp – 150 in Peoria Pool and 50 in Starved Rock Pool. An additional Silver Carp was tagged in Starved Rock Pool with viable tags from recaptured fish in 2024 (see: TELEMETRY SUPPORT FOR THE SPATIALLY EXPLICIT INVASIVE CARP POPULATION MODEL (SEICarP)).
- From 2010 to 2025, ILDNR, working with contracted fishers, has removed 106,955 Bighead Carp, 1,916,468 Silver Carp, and 12,977 Grass Carp from the IWW. The total estimated weight of invasive carp removed is 8,511 tons (17,022,381 pounds) (see: CONTRACTED COMMERCIAL FISHING BELOW THE ELECTRIC DISPERSAL BARRIER).

- Supported by ILDNR, contracted fishers removed more than 5.8 million pounds of invasive carp from the Peoria, La Grange, and Alton pools of the Illinois River in 2025 (see: INVASIVE CARP ENHANCED CONTRACT REMOVAL PROGRAM).
- ILDNR continued to support the Copi brand, with increased domestic and international interest and development of new value-added products using the brand (see: INVASIVE CARP ENHANCED CONTRACT REMOVAL PROGRAM).
- The U.S. Geological Survey (USGS) published the Riverine Acoustic Fish Telemetry Network web application, with 30 member projects, over 1,300 receivers, 12,000 transmitters, and over 100 million detections. Completed extensive bug fixes, optimization, and testing (https://usgs.gov/apps/raft) (see: USGS INVASIVE CARP DATABASE MANAGEMENT AND INTEGRATION SUPPORT).
- USGS presented the Invasive Carp Open Data Hub at the Upper Midwest Invasive Species Conference and USGS Invasive Carp Science Meeting (see: USGS INVASIVE CARP DATABASE MANAGEMENT AND INTEGRATION SUPPORT).
- Results from the SEICarP model suggest that harvest of invasive carp from the downstream pools (Alton through Peoria pools; source population) remains more effective than harvest from upstream pools (Starved Rock through Dresden Island pools; sink population) at reducing the Dresden Island population (see: SUPPORT FOR INVASIVE CARP POPULATION MODELING IN THE ILLINOIS RIVER).
- In 2025, INHS and ILDNR completed 65 paired hoop nets baited with cottonseed-based baits, 65 paired hoop nets baited with clams, and 65 un-baited paired hoop nets within the Alton Reaches of the Illinois River. One Black Carp was captured during these efforts with a non-baited hoop net. Sampling sites were re-stratified using Black Carp preferences to increase the likelihood of capture success (see: ENHANCED DETECTION OF BLACK CARP IN THE LOWER ILLINOIS RIVER).
- In 2025, 133 Black Carp were reported by five states, and aging structures were pulled and shipped to USFWS for age assessments, with three Black Carp reported from the Alton Pool of the Illinois River (see: DATA COLLECTION FROM COMMERCIAL FISHERS AND RECREATIONAL ANGLER CAPTURES OF BLACK CARP IN THE LOWER ILLINOIS RIVER).

Response Projects

- No responses were conducted in 2025.

INTRODUCTION

The 2025 ISR presents a comprehensive accounting of project results from activities completed by the invasive carp MWRG in 2025. These projects have been carefully selected and tailored to contribute to the overall goal of preventing invasive carp from establishing self-sustaining populations in the CAWS and Lake Michigan. Efforts to prevent the spread of invasive carp to the Great Lakes have been underway for over 14 years. Throughout this time, goals, objectives, and strategic approaches have been refined to focus on five key objectives:

(1) Determining the distribution and abundance of any invasive carp in the CAWS and using this information to inform response removal actions.

(2) Removing any invasive carp found in the CAWS to the maximum extent practicable.

(3) Identifying, assessing, and reacting to any vulnerability in the current system of barriers to prevent invasive carp from moving into the CAWS.

(4) Determining the leading edge of major invasive carp populations in the Illinois River and the reproductive successes of those populations.

(5) Improving the understanding of factors behind the likelihood that invasive carp could become established in the Great Lakes.

The 19 projects presented in this document represent the results of efforts undertaken in 2025 to further the implementation of each of these objectives. Also included in this ISR is an update to Appendix A: Zooplankton as Dynamic Assessment Targets for Invasive Carp Removal. The Upper Illinois Waterway CRP, which includes the Barrier Maintenance and Fish Suppression update, is an important component of the effort to prevent invasive carp from establishing a presence in the IWW; therefore, the CRP is also identified in the project location crosswalk included in the ISR, but the CRP is a separate document that can be found on https://icrcc.fws.gov. To align with the 2025 Monitoring and Response Plan, the projects have been organized by MRWG work group.

Table 1 provides a current list of MRWG work groups, including leads, co-leads, and respective agencies.

Table 1. MRWG Work Group and Leads

Work Group	Lead	Agency	Co-Lead(s)	Agency
Contingency Response	Nick Barkowski	USACE	Alex Catalano Mindy Barnett	USACE ILDNR
Detection	Steve Butler	INHS	Jen-Luc Abeln Joe Parkos	USFWS INHS
Monitoring	Jim Lamer	INHS	Eli Lampo	ILDNR
Hydroacoustics	Jim Garvey	SIU	Elizabeth Harrell	USFWS
Telemetry	Marybeth Brey	USGS	Alex Catalano	USACE
Removal	Allie Lenaerts	ILDNR	Justin Widloe	ILDNR
Modeling	Richie Erickson	USGS	Benjamin Marcek	USFWS
Behavioral Deterrents	Marybeth Brey	USGS	Christa Woodley Nick Barkowski	USACE USACE
Black Carp	Rob Simmonds	USFWS	-	-

BACKGROUND

Invasive carp are native to central and eastern Asia, with a wide distribution throughout eastern China. They typically live in river systems and have predators and competitors in their native habitats that are well adapted to compete with invasive carp for food sources, thus limiting their population growth. In the early 1970s, invasive carp were intentionally imported to the U.S. for use in aquaculture and wastewater treatment detention ponds. In these settings, invasive carp were used to control the growth of weeds, algae, and pests. By 1980, invasive carp had been captured by fishermen in river systems in Arkansas, Louisiana, and Kentucky.

The term “invasive carp” generally refers to four species of carp native to central and eastern Asia that were introduced to the waters of the United States and have become highly invasive. The four species generally referred to by the “invasive carp” moniker are:

- **Bighead Carp** (*Hypophthalmicthys nobilis*)
- **Silver Carp** (*Hypophthalmicthys molitrix*)
- **Grass Carp** (*Ctenopharyngodon idella*)
- **Black Carp** (*Mylopharyngodon piceus*)

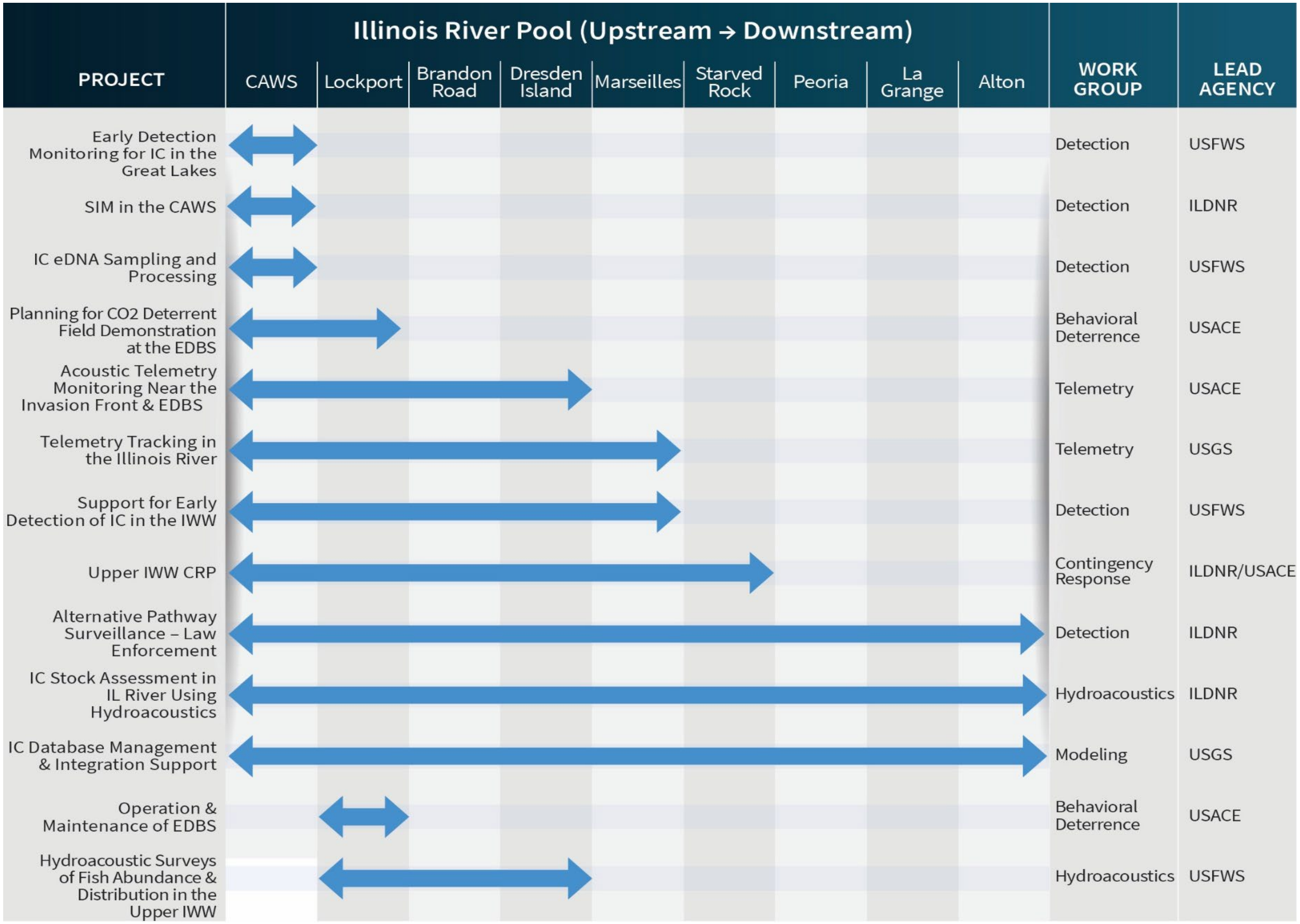
Flooding events during the 1980s and 1990s allowed invasive carp to greatly expand their range from isolated detention ponds to natural river systems. Invasive carp are currently widespread in the Mississippi River basin, including the Ohio River, Missouri River, and Illinois River. Areas with large populations of invasive carp have seen an upheaval of native ecosystem structure and function. Invasive carp are voracious consumers of phytoplankton, zooplankton, and macroinvertebrates. They grow quickly and are highly adapted for feeding on these organisms, allowing them to outcompete native species and quickly grow too large for most native predators to prey upon. As a result, their populations have exploded in the Mississippi River basin.

The expansion of invasive carp populations throughout the central U.S. has had enormous impacts on local ecosystems and economies. Where invasive carp are present, the native ecosystems have been altered, resulting in changes to the populations and community structure of aquatic organisms. The trademark leaping behavior of startled Silver Carp has also impacted recreational activities where they are populous, presenting a new danger to people on the water. Current academic studies estimate that the economic impact of invasive carp is in the range of billions of dollars per year. A central focus of governmental agencies is preventing the spread of invasive carp to the Great Lakes. Ecological and economic models forecast that the introduction of invasive carp to the Great Lakes could have enormous impacts.

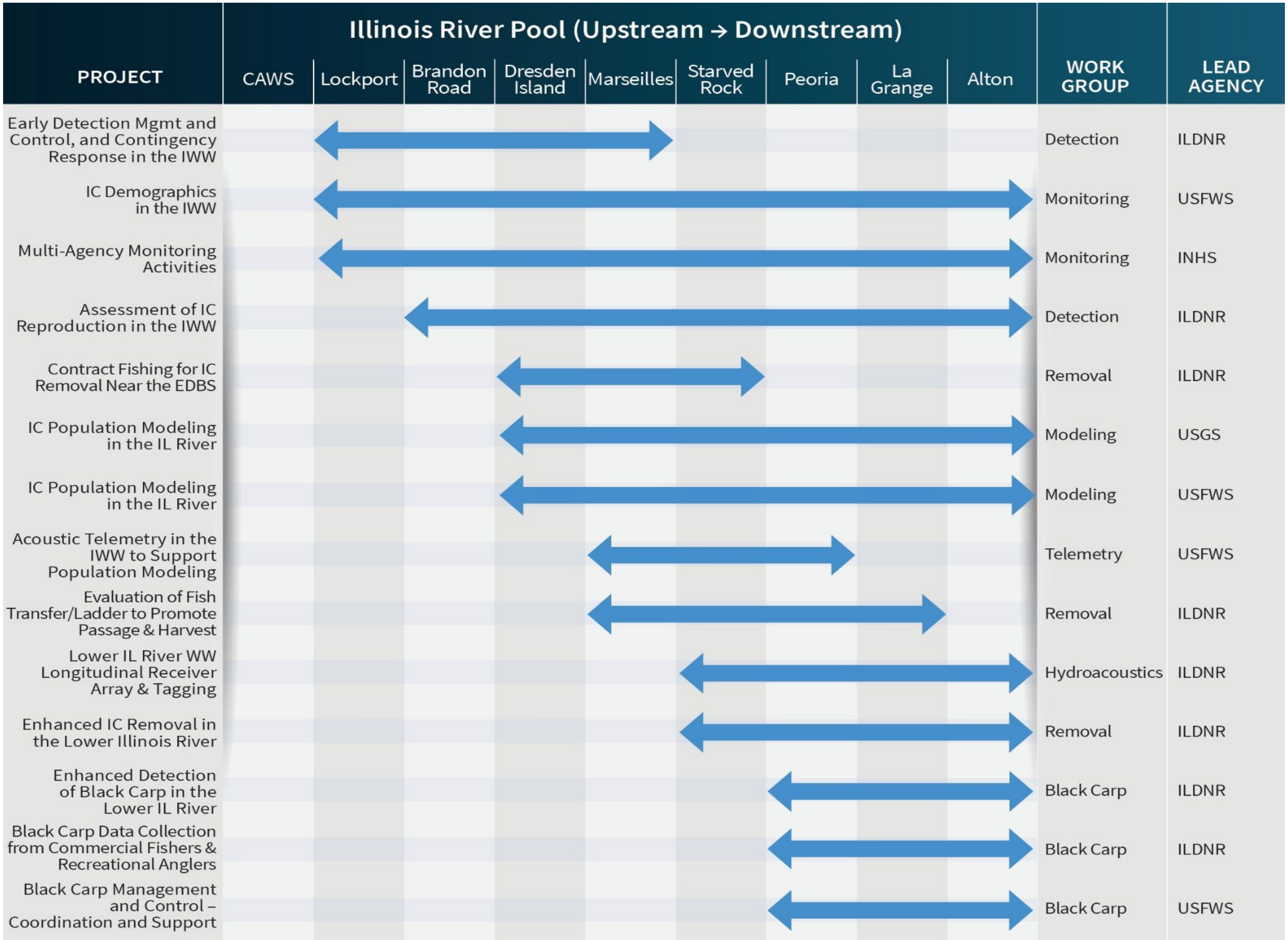
In response to the threat posed to the Great Lakes by invasive carp, the ICRCC and the MRWG present the following projects to further the understanding of invasive carp, improve methods for capturing invasive carp, and directly combat the expansion of invasive carp range.

PROJECT LOCATIONS

To clearly depict the geospatial scale and focus of the projects included in this ISR, the MRWG has prepared a project location crosswalk. This crosswalk tool allows readers to understand where a specific project focuses its efforts and quickly discern all projects that are operating in a specific portion of the IWW and CAWS.



Illinois River Pool (Upstream → Downstream)
PROJECT
CAWS
Lockport
Brandon Road
Dresden Island
Marseilles
Starved Rock
Peoria
La Grange
Alton
WORK GROUP
LEAD AGENCY
Early Detection Monitoring for IC in the Great Lakes
Detection
USFWS
SIM in the CAWS
Detection
ILDNR
IC eDNA Sampling and Processing
Detection
USFWS
Planning for CO2 Deterrent Field Demonstration at the EDBS
Behavioral Deterrence
USACE
Acoustic Telemetry Monitoring Near the Invasion Front & EDBS
Telemetry
USACE
Telemetry Tracking in the Illinois River
Telemetry
USGS
Support for Early Detection of IC in the IWW
Detection
USFWS
Upper IWW CRP
Contingency Response
ILDNR/USACE
Alternative Pathway Surveillance – Law Enforcement
Detection
ILDNR
IC Stock Assessment in IL River Using Hydroacoustics
Hydroacoustics
ILDNR
IC Database Management & Integration Support
Modeling
USGS
Operation & Maintenance of EDBS
Behavioral Deterrence
USACE
Hydroacoustic Surveys of Fish Abundance & Distribution in the Upper IWW
Hydroacoustics
USFWS


Illinois River Pool (Upstream → Downstream)
PROJECT
CAWS
Lockport
Brandon Road
Dresden Island
Marseilles
Starved Rock
Peoria
La Grange
Alton
WORK GROUP
LEAD AGENCY
Early Detection Mgmt and Control, and Contingency Response in the IWW
Detection
ILDNR
IC Demographics in the IWW
Monitoring
USFWS
Multi-Agency Monitoring Activities
Monitoring
INHS
Assessment of IC Reproduction in the IWW
Detection
ILDNR
Contract Fishing for IC Removal Near the EDBS
Removal
ILDNR
IC Population Modeling in the IL River
Modeling
USGS
IC Population Modeling in the IL River
Modeling
USFWS
Acoustic Telemetry in the IWW to Support Population Modeling
Telemetry
USFWS
Evaluation of Fish Transfer/Ladder to Promote Passage & Harvest
Removal
ILDNR
Lower IL River WW Longitudinal Receiver Array & Tagging
Hydroacoustics
ILDNR
Enhanced IC Removal in the Lower Illinois River
Removal
ILDNR
Enhanced Detection of Black Carp in the Lower IL River
Black Carp
ILDNR
Black Carp Data Collection from Commercial Fishers & Recreational Anglers
Black Carp
ILDNR
Black Carp Management and Control – Coordination and Support
Black Carp
USFWS

DETECTION WORK GROUP PROJECTS

- Seasonal Intensive Monitoring in the CAWS
- Support for Early Detection of Invasive Carp in the Upper Illinois Waterway
- Assessment of Invasive Carp Reproduction in the Illinois Waterway
- Invasive Carp eDNA Sampling and Processing
- Alternative Pathway Surveillance in Illinois – Law Enforcement

SEASONAL INTENSIVE MONITORING IN THE CAWS

Participating Agencies: ILDNR (lead); USFWS, and USACE; USCG (waterway closures when needed), USGS (flow monitoring when needed); MWRDGC (waterway flow management and access); and USEPA and GLFC (project support); Andrew Wieland; Allison Lenaerts, Amanda Carter, Mitch Rosandich Justin Widloe, Eli Lampo, Mindy Barnett, Brian Schoenung (ILDNR)

MWRG Work Group: Detection

Pools Involved: CAWS

INTRODUCTION AND NEED

Detections of invasive carp (Silver Carp and Bighead Carp) eDNA upstream of the EDBS in 2009 initiated the development of a monitoring plan that utilized boat electrofishing and contracted commercial fishers to sample for invasive carp at five fixed sites upstream of the barrier. Random area sampling began in 2012, increasing the chance of detecting invasive carp in the CAWS beyond the designated fixed sites. Extensive sampling performed upstream of the EDBS from 2010 through 2013 resulted in one Bighead Carp being collected in Lake Calumet in 2010. Fixed-site and random area sampling efforts were then reduced upstream of the barrier to two SIM events from 2014 to 2025. Following effort reduction, one Silver Carp was collected in the Little Calumet River in 2017, resulting in a rapid interagency contingency response effort. One additional Silver Carp was captured in 2022 in Lake Calumet outside of SIM sampling. Effort reduction upstream of the EDBS allows for increased monitoring efforts downstream of the barrier. Increased sampling downstream of the EDBS focuses sampling efforts at the leading edge (Dresden Island Pool) of the invasive carp population, which serves to reduce their numbers in that area, reducing the risk of individuals moving upstream toward the EDBS and Lake Michigan by way of the CAWS. Results from the SIM upstream of the EDBS contribute to our understanding of invasive carp abundance in the CAWS and guide actions designed to remove invasive carp from areas where they have been captured or observed.

OBJECTIVES

- Determine invasive carp population abundance through intense fixed, random, and targeted sampling efforts at locations deemed likely to hold fish.
- Remove invasive carp from the CAWS upstream of the EDBS.

PROJECT HIGHLIGHTS

- Completed two 2-week SIM events with conventional gears in the CAWS upstream of the EDBS in 2025.
- No live Silver Carp or Bighead Carp were captured or observed during SIM 2025. One live Bighead Carp was captured in Lake Calumet in 2010, and one live Silver Carp was captured in the Little Calumet River in 2017, with no other captures or observations in any other years. One dead Silver Carp was observed in 2018 on the banks of the Cal-Sag Channel, and another dead Silver Carp was observed in 2022 on the banks of the Calumet River. One live Silver Carp was captured in Lake Calumet in 2022 outside of SIM sampling. For more information on response actions, please

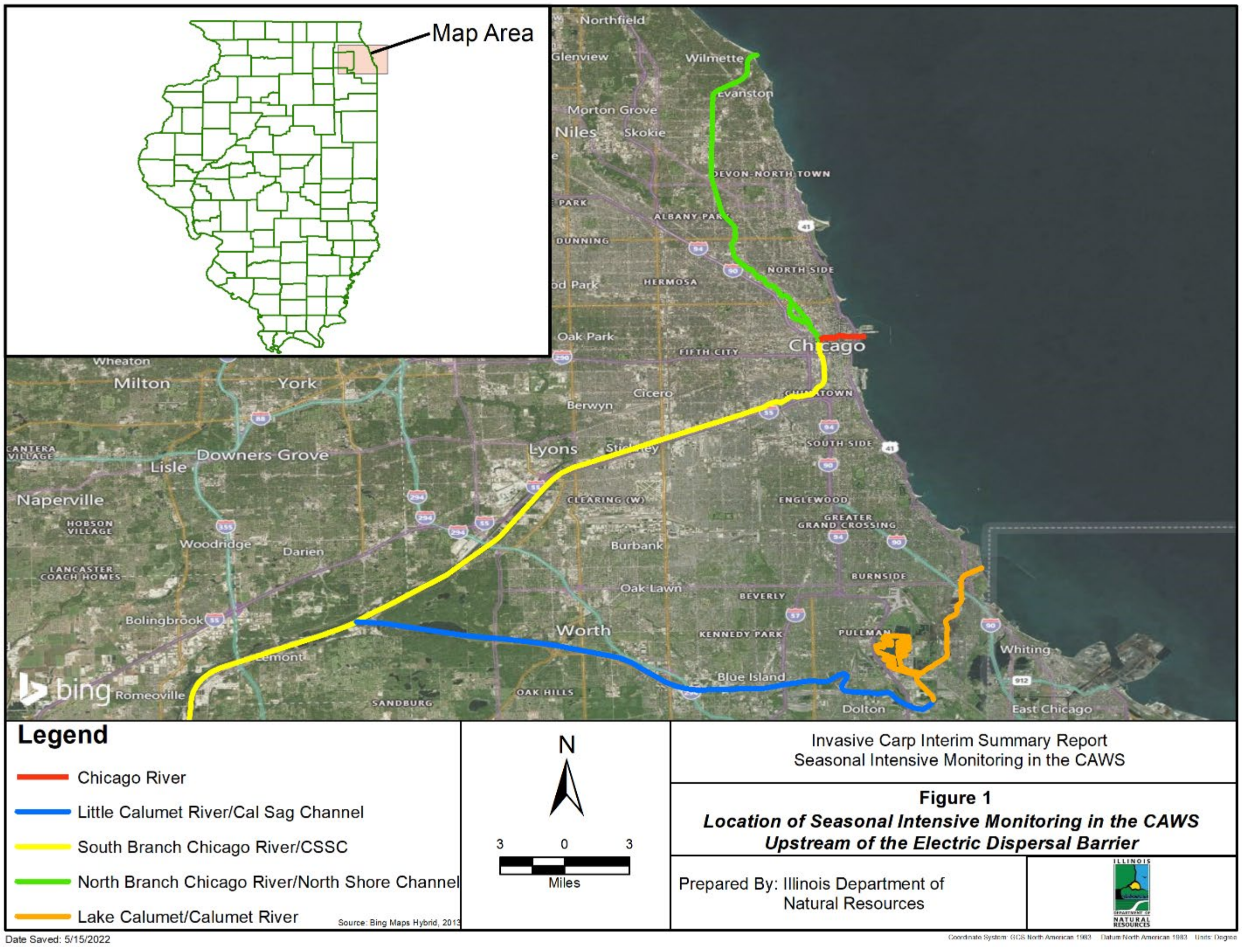
refer to the Response Project section of the appropriate year's ISR (Action Plans and Reports | Invasive Carp Regional Coordinating Committee).

- Two Grass Carp were captured and removed from Lake Calumet and the Little Calumet River during the spring SIM. From 2010 to 2025, a total of 71 Grass Carp upstream of the EDBS have been removed in the CAWS.
- An estimated 3,240 person-hours were spent completing 140 hours of electrofishing, setting 155.1 kilometers (96.3 miles) of gill net, and setting 2.9 kilometers (1.8 miles) of commercial seine in 2025.
- Across all locations and gears, 43,002 fish were sampled in 2025, representing 60 species and 3 hybrid groups.
- An estimated 50,806 person-hours have been spent completing 2009.2 hours of electrofishing, setting 2068.1 kilometers (1285.2 miles) of gill/trammel net, setting 33.6 kilometers (20.9 miles) of commercial seine, and setting 114.2 net nights of tandem trap nets, hoop nets, fyke nets, and pound nets since 2010.
- From 2010 to 2025, a total of 633,384 fish representing 88 species and 7 hybrid groups were sampled.
- YOY Gizzard Shad (n = 149,493) were examined, and no YOY invasive carp were found when sampling from 2010 to 2025.
- Non-native species (n = 16) have been captured, accounting for 15 percent of the total number of fish caught and 15 percent of the total species since 2010.

METHODS

Pulsed DC-electrofishing, gill nets, and a commercial seine were used to monitor for invasive carp in the CAWS upstream of the EDBS (Figure 1). In previous years, trammel nets, deep water gill nets, fyke nets, and pound nets were also used. Those gear specifications can be found in prior ISRs. Intensive electrofishing and netting occurred at five fixed-site and four random-site sampling areas. Random sites were generated with GIS software from shape files of designated random site areas. In 2025, random site sampling also took place within fixed-site areas, as it was found that the effort level (number of sampling sites per river kilometer) in fixed-site areas was much lower than in random site areas. Adding random sites into fixed-site sampling areas increased effort levels within the fixed-site areas and allowed for more thorough surveillance in areas that might hold invasive carp, such as the Little Calumet River and Lake Calumet. For a more detailed description of fixed and random sampling areas, see the 2025 MRP (2025 Invasive Carp Monitoring and Response Plan). Decontamination protocols for PDC electrofishing and netting can also be found in the 2025 MRP.

Figure 1. *Location of SIM in the CAWS upstream of the EDBS.*

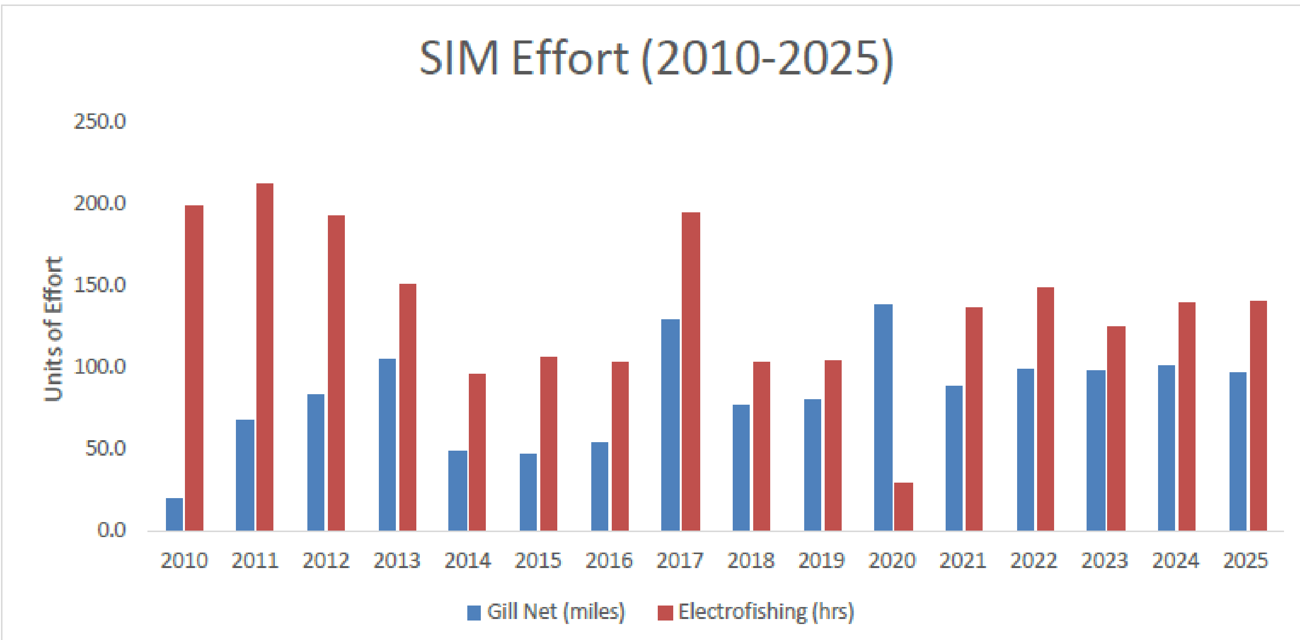


RESULTS AND DISCUSSION

SIM sampling in 2025 took place from May 12 to 23 and September 29 to October 10, for a total of 20 sampling days. Sampling in 2024 also took place in May and October. From 2014 to 2020, sampling events were conducted in June and September. To continually focus monitoring efforts on the leading edge of the invasive carp population below the EDBS, the same reduced sampling effort protocols established in 2014 upstream of the barrier were followed in 2025 (Figure 2). Sampling events in the spring and fall were both preceded by eDNA monitoring (see the "Invasive Carp eDNA Sampling and Processing" report in this ISR for more information on protocols and results). Effort in 2025 was 140 hours of electrofishing (560 transects), with an estimated 1,600 person-hours; 155.1 kilometers (96.3 miles) of gill netting (848 sets), with an estimated 1,410 person-hours; and 2.9 kilometers (1.8 miles) of commercial seine, with an estimated 210 person-hours (Table 1).

Across all locations and gears, 43,002 fish representing 60 species and 3 hybrid groups were sampled in 2025 (Table 2). Gizzard Shad (49.7 percent), Largemouth Bass (8.6 percent), Common Carp (8.5 percent), Freshwater Drum (6.2 percent), Bluegill (3.6 percent), Pumpkinseed (3.2 percent), and Emerald Shiner (2.72 percent) were the predominant species, comprising 82.7 percent of all fish sampled. Twelve non-native species were sampled, including Common Carp and hybrids (Common carp x goldfish), Round Goby, Alewife, Goldfish, White Perch, Oriental Weatherfish, Grass Carp, Chinook Salmon, Coho Salmon, Brown Trout, and Rainbow Trout. Non-native species made up 15 percent of the total species collected and 14 percent of the total fish by count in 2025. In addition, 5,568 YOY Gizzard Shad were examined, and none were found to be YOY invasive carp. No live Bighead Carp or Silver Carp were captured or observed.

Figure 2. *Total electrofishing and trammel/gill netting effort at fixed and random sites in the CAWS upstream of the EDBS, 2010 to 2025.*



An estimated 50,806 person-hours have been expended monitoring fixed and random sites upstream of the EDBS since 2010. From 2010 to 2025, the total effort consisted of 2,009.2 hours of electrofishing (8,131 transects); 2,068.1 kilometers (1,285.2 miles) of gill/trammel net (11,330 sets); 33.6 kilometers (20.9 miles) of commercial seine hauls; and 114.2 net nights of hoop, pound, and fyke nets (Table 3). Hoop net use was suspended after 2013 due to low gear efficiency. A total of 633,384 fish representing 88 species and 7 hybrid groups have been sampled since 2010 (Table 3). Gizzard Shad, Common Carp, Bluegill, Largemouth Bass, Bluntnose Minnow, and Pumpkinseed were the predominant species sampled, accounting for 82 percent of all fish collected. Since 2010, 16 non-native species have been caught, including Alewife, Bighead Carp, Brown Trout, Chinook Salmon, Coho Salmon, Common Carp and hybrids, Goldfish, Grass Carp, Oriental Weatherfish, Rainbow Smelt, Rainbow Trout, Round Goby, Silver Arrowana, Silver Carp, Tilapia, and White Perch and hybrids. Non-native species constitute 15 percent of the total number of fish caught and 15 percent of the total species. Since 2010, 149,493 YOY Gizzard Shad have been examined, with no YOY invasive carp being identified. One live Bighead Carp was caught in a trammel net in Lake Calumet in 2010, and one live Silver Carp was captured in a trammel net in the Little Calumet River on June 22, 2017, with no other captures or observations in other years. One live Silver Carp was captured in Lake Calumet on August 4, 2022, outside of SIM sampling. For more information on this capture and the subsequent response, please see the Response Projects section of the 2022 ISR.

RECOMMENDATIONS

Continue conducting SIM upstream of the EDBS. SIM with conventional gears represents the best available tool for localized detection and removal of invasive carp to prevent them from becoming established in the CAWS or Lake Michigan.

REFERENCES

MRWG. 2025. 2025 Monitoring and Response Plan for Invasive Carp in the upper Illinois River and Chicago Area Waterway System. Illinois, Chicago.

Table 1. *Summary of effort and catch data for SIM in the CAWS upstream of the EDBS, 2025.*

	Effort and Catch	Lake Calumet/ Calumet River	Little Calumet River/Cal Sag	S. Branch Chi. River/CSSC	Chicago River	N. Branch Chi River/N. Shore	Total
Electrofishing Effort	Estimated person-hours	730	350	270	0	240	1,590
	Samples (transects)	225	125	120	0	90	560
	Electrofishing hours	56	32	30	0	22	140
Electrofishing Catch	All fish (*N*)	10,864	14,162	3,603	0	7,702	36,331
	Species (*N*)	42	45	25	0	39	60
	Hybrids (*N*)	2	2	2	0	1	3
	Bighead Carp (*N*)	0	0	0	0	0	0
	Silver Carp (*N*)	0	0	0	0	0	0
	CPUE (fish/hr)	194	442.46	120.1	0	350.1	226.5
Netting Effort	Estimated person-hours	510	410	220	20	280	1430
	Samples (net sets)	276	303	165	7	97	848
	Miles of net	31.4	34.43	18.75	0.795	11.02	96.3
Netting Catch	All fish (*N*)	714	500	177	7	95	1,420
	xSpecies (*N*)	14	14	5	3	4	18
	Hybrids (*N*)	0	1	0	0	1	1
	Bighead Carp (*N*)	0	0	0	0	0	0
	Silver Carp (*N*)	0	0	0	0	0	0
	CPUE (fish/100 yds of net)	1.1	1.2	1.4	1.8	2.07	1.5
Seine Effort	Estimated person-hours	210	0	0	0	0	210
	Samples (seine hauls)	4	0	0	0	0	4
	Miles of seine	1.8	0	0	0	0	1.8
Seine Catch	All fish (*N*)	5,273	0	0	0	0	5,273
	Species (*N*)	22	0	0	0	0	22
	Hybrids (*N*)	0	0	0	0	0	0
	Bighead Carp (*N*)	0	0	0	0	0	0
	Silver Carp (*N*)	0	0	0	0	0	0
	CPUE (fish/seine haul)	1,757.6	0	0	0	0	1,757.6

Table 2. *Total number of fish captured with electrofishing (EF), trammel/gill nets (Nets), and commercial seine (Seine) in the CAWS upstream of the EDBS during SIM 2025.*

Common Name	Cal River EF	Cal River GN	Chicago River GN	CSSC EF	CSSC GN	Lake Calumet EF	Lake Calumet GN	Lake Calumet CS	Little Cal-Cal Sag EF	Little Cal-Cal Sag GN	N Branch-N Shore EF	N Branch-N Shore GN	Total All Gears
Alewife	109	0	0	0	0	198	1	0	44	0	13	0	365
Banded killifish	92	0	0	1	0	119	0	0	40	0	183	0	435
Bigmouth buffalo	2	10	0	0	0	2	4	0	3	11	0	0	32
Black buffalo	23	24	0	0	0	14	28	36	1	8	0	0	134
Black bullhead	5	0	0	0	0	55	0	0	3	0	1	0	64
Black crappie	1	0	0	2	0	10	0	37	2	0	23	0	75
Blackstripe topminnow	0	0	0	17	0	13	0	0	40	0	1	0	71
Bluegill	112	0	0	154	0	535	0	0	231	0	520	0	1,552
Bluntnose minnow	112	0	0	183	0	231	0	0	123	0	371	0	1,020
Bowfin	6	0	0	0	0	37	0	2	6	0	2	0	53
Brook silverside	5	0	0	19	0	152	0	0	59	0	82	0	317
Brown bullhead	10	0	0	0	0	100	0	0	0	0	0	0	110
Brown trout	1	0	0	0	0	0	0	0	0	0	0	0	1
Carp x goldfish hybrid	0	0	0	6	0	0	0	0	2	1	0	0	9
Channel catfish	0	2	1	85	6	37	12	143	59	18	4	0	367
Chinook Salmon	4	0	0	0	0	20	2	0	0	0	0	0	26
Coho salmon	3	0	0	0	0	0	0	0	0	0	0	0	3
Common carp	96	67	6	493	157	909	213	319	795	315	332	91	3,702
Emerald shiner	8	0	0	264	0	71	0	0	534	0	297	0	1,174
Flathead catfish	0	1	0	0	0	0	2	4	0	0	0	0	7
Freshwater drum	27	97	0	12	10	52	158	2,156	76	121	1	4	2,710
Gizzard shad	352	0	0	833	0	1,198	3	2,477	7,793	0	3,189	0	15,845

Common Name	Cal River EF	Cal River GN	Chicago River GN	CSSC EF	CSSC GN	Lake Calumet EF	Lake Calumet GN	Lake Calumet CS	Little Cal-Cal Sag EF	Little Cal-Cal Sag GN	N Branch-N Shore EF	N Branch-N Shore GN	Total All Gears
Gizzard Shad < 6 in	725	0	0	1,084	0	388	0	0	2,603	0	768	0	5,568
Golden shiner	0	0	0	35	0	41	0	0	36	0	148	0	260
Goldfish	2	0	0	3	0	500	0	6	65	2	24	0	602
Grass carp	2	0	0	0	0	0	0	0	0	0	0	0	2
Green sunfish	26	0	0	203		99	0	0	158	0	15	0	501
Green sunfish x bluegill hybrid	0	0	0	0	0	0	0	0	1	0	0	0	1
Highfin carpsucker	0	0	0	0	0	1	0	0	0	0	0	0	1
Hybrid Sunfish	0	0	0	0	0	0	0	0	2	0	1	0	3
Largemouth bass	430	0	0	130	0	1,285	2	14	857	1	991	0	3,710
Muskellunge	0	0	0	0	0	0	0	0	0	0	1	0	1
Northern pike	0	0	0	0	0	5	0	12	0	0	2	0	19
Oriental Weatherfish	0	0	0	7	0	0	0	0	0	0	11	0	18
Pumpkinseed	112	0	0	24	0	764	0	3	350	0	127	0	1,380
Quillback	16	0	0	0	0	6	0	1	1	0	0	0	24
Rainbow trout	7	0	0	0	0	1	0	0	0	0	0	0	8
River carpsucker	0	1	0	0	0	2	0	1	1	0	0	0	5
Rock bass	277	0	0	0	0	58	0	2	7	0	45	0	389
Round Goby	101	0	0	4	0	2	0	0	5	0	2	0	114
Sand shiner	8	0	0	0	0	0	0	0	0	0	0	0	8
Smallmouth bass	391	2	0	3	0	114	0	7	24	0	27	0	568
Smallmouth buffalo	51	38	0	0	3	52	35	17	22	23	0	0	241
Spotfin shiner	0	0	0	5	0	0	0	0	25	0	55	0	85
Spottail shiner	1	0	0	0	0	0	0	0	3	0	5	0	9

Common Name	Cal River EF	Cal River GN	Chicago River GN	CSSC EF	CSSC GN	Lake Calumet EF	Lake Calumet GN	Lake Calumet CS	Little Cal-Cal Sag EF	Little Cal-Cal Sag GN	N Branch-N Shore EF	N Branch-N Shore GN	Total All Gears
Striped bass x white bass hybrid	0	0	0	0	0	1	0	0	2	0	1	0	4
Threadfin shad	0	0	0	0	0	0	0	0	2	0	0	0	2
Unidentified buffalo	0	1	0	0	0	2	6	0	0	0	0	0	9
Walleye	1	3	0	1	0	0	1	11	0	0	1	0	18
Warmouth	0	0	0	0	0	0	0	0	1	0	0	0	1
Western mosquitofish	0	0	0	16	0	0	0	0	20	0	0	0	36
White bass	23	0	0	5	1	22	0	12	38	0	2	0	103
White crappie	0	0	0	1	0	1	0	0	0	0	0	0	2
White perch	1	0	0	0	0	5	0	6	31	0	5	0	48
White sucker	11	1	0	8	0	0	0	1	41	0	437	0	499
Yellow bass	0	0	0	0	0	7	0	0	32	0	8	0	47
Yellow bullhead	11	0	0	5	0	29	0	0	12	0	6	0	63
Yellow perch	28	0	0	0	0	534	0	6	12	0	1	0	581
Total Fish (N)	3,192	247	7	3,603	177	7,672	467	5,273	14,162	500	7,702	95	43,002
Total Species (N)	38	12	2	28	5	41	13	22	43	9	37	2	60
Total Hybrids (N)	1	0	0	1	0	1	0	0	3	0	2	0	3

Table 3. *Summary of effort and catch data for all fixed and random site monitoring in the CAWS upstream of the EDBS 2010* to *2025.*

	Effort and Catch	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Electrofishing Effort	Estimated person-hours	1,280	2,180	4,330	1,528	945	990	990	990	990	1,118	195	1,350	1,260	1,440	1,610	1600	**21,196**
	Samples (transects)	519	844	765	588	348	422	407	437	414	412	127	592	620	516	560	560	**7,571**
	EF (hrs)	130	211	192	149.3	87.1	106	102	109	103.5	103	28.7	136	148	124.3	140	140	**1,870**
Electrofishing Catch	All fish (N)	33,688	52,385	97,510	45,443	24,492	28,549	22,557	26,198	26,944	18,247	5,244	26,134	28,214	41,444	34,519	36,361	**547,929**
	Species (N)	51	58	59	56	56	61	59	58	60	48	39	53	65	60	60	60	**90**
	Hybrids (N)	3	3	3	2	2	2	2	2	2	2	1	4	2	3	3	3	**8**
	Bighead Carp (N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Silver Carp (N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	CPUE (fish/hr)	259.1	248.3	507.9	304.4	281.2	269.3	221.1	239.7	260.3	177.2	182.7	192.2	190.8	333.4	226.5	224	**274.2**
Netting Effort	Estimated person-hours	885	1,725	3,188	1,932	1,125	1,125	1,125	1,485	1,148	1,440	2,655	2,070	1,588	1,416.5	1,430	1,400	**25,737.5**
	Samples (net sets)	208	389	699	959	440	445	498	803	710	711	1252	772	860	860	876	848	**11,278**
	Miles of net	23.8	67	81.7	104.9	48.2	46.6	53.3	86.5	76.6	79.7	138.2	87.7	98	97.6	99.5	96.3	**1,285.3**
Netting Catch	All fish (N)	2,439	4,923	3,060	4,195	1,461	1,062	1,283	1,917	1,174	1,622	1,964	1,321	1,641	1,513	1,420	1,493	**30,995**
	Species (N)	17	20	20	30	18	13	18	14	23	19	18	17	57	18	18	18	**43**
	Hybrids (N)	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	**2**
	Bighead Carp (N)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
	Silver Carp (N)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**1**
	CPUE (fish/100 yds of net)	5.8	4.2	2.1	2.3	1.7	1.3	1.4	1.3	0.9	1.2	0.81	0.9	1.0	0.06	1.5	1.7	**1.5**

	Effort and Catch	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Seine Effort	Estimated person-hours	0	0	0	135	135	135	135	135	135	135	135	210	328	210	210	205	**2,038**
	Samples (seine hauls)	0	0	0	3	2	3	3	4	3	4	4	4	4	4	4	4	**46**
	Miles of seine	0	0	0	1.4	0.9	1.4	1.4	1.8	1.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	**20.8**
Seine Catch	All fish (N)	0	0	0	7,577	1,725	5,989	3,765	2,763	3,110	7,457	2,879	3,490	7,181	1,949	2,756	5,237	**55,878**
	Species (N)	0	0	0	15	11	14	15	10	10	16	11	18	19	21	20	20	**30**
	Hybrids (N)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**
	Bighead Carp (N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Silver Carp (N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	CPUE (fish/seine haul)	0	0	0	2,525.7	862.5	1,996.3	1,255.0	690.8	1,036.7	1,864.3	719.8	872.5	1,795.3	487.3	689	1,309.4	**1,260.1**
Hoop/Trap Net/ Tandem Trap Net	Estimated person-hours	0	0	0	0	0	30	28	135	135	0	0	0	0	0	0	0	**328**
	Samples (sets)	0	0	0	11	0	4	3	8	7	0	0	0	0	0	0	0	**33**
	Net-days	0	0	0	25.2	0	16	12	52.1	43	0	0	0	0	0	0	0	**148.3**

	Effort and Catch	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Hoop/Trap Net/ Tandem Trap Net Catch	All fish (N)	0	0	0	93	0	172	102	294	693	0	0	0	0	0	0	0	**1,354**
	Species (N)	0	0	0	17	0	17	15	17	19	0	0	0	0	0	0	0	**34**
	Hybrids (N)	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	**2**
	Bighead Carp (N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Silver Carp (N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	CPUE (fish/net-day)	0	0	0	3.7	0	10.75	8.5	5.6	16.1	0	0	0	0	0	0	0	**9.1**
	Estimated person-hours	0	0	0	0	0	0	0	0	135	0	0	0	0	0	0	0	**135**
	Net-days	0	0	0	0	0	0	0	8.9	0	0	0	0	0	0	0	0	**8.9**
	All fish (N)	0	0	0	0	0	0	0	646	0	0	0	0	0	0	0	0	**646**
	Species (N)	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	**15**
	Hybrids (N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Bighead Carp (N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Silver Carp (N)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	CPUE (fish/net-day)	0	0	0	0	0	0	0	72.6	0	0	0	0	0	0	0	0	**72.6**

SUPPORT FOR EARLY DETECTION OF INVASIVE CARP IN THE UPPER ILLINOIS WATERWAY

Participating Agencies: USFWS Carterville FWCO (lead), ILDNR, USGS, INHS, SIU, USACE – Chicago District; Jen-Luc Abeln

MWRG Work Group: Detection

Pools Involved: Marseilles, Dresden Island, Brandon Road, Lockport, CAWS

INTRODUCTION AND NEED

Invasive carp (Bighead Carp, Black Carp, Grass Carp, and Silver Carp) pose a litany of detrimental effects and threaten the Great Lakes ecosystem and industry through their connection with the IWW (Altenritter et al. 2022; Sass et al. 2014; Wittmann et al. 2014). The large (>153 mm) Bighead Carp and Silver Carp (collectively known as bigheaded carp) invasion front in the IWW is currently in the Dresden Island Pool, approximately 16 km downstream of the EDBS and 76 km downstream from Lake Michigan (ICRCC 2024). The small (<153 mm) bigheaded carp invasion front in the IWW is currently in the Peoria Pool, though small bigheaded carp were found in Starved Rock Pool in 2015 and 2021 (ICRCC 2024). Grass Carp are documented throughout the IWW and several other Great Lakes waterways (Cudmore et al. 2017), but limited recruitment of the species is known in the Great Lakes, so the ability to contain and reduce the population still exists (Lang et al. 2025). The Black Carp invasion front in the IWW is currently in the Peoria Pool (ICRCC 2024). The objective of this project is to specifically target the detection of individual invasive carp at and above the invasion fronts, informed by the CRP. This project differs from other IWW monitoring actions by using methods focused on detecting bigheaded carp individuals rather than generalized population and assemblage sampling methods (multi-agency monitoring and hydroacoustic monitoring). EDM will occur in areas that lead toward the Great Lakes, areas of concern of spilling over eggs and larvae upstream of the EDBS (Des Plaines River upstream of the connection with the CAWS or areas that may provide spawning refuge or drive propagule pressure to the upper IWW [Kankakee River]). This project also supports partners' early detection and monitoring efforts in the CAWS upstream of the EDBS, via SIM, to detect and remove any invasive carp that may be unimpeded in reaching the Great Lakes.

OBJECTIVES

- Conduct monthly fixed electrofishing sampling to detect large bigheaded carp in Brandon Road and Lockport pools from March through November.
- Conduct monthly fixed and randomized electrofishing, dozer trawling, and mini-fyke netting sampling to detect small invasive carp in Dresden Island Pool, Marseilles Pool, and the lower Kankakee River from June through November.
- Monitor for changes in adult bigheaded carp population using monthly fixed and randomized electrofishing and dozer trawling in Dresden Island Pool and Kankakee River from March through November.

- Conduct opportunistic sampling of the Des Plaines River (upstream of the CAWS) during increased water stage (> 2.14 meters gage height on USGS-05533600). Respond to any spillover events.
- Remove all invasive carp captured during sampling.
- Report and respond to invasive carp detections outside of current designated status in the CRP.

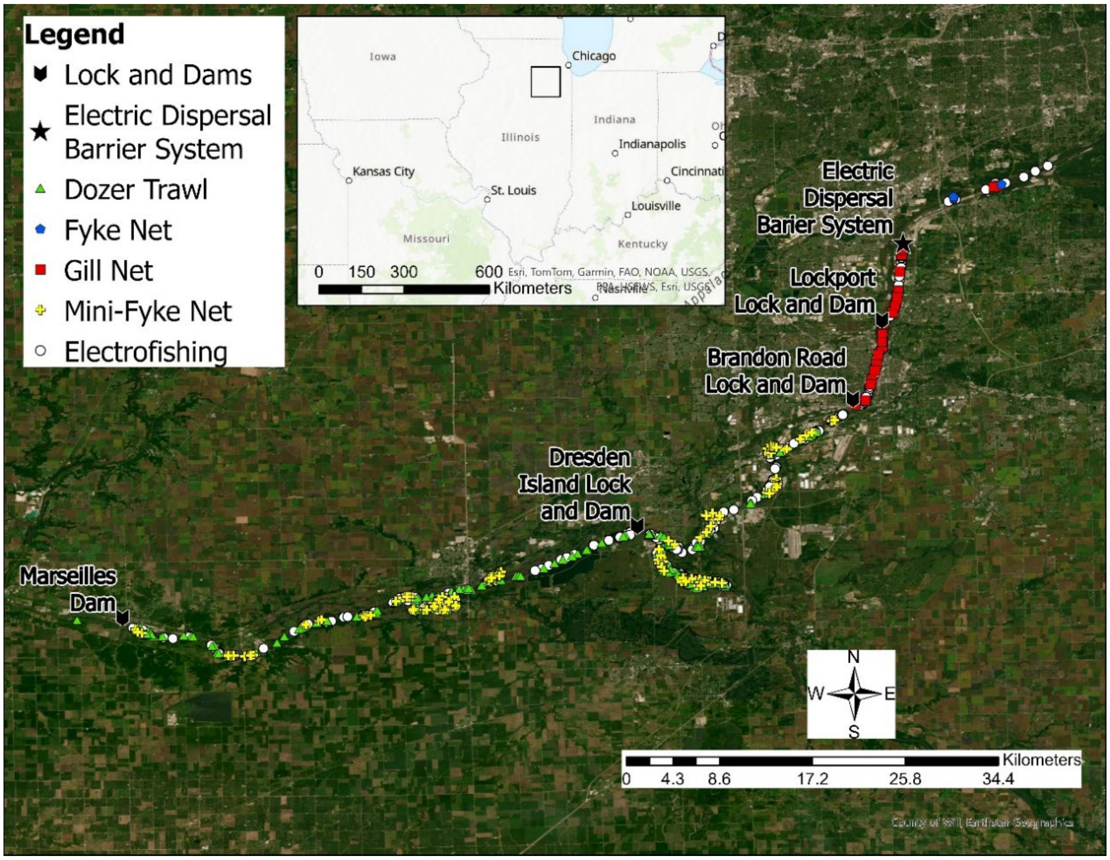
PROJECT HIGHLIGHTS

- No large invasive carp were detected upstream of Brandon Road L&D.
- No small invasive carp were detected in Marseilles, Dresden Island, Brandon Road, or Lockport pools.
- 473 electrofishing runs, 265 electrified dozer trawls, 38 gill net sets, 213 mini-fyke net sets, and 3 fyke net sets were completed across all pools between March 3 and November 25, 2025.
- USFWS captured and removed two large Bighead Carp, 490 large Silver Carp, and 10 large Grass Carp from Marseilles Pool, Dresden Island Pool, and the lower Kankakee River in 2025. No Black Carp were encountered during sampling.

METHODS

Target analysis completed in previous years identified a combination of fixed and random site sampling, including habitat stratifications, utilizing appropriate gear types for both large and small invasive carp life stages, and electrofishing power goals targeting invasive carp (Young et al. 2023). Sampling site selection in 2025 considered areas to target or avoid based on professional experience from previous sampling years. Fixed sites were located in areas with previously known captures of invasive carp or in habitats expected to attract or hold invasive carp if novel invasions occurred in the pool. Random sites were stratified by habitat type, such as main channel borders, side channels, and backwaters, proportionally by the spatial area of each habitat. Generated sampling sites not compatible with a respective gear type were relocated to a compatible randomly generated alternate site within the same habitat or habitat type whenever possible. Gears selected for Marseilles and Dresden Island pools and the lower Kankakee River were daytime DC boat electrofishing, electrified dozer trawling, and mini-fyke netting. The gear selected for Brandon Road and Lockport pools was daytime DC boat electrofishing. Gears selected for the Des Plaines River were daytime DC boat electrofishing, fyke netting, and gill netting. All captured invasive carp were examined for total length (mm), mass (g), and sex, and then euthanized. Non-invasive species were released after identification to species and enumeration. Yearly sampling sites for 2025 are shown in Figure 1.

Figure 1. *Sites sampled by the USFWS Carterville FWCO in 2025.*

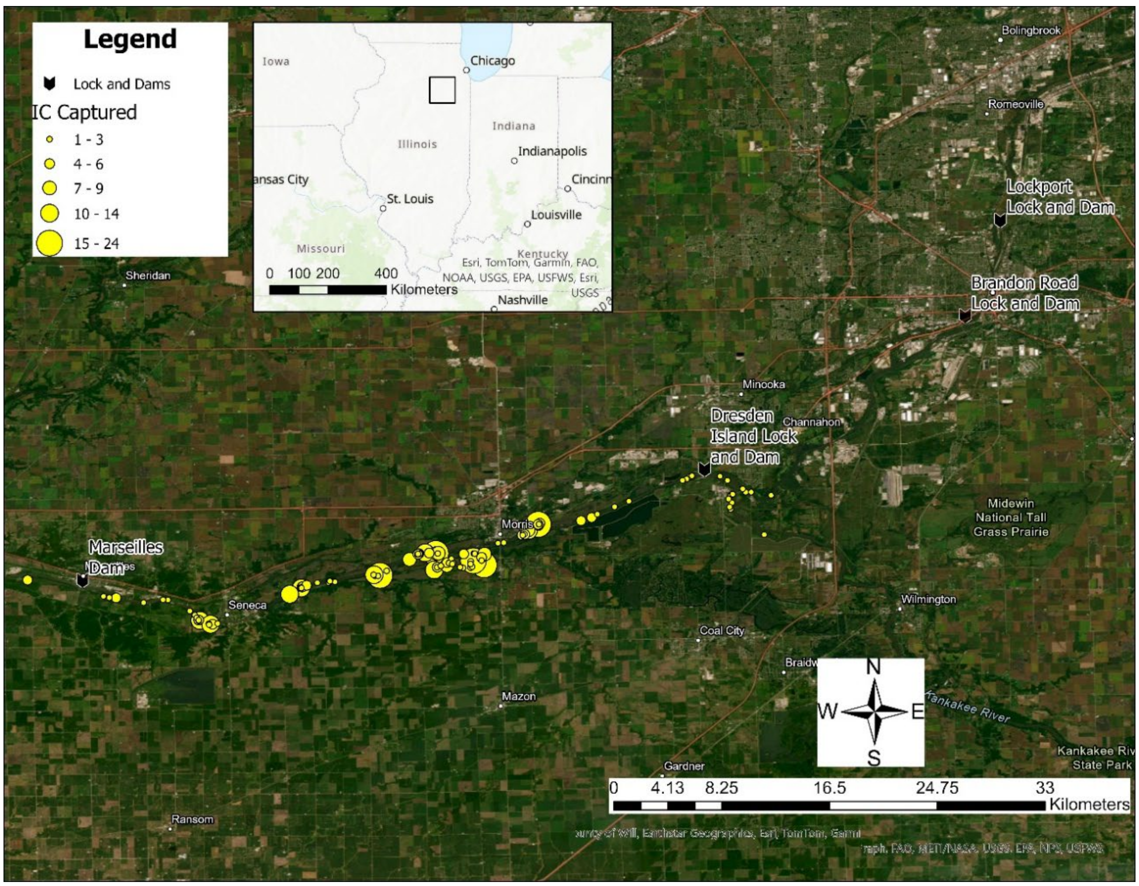


Early detection programs (i.e., this project) are inherently challenged by and focused on detecting the presence of rare non-native species (Rew et al. 2006; Mehta et al. 2007; Harvey et al. 2009). Fortunately, the challenges of early detection are analogous to the challenges of threatened and endangered species assessment, which focuses on detecting the presence of rare native species. Therefore, many of the sampling techniques and analytical tools developed for threatened and endangered species are transferable to an invasive species early detection context (Trebitz et al. 2009; Jerde et al. 2011). To determine the amount of sampling required to detect most species within a pool, a rarefaction analysis was used (a common analysis done to assess the effectiveness of a fishery sampling program; Radinger et al. 2019). Species richness was estimated using the Mao-Tau method for species accumulation (Colwell, Mao & Chang 2004) and using 1,000 resamples within each study area by gear. Additionally, fish community data were used to estimate sample completeness to determine the thoroughness of sampling efforts at capturing species in the community. Using data from 2022 to 2024, sample completeness was assessed for each gear type per pool. Richness estimates for each pool were developed using species lists from capture data from multi-agency monitoring (2019 through 2024), long-term electrofishing (2009 through 2023), and EDM (2022 through 2024). Species Richness curves that reach an asymptote suggest that the level of effort applied is sufficient to capture most species that are vulnerable to the effort applied (i.e., gear type), and additional effort beyond the asymptote delivers diminished return on species detection. These analyses were performed in R 4.5.2 (R Core Team 2025).

RESULTS AND DISCUSSION

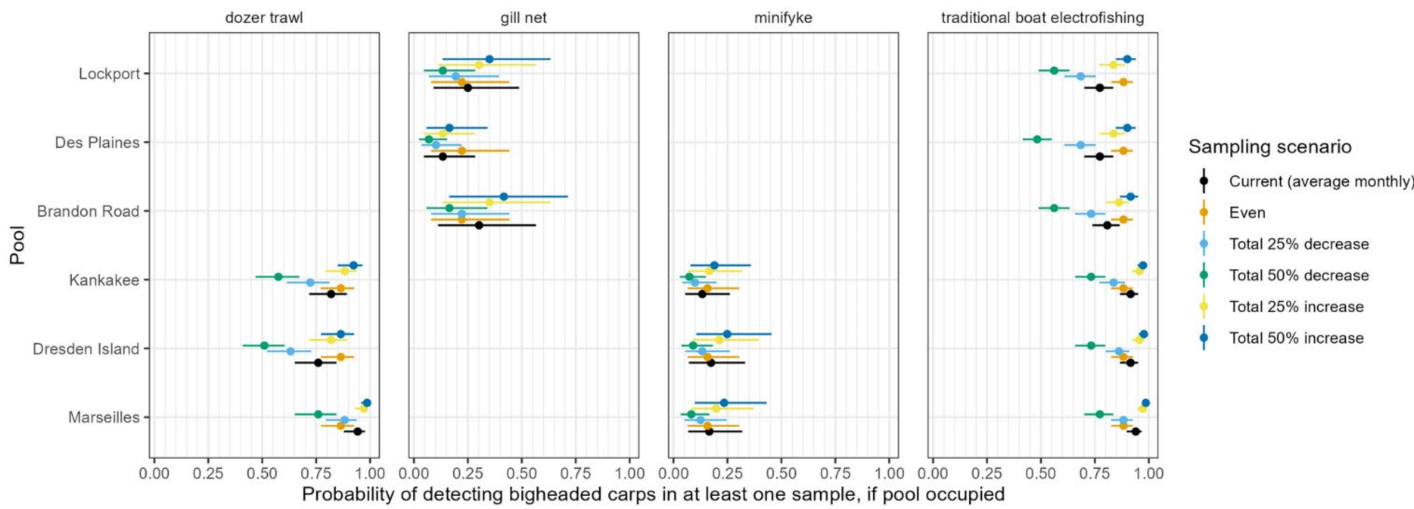
Between March 3 and November 25, 2025, USFWS effort included 992 sampling events across four IWW pools (Marseilles, Dresden Island, Brandon Road, and Lockport), the Des Plaines River, and the lower Kankakee River. The total effort consisted of 118.4 hours of boat electrofishing, 22.1 hours of electrified dozer trawling, 7,400 yards of gill nets deployed, 205.2 net-nights of mini-fyke netting, and 3 net-nights of fyke netting. The USFWS captured 132,129 total fish during 2025, consisting of 91 species and 3 hybrid taxa. A total of 502 large invasive carp were captured in Dresden Island Pool (n = 17) and Marseilles Pool (n = 485; see Figure 2), whereas no small invasive carp were observed during this sampling. No invasive carp were found outside of their known range (i.e., no expansion of large or small invasive carp populations was documented). No Black Carp were captured during sampling.

Figure 2. *Location map of invasive carp captured by USFWS Carterville FWCO in 2025.*



USWFS provided 12 crew days of SIM effort. Pool-wide and SIM sampling efforts were reduced due to a lapse in government funding from October 1 through November 12. Pool-wide sampling was further reduced due to the discontinuation of gill netting efforts in Brandon Road and Lockport and limited staff. Continued staff limitations during 2026 will necessitate further reductions in effort for this project. High (75 percent or greater; see Figure 3) detection probabilities can be maintained with up to a 50 percent reduction in electrified effort in the Marseilles Pool (See Figure 3). Shifting mini-fyke effort from spawning cues (i.e., water temperature reaching 17°C) to when YOY invasive carp recruit to the gear (i.e., July in lower IWW) may also reduce crew days while maintaining the ability of this project to detect small invasive carp.

Figure 3. *Effort-based sampling scenarios for each gear type, pool combination during 2022 through 2024, including the "Current (average monthly)" detection probabilities and simulated detection probabilities at four different effort levels. The "Even" sampling scenario assumes the amount of effort is distributed equally across the pools.*



Species accumulation curves for 2025 (Figure 4) suggest electrofishing and dozer trawl efforts were starting to asymptote in all pools, suggesting effort was sufficient to capture most species vulnerable to the gear. Mini-fyke effort in Marseilles was also starting to asymptote, but mini-fyke effort in the Kankakee River and Dresden Island was not sufficient to capture a significant amount of the species richness in those areas. Mini-fyke nets in the Kankakee River and Dresden Island Pool were the first to be reduced due to low staffing because they were two pools upstream from the small invasive carp leading edge and viewed as the least likely to commit type II error (in this case, missing a small invasive carp when one was present in the Dresden Island Pool). The species accumulation curves for the work this project performed from 2022 to 2024 suggest that asymptotes were reached for most gears and pools, except for Dresden Island dozer trawl effort (Figure 5). Considering the dozer trawl accumulation curves and sample completeness (see Table 1), dozer trawl effort in Dresden Island Pool may need to be increased to more precisely capture the most species in Dresden Island Pool and monitor for changes in the community, such as abundance trends of invasive carp. Sample completeness for Dresden Island electrofishing also suggests species may be missed during EDM sampling, but species accumulation curves suggest that more effort for electrofishing may not be the way to detect those species (Table 2). Similarly, mini-fykes' yearly sample completeness (Table 3) may suggest that species are being missed; however, with these gears being the first to be reduced in limited staffing instances, the prioritization and evaluation of effort may be needed. Combining multiple years of effort together increases sample completeness, which suggests gears are capturing rare or non-target (due to gear bias) species over time (Table 4). Keeping a multi-gear approach with sufficient effort (informed by Figure 3) will help account for gear bias and provide confidence that detection probability is high.

Figure 4. *Species accumulation curves by pool by gear from USFWS Carterville FWCO captures in 2025. The x-axis denotes number of samples, and the y-axis denotes count of unique species observed.*

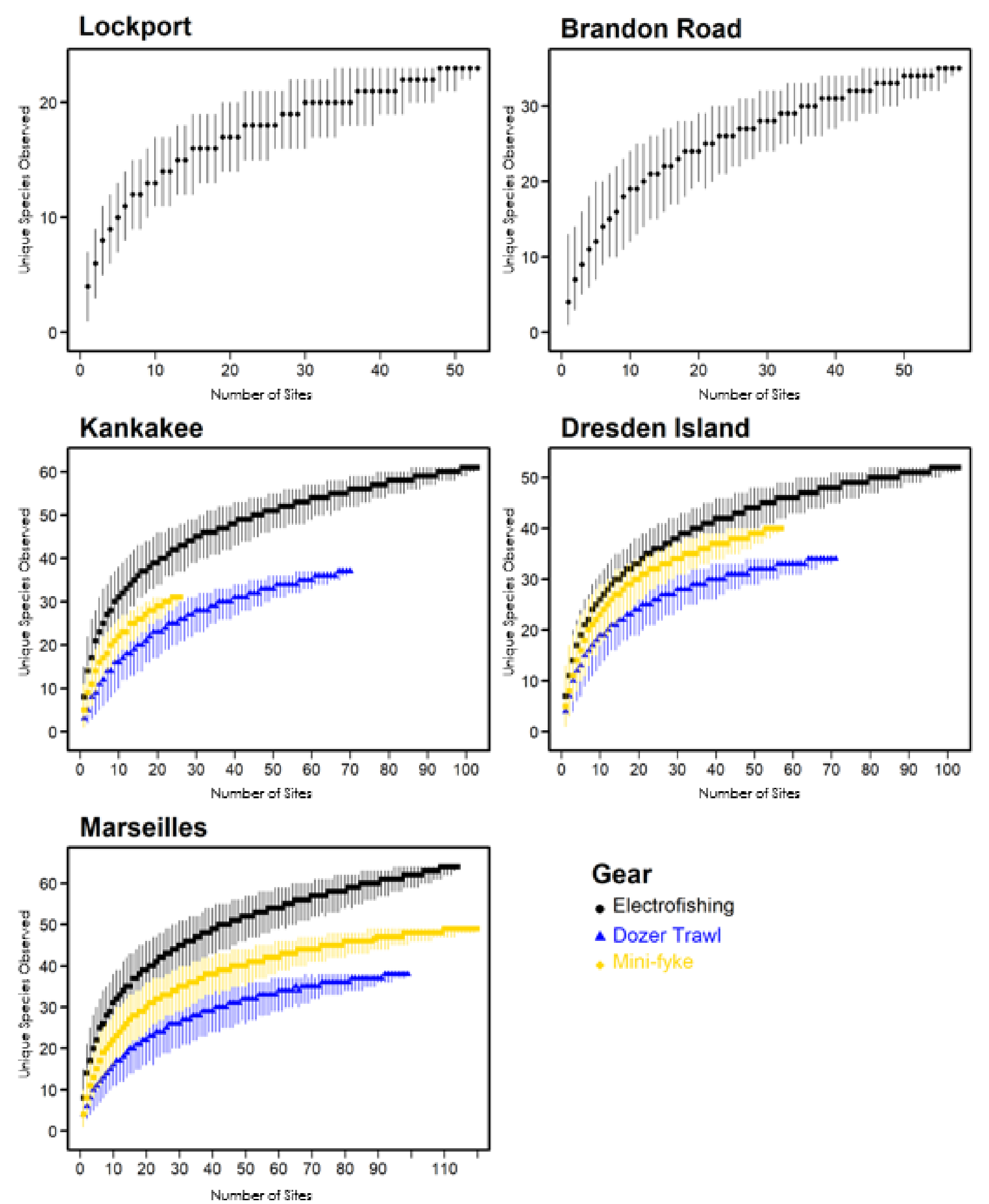
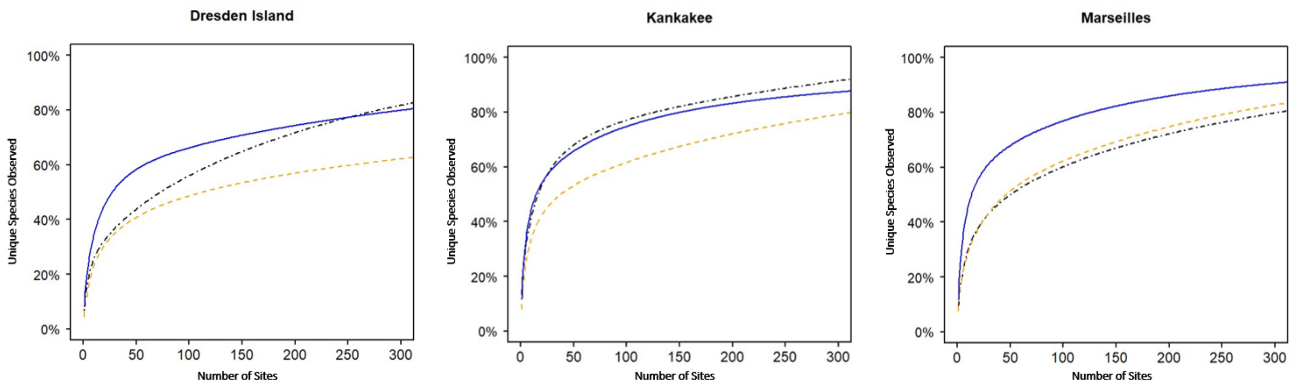


Figure 5. *Species accumulation curves by pool by gear from USFWS Carterville FWCO captures from 2022 to 2024. DT = dozer trawl, EF = boat electrofishing. The x-axis denotes number of samples, and the y-axis denotes count of unique species observed.*



Black: DT
Orange: EF
Blue: MF

Table 1. *Dozer Trawl sample completeness for Dresden Island Pool, the Kankakee River, and Marseilles Pool for 2022 through 2024. "Effort (tows/lifts)" is the number of dozer trawl samples completed in the corresponding "Year." The "Observed" column is the number of unique species captured during the total gear "Effort" in that "Year."*

Location	Year	Effort (tows/lifts)	Observed	Sample Completeness
Dresden Island	2022	40	9	38%
Richness$_{est}$ = 24.0 (8.3)	2023	112	16	67%
Richness$_{est}$ = 24.0 (8.3)	2024	77	9	38%
Kankakee	2022	60	7	58%
Richness$_{est}$ = 12.0 (1.2)	2023	136	8	67%
Richness$_{est}$ = 12.0 (1.2)	2024	108	11	92%
Marseilles	2022	50	7	33%
Richness$_{est}$ = 21.0 (6.0)	2023	150	12	57%
Richness$_{est}$ = 21.0 (6.0)	2024	120	16	76%

Table 2. *Boat electrofishing sample completeness for Dresden Island Pool, the Kankakee River, and Marseilles Pool for 2022 to 2024. "Effort (tows/lifts)" is the number of boat electrofishing samples completed in the corresponding "Year." The "Observed" column is the number of unique species captured during the total gear "Effort" in that "Year."*

Location	Year	Effort (tows/lifts)	Observed	Sample Completeness
Dresden Island	2022	62	16	46%
Richness$_{est}$ = 34.5 (10.4)	2023	138	16	46%
Richness$_{est}$ = 34.5 (10.4)	2024	138	17	49%
Kankakee	2022	79	16	73%
Richness$_{est}$ = 22.0 (5.8)	2023	135	13	59%
Richness$_{est}$ = 22.0 (5.8)	2024	135	12	55%
Marseilles	2022	80	13	50%
Richness$_{est}$ = 26.2 (6.9)	2023	122	17	65%
Richness$_{est}$ = 26.2 (6.9)	2024	121	17	65%

Table 3. *Mini-fyke sample completeness for Dresden Island Pool, the Kankakee River, and Marseilles Pool for 2022 to 2024. "Effort (tows/lifts)" is the number of mini-fyke samples completed in the corresponding "Year." The "Observed" column is the number of unique species captured during the total gear "Effort" in that "Year."*

Location	Year	Effort (tows/lifts)	Observed	Sample Completeness
Dresden Island	2022	54	32	59%
Richness$_{est}$ = 54.6 (12.9)	2023	120	33	60%
Richness$_{est}$ = 54.6 (12.9)	2024	140	37	68%
Kankakee	2022	80	36	69%
Richness$_{est}$ = 52.2 (8.3)	2023	140	42	80%
Richness$_{est}$ = 52.2 (8.3)	2024	105	35	67%
Marseilles	2022	80	41	83%
Richness$_{est}$ = 49.2 (8.4)	2023	120	37	75%
Richness$_{est}$ = 49.2 (8.4)	2024	130	36	73%

Table 4. *EDM sample completeness by pool by gear for all years (2022 to 2024), combined. The "Observed" column is the number of unique species captured during the total gear "Effort" in that "Year." The "Estimated" column is the calculated maximum number of species present within the "Location" derived from EDM, Long-term Electrofishing, and Multi-agency Monitoring captures. Highlighted (purple) values were "Locations" and "Gear" that had high sample completeness.*

Location	Gear	Observed	Estimated	Sample completeness	Effort (tows/lifts)
Dresden Island	DT	18	24.0 (8.3)	75.1%	229
Dresden Island	EF	22	34.5 (10.4)	63.8%	304
Dresden Island	Mini-fyke	44	54.6 (12.9)	80.5%	320
Kankakee	DT	11	12.0 (1.2)	**91.7%**	338
Kankakee	EF	18	22.0 (5.8)	81.9%	349
Kankakee	Mini-fyke	46	52.2 (8.3)	88.1%	323
Marseilles	DT	17	21.0 (6.0)	81.0%	314
Marseilles	EF	22	26.2 (6.9)	84.1%	325
Marseilles	Mini-fyke	45	49.2 (8.4)	**91.5%**	333

RECOMMENDATIONS

- Continue EDM for all life stages of invasive carp in the Upper IWW to provide additional assurance that adult invasive carp are absent from the area upstream of Brandon Road Lock and Dam and small invasive carp are absent from the area upstream of Marseilles Lock and Dam.
- Continue to monitor the large bigheaded carp invasion front in Dresden Island Pool for changes in abundance to inform the CRP.
- Refine effort allocation to maximize detection probability with reduced staffing.
- Continue to refine detection methods and effort using professional experience and model-based estimates to increase efficiency and effectiveness of the project.

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ASSESSMENT OF INVASIVE CARP REPRODUCTION IN THE ILLINOIS WATERWAY

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MWRG Work Group: Detection

Pools Involved: Brandon Road, Dresden Island, Marseilles, Starved Rock, Peoria, La Grange, Alton; major tributaries (Kankakee River [Dresden Island], Fox River [Starved Rock], Vermilion River [Peoria], Mackinaw River [La Grange], Spoon River [La Grange], Sangamon River [La Grange])

INTRODUCTION AND NEED

Understanding the spatial and temporal dynamics of reproduction by invasive fish can offer insight into the risk of further population expansion, factors influencing recruitment to the population, and the success of control measures. Evaluating invasive carp reproduction and the distribution of early life stages in different sections of the IWW and its tributaries is needed to monitor for changes in the reproductive front of invasive carp populations in this system, monitor for potential reproduction by the newly expanding Black Carp population in Illinois, and better understand the impacts of removal efforts on the reproductive capacity of these populations. Reproduction and recruitment of invasive carp in the IWW are highly variable among years (Gibson-Reinemer et al. 2017; Parkos et al. 2023), and multiyear efforts are necessary to assess the magnitude, location, and timing of reproduction, as well as to evaluate the relationship between invasive carp stock abundance and reproductive output to determine if removal efforts are reducing invasive carp densities enough to degrade their ability to perpetuate themselves through reproduction.

The magnitude of invasive carp reproduction varies considerably among the pools and tributaries of the IWW (Parkos et al. 2023; Schaick et al. 2023). Reproduction by invasive carp in the upper navigation pools of the IWW is of concern due to the risk of expansion of the invasion front toward Lake Michigan and the increased potential for these species to challenge the EDBS. Observations of eggs, larvae, and juveniles in the upper Illinois River indicate that some reproduction and potential recruitment occur above Starved Rock L&D in some years (Zhu et al. 2018; Parkos et al. 2023; MRWG 2025). Due to egg and larval drift, reproduction in upper river pools may also be an important source for recruits in downstream pools, particularly the Peoria Pool. Invasive carp reproductive output is more consistent downstream of Starved Rock L&D but still varies by several orders of magnitude across years. Invasive carp spawning also appears to occur in smaller tributary rivers. Large populations of invasive carp can be found in several tributaries of the Illinois River (Sangamon, Spoon, and Mackinaw rivers), although the magnitude of reproductive output varies considerably among these rivers (Schaick et al. 2023). The contribution of tributaries to the reproductive productivity of system-wide invasive carp populations is not well understood, but these rivers may be an important source of early life stages to the lower Illinois River in some years. Monitoring any changes to these patterns can help to evaluate the risk for further population growth in the upper Illinois River or determine if harvest efforts are effectively reducing the capacity of invasive carp populations to replenish themselves through reproduction and subsequent recruitment.

Complementary annual assessments of invasive carp reproduction and stock density provide data needed to quantify stock-reproduction relationships and evaluate the impact of invasive carp removal efforts on the reproductive potential of these populations. The relationship between invasive carp spawning stock density and the magnitude of reproduction provides evidence of both diminished reproductive output at low adult abundances and density-limitation of reproductive output at very high adult densities (Parkos et al. 2023). Continuing the assessment of the reproductive productivity of invasive carp populations may therefore aid in evaluating the success of control efforts and refining our understanding of potential compensatory responses to harvest. However, even if enough adult invasive carp are removed to diminish reproductive productivity, recruitment may still vary considerably across a range of reproductive magnitudes. Determinants of recruitment variability and the life stages at which recruitment bottlenecks occur are not well understood for invasive carp species. Evaluating relationships between abundances of early life stages of invasive carp and corresponding year class strength, and the environmental factors affecting these relationships, will aid in understanding conditions that contribute to successful recruitment and identifying life stages, where accounting for compensatory dynamics is needed to accomplish the management goals of reducing invasive carp population sizes and preventing upstream movement of the invasion front toward Lake Michigan.

OBJECTIVES

Ichthyoplankton are being sampled in the IWW and its tributaries to:

- Monitor for potential changes in the reproductive front of invasive carp populations.
- Monitor for Black Carp reproduction in the IWW.
- Quantify the relationship between invasive carp adult density, reproductive output, and recruitment.

PROJECT HIGHLIGHTS

- Ichthyoplankton sampling was conducted from late April to early October 2025 in the Brandon Road to Alton navigation pools of the IWW and in major tributaries of the IWW. Overall, invasive carp reproductive productivity in the IWW was low during 2025, whereas reproductive output was moderate to high in lower IWW tributaries.
- Invasive carp eggs and larvae were collected in samples from all pools in and downstream of the Marseilles Pool in 2025. Despite widespread regional drought in 2025, several precipitation events caused moderate rises in discharge that triggered multiple low-magnitude spawning events in the IWW main channel from April to August. Brief but high-magnitude spawning events occurred in tributary rivers. No evidence of invasive carp reproduction was detected upstream of Dresden Island L&D in 2025.

- Updated analyses examining factors affecting invasive carp reproductive output found similar results to previous modeling efforts in that both adult invasive carp density and environmental conditions influence spatiotemporal variation in the magnitude of invasive carp reproduction. Invasive carp egg drift is highest at intermediate densities of adults and during years with warmer water temperatures through the end of May and higher flows during May and June.
- Juvenile invasive carp abundances were found to be related to total annual invasive carp egg and larval drift, such that when egg and larval production was low, juvenile invasive carp abundances were also consistently low, whereas years with higher reproductive output produced highly variable juvenile abundances.

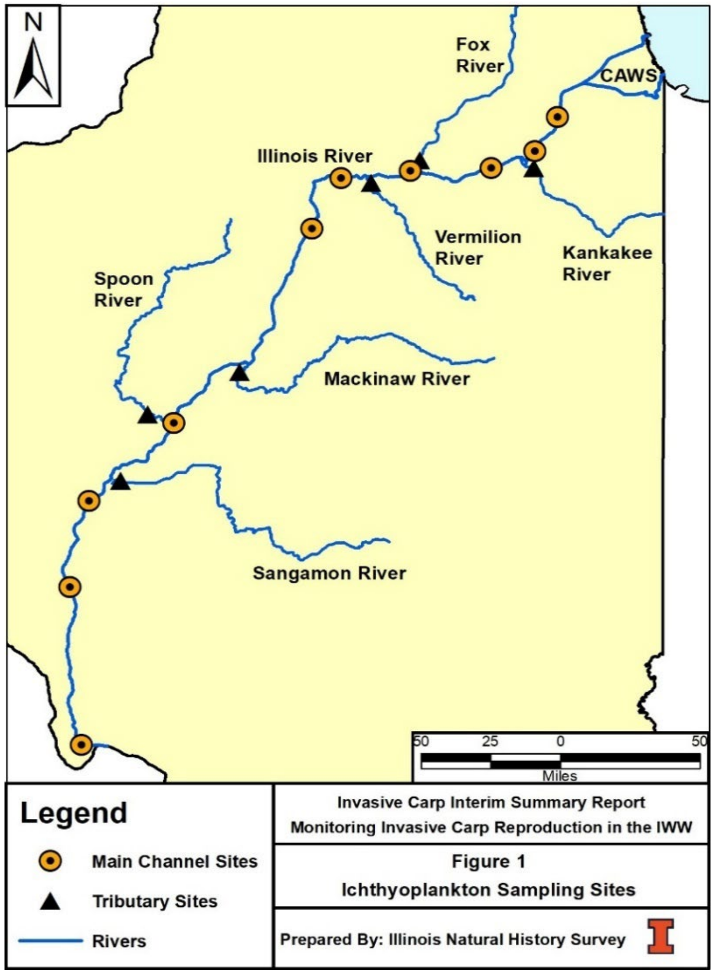
METHODS

Ichthyoplankton sampling occurred at 10 sites in the CSSC, Des Plaines River, and Illinois River downstream of the EDBS in 2025 (Figure 1). Additional sampling occurred in six tributary rivers (Kankakee, Fox, Vermilion, Mackinaw, Spoon, and Sangamon rivers). Sampling occurred weekly from late April to mid-July and biweekly from mid-July to the beginning of October. At main channel sites, a minimum of four ichthyoplankton samples were collected at each site on each sampling date. Sampling transects were located on each side of the navigation channel, parallel to the bank, at both upstream and downstream locations within each study site. At tributary sites, three samples (one mid-channel and one on each side of the channel) were collected on each sampling date. Tributary samples were collected far enough upstream of the confluence of each tributary with the mainstem Illinois River to ensure any fish eggs or larvae collected were derived from the tributary itself rather than potentially originating in the Illinois River.

Ichthyoplankton samples were collected using a 0.5-meter diameter plankton push net with 500-micrometer mesh. The net was pushed upstream through the top 1.0 meter of the water column using an aluminum frame mounted to the front of the boat. Boat speed was adjusted to obtain 1.0 to 1.5 meters per second water velocity through the net. The flow was measured using a flow meter mounted in the center of the net mouth and was used to calculate the volume of water sampled. Fish eggs and larvae were collected in a meshed tube at the tail end of the net, transferred to sample jars, and preserved in 90 percent ethanol.

In the laboratory, select main channel ichthyoplankton samples collected from May to mid-July were screened for the presence of Black Carp DNA derived from eggs or larvae (Fritts et al. 2019; Butler et al. 2025). The number of DNA copies in each extraction replicate was quantified and used to assess the probability that Black Carp eggs or larvae were present in the sample. Following extraction of qPCR aliquots, fish eggs and larvae were separated from other materials in each sample, and all larval fish were identified to the lowest possible taxonomic unit under dissecting microscopes. Fish eggs were separated by size, with all eggs having a membrane diameter larger than 3 mm being identified as potential invasive carp eggs and retained for later genetic analyses. Invasive carp larvae were identified according to Chapman (2006) and by comparison to a developmental series of larvae obtained from a hatchery (Osage Catfisheries, Inc.; Osage Beach, Missouri). Larval fish and egg densities were calculated as the number of individuals per cubic meter of water sampled.

Figure 1. *Map of ichthyoplankton sampling sites in the IWW (circles) and tributary rivers (triangles).*



Densities of invasive carp eggs and larvae were summarized by sampling location through time and compared to water temperature and river discharge to examine spatial and temporal patterns in invasive carp reproduction, identify conditions associated with spawning, and assess trends in invasive carp reproductive output. An index of annual invasive carp egg totals was estimated for each monitoring site by multiplying mean egg density on each sampling date by discharge to standardize egg abundances observed under varying discharge conditions, then scaling these estimates from a single second to a 24-hour period and summing these estimates across sampling dates.

Updated analyses examining the influence of adult spawning stock density and environmental factors on invasive carp reproductive output were conducted using data collected through 2023 to assess the potential for invasive carp harvest efforts to diminish the reproductive potential of invasive carp populations in targeted navigation pools. Invasive carp spawning stock density estimates were generated by annual hydroacoustic surveys conducted by SIU. Water temperatures were obtained from USGS gages at Seneca (USGS 5543010) to represent the upper Illinois River pools and at Florence (USGS 5586300) to represent La Grange Reach locations. Discharge data for each pool was obtained from upstream USACE gages located at the Dresden Island, Marseilles, and Starved Rock L&Ds. Data from the USGS gage at Kingston Mines (USGS 5568500) was used for La Grange Pool discharge.

Based on probable spawning locations identified by FluEgg model analysis of invasive carp egg collections (Zhu et al. 2018), annual egg totals in each navigation pool were related to the combined density of adult invasive carp within that pool and the next upstream pool. Mixed-model methodology with a repeated measures framework was used to model annual egg totals as a function of adult density and spring warming and discharge variables (May through June period). The same environmental factors used in previous analyses (Parkos et al. 2023) were included in candidate models. These included cumulative degree days (base 18°C) through the end of May, cumulative degree days through the end of June, and both the mean and coefficient of variation of mean daily discharge during May and June. Mean May through June discharge and cumulative degree days through the end of May were both highly correlated with cumulative degree days through the end of June, so these were not included together in any models. A null model (i.e., intercept only) was included for comparison to assess whether there was meaningful support for any of the models in the set. To facilitate the comparison of empirical support for each model, Akaike information criteria corrected for small sample size, and AICc weights were computed for each model (Anderson 2008).

To assess relationships between combined egg and larval abundances and subsequent abundance of juvenile invasive carp, CPUE of age-0 invasive carp species (Silver Carp ≤ 125 mm, Bighead Carp ≤ 125 mm, Grass Carp ≤ 200 mm) during 2012 through 2024 was obtained from the Long-Term Resource Monitoring Program (Gutreuter et al. 1995), Long Term Illinois River Fish Population Monitoring Program (McClelland et al. 2012; Fritts et al. 2017), and Multi-Agency Monitoring (MRWG 2025) databases. Because no age-0 invasive carp have been captured by LTRM, LTEF, or MAM sampling in or upstream of the Starved Rock Pool, analyses were limited to the La Grange and Peoria pools. Only pulsed-DC electrofishing captures of juvenile invasive carp from unstructured main-channel border habitats were used to have data from a consistent gear type and hydrogeomorphic stratum in the analysis. Because eggs and larvae are not always identified to species, juvenile CPUE was combined across all invasive carp taxa. LTRM, LTEF, and MAM sampling is conducted across three time periods (Period 1 = June 15 to July 31, Period 2 = August 1 to September 14, and Period 3 = September 15 to October 31), so mean (+ 1 SE) CPUE was examined separately for each period in each navigation pool. Due to high heterogeneity in CPUE among time periods and pools and the presence of extreme outliers, the harmonic mean of juvenile invasive carp catch rates across sampling periods was used as a conservative estimate of annual relative abundance of juvenile invasive carp in each pool. Because mean age-0 invasive carp CPUE was estimated at the pool scale, but ichthyoplankton is sampled at multiple sites within the La Grange and Peoria pools, the site with the highest annual total egg and larval drift was used as the estimate for the annual total for each pool. Total annual drift of invasive carp eggs and larvae was only moderately correlated with each other (Spearman correlation: r_S=0.49, P=0.01), and only eggs were collected in some years, whereas only larvae were collected in other years. Therefore, the combined total of invasive carp egg and larval drift was used as a comprehensive index of annual invasive carp reproductive output. Because scatterplots of the harmonic mean of age-0 invasive carp CPUE versus total annual invasive carp egg and larval drift indicated substantial heteroscedasticity, a 2-dimensional Kolmogorov-Smirnov test (Garvey et al. 1998) was used to evaluate if invasive carp reproductive output was related to subsequent juvenile abundances.

RESULTS AND DISCUSSION

Overall, invasive carp reproductive productivity in the Illinois River was relatively low during 2025 (Figure 2). Although flows in the Illinois River from April to September 2025 were generally below long-term averages due to regional drought conditions, several precipitation events during this time produced moderate rises in discharge that triggered repeated, albeit low-magnitude, spawning events by invasive carp (Figure 3). Invasive carp reproduction was documented from late April to the end of August 2025, and invasive carp eggs or larvae were collected from all navigation pools in and downstream of the Marseilles Pool. Laboratory processing of extracted DNA from qPCR aliquots, now primarily used to identify the potential presence of Black Carp eggs or larvae, did not detect any Black Carp spawning during 2025.

Figure 2. *Index of total annual invasive carp egg and larvae drift in the La Grange (Havana), Peoria (Henry), Starved Rock (Ottawa), and Marseilles (Morris) navigation pools from 2012 to 2025. The index of total annual egg and larvae drift was estimated by summing observed egg and larval densities standardized by site-specific discharge and scaled to 24-hour intervals.*

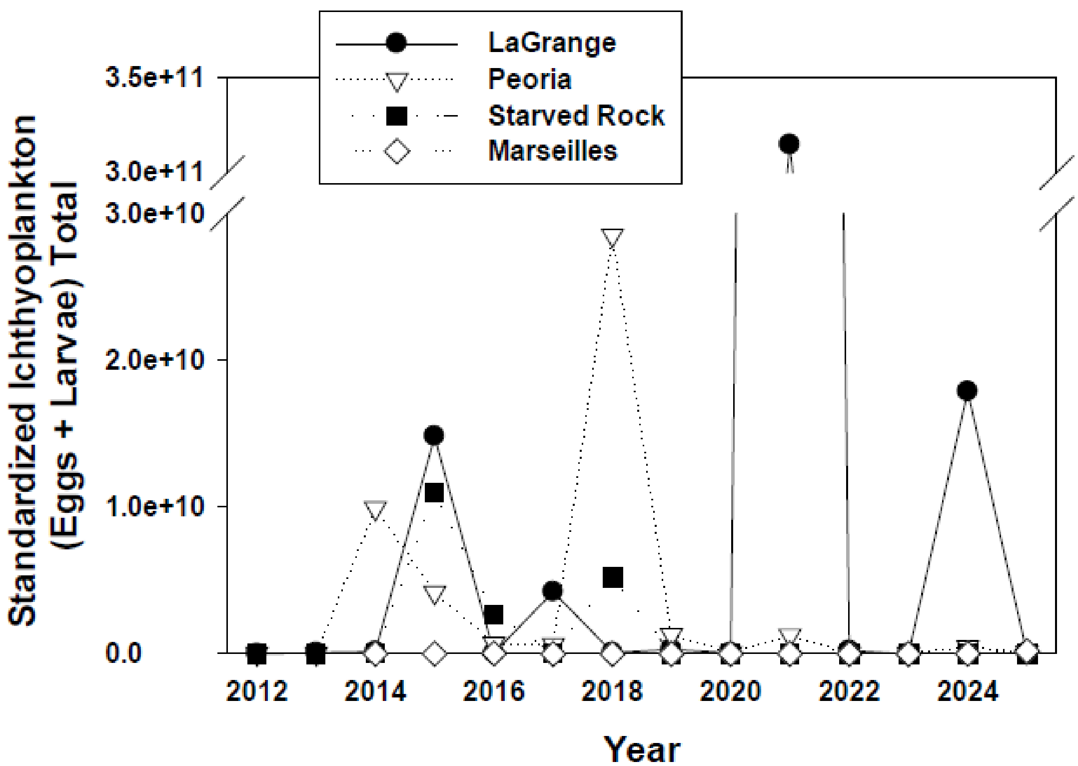
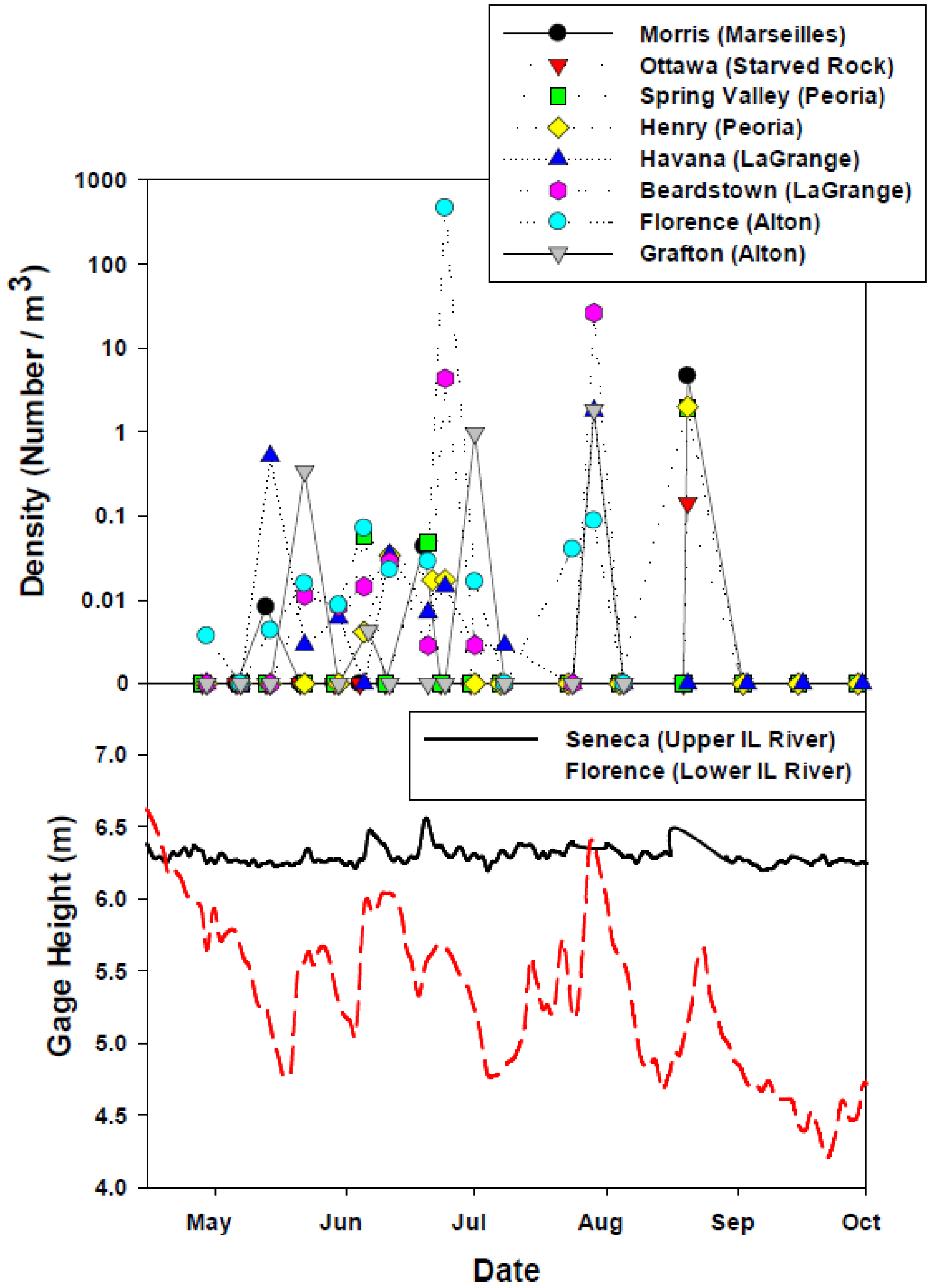


Figure 3. *Densities (number/cubic meter; note log scale) of invasive carp eggs and larvae (top panel) collected from main channel sites of the IWW in 2025. Mean daily gage height (meters) of the Illinois River from April through October 2025 (bottom panel) were obtained from USGS gage 5543010 at Seneca, Illinois, and gage 55836300 at Florence, Illinois.*



No evidence of invasive carp reproduction was observed in the Kankakee or Fox rivers, but invasive carp eggs and larvae were collected in all other sampled tributaries during 2025. Widespread drought restricted boat access to several tributaries during 2025, preventing sampling in the Sangamon River after mid-June and the Vermilion River after the end of June, and limiting sampling in the Mackinaw

River to just 3 weeks in June. Despite low average flows, localized rainfall events produced periods of increased discharge that triggered invasive carp reproductive events that varied considerably in timing and magnitude among tributaries (Figure 4). Due to the high magnitude of these brief periods of reproduction, overall invasive carp reproductive output was moderate to high in lower Illinois River tributaries in 2025 (Figure 5). The Spoon and Sangamon rivers have tended to produce higher overall numbers of invasive carp eggs and larvae across years, but the Mackinaw River exceeded these during 2025. Years of high invasive carp reproduction in tributaries tend to also be years with high magnitudes of invasive carp ichthyoplankton drift in the main channel (Figure 6).

Figure 4. *Densities (number/cubic meter) of invasive carp eggs and larvae (dark symbols) and mean daily discharge (cubic meters/second; dashed lines) of lower Illinois River tributaries (Mackinaw River [top panel], Spoon River [middle panel], and Sangamon River [bottom panel]) from April through August 2025. Discharge data was obtained from USGS gage 5568000 (Green Valley, IL; Mackinaw River), gage 5570000 (Seville, IL; Spoon River), and gage 5583000 (Oakford, IL; Sangamon River).*

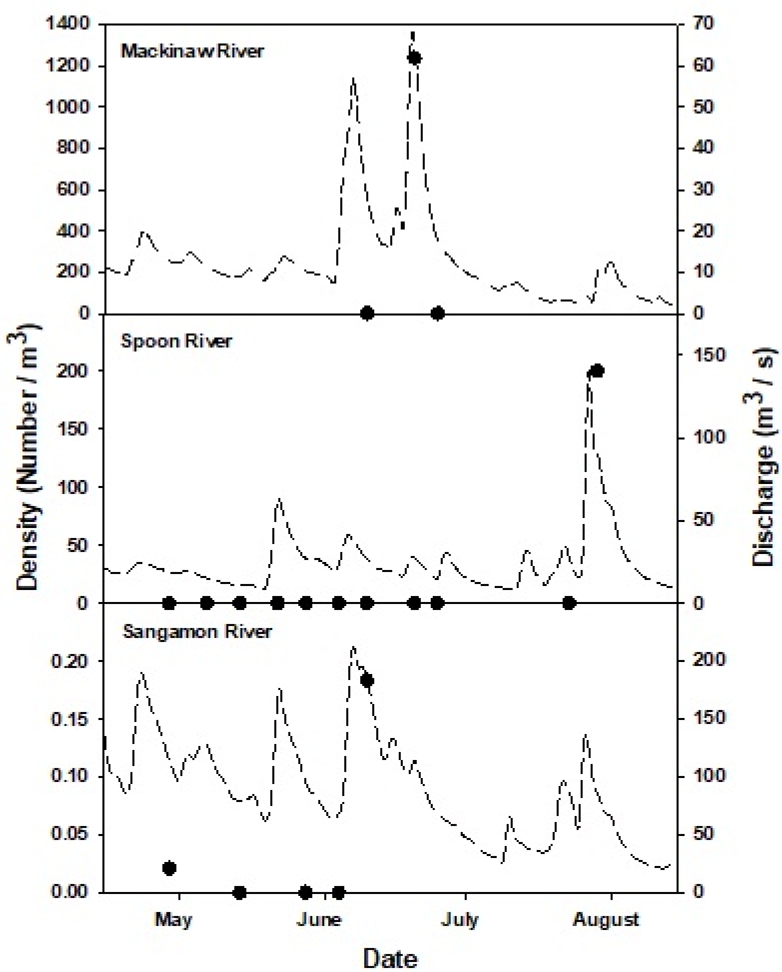


Figure 5. *Index of total annual invasive carp egg and larvae drift in the Sangamon, Spoon, and Mackinaw rivers from 2012 to 2025. The index of total annual egg and larvae drift was estimated by summing observed egg and larval densities standardized by site-specific discharge and scaled to 24-hour intervals.*

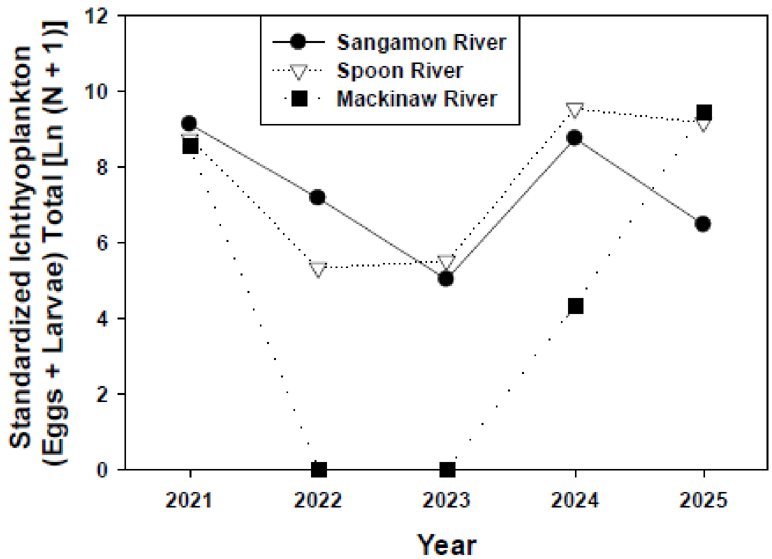
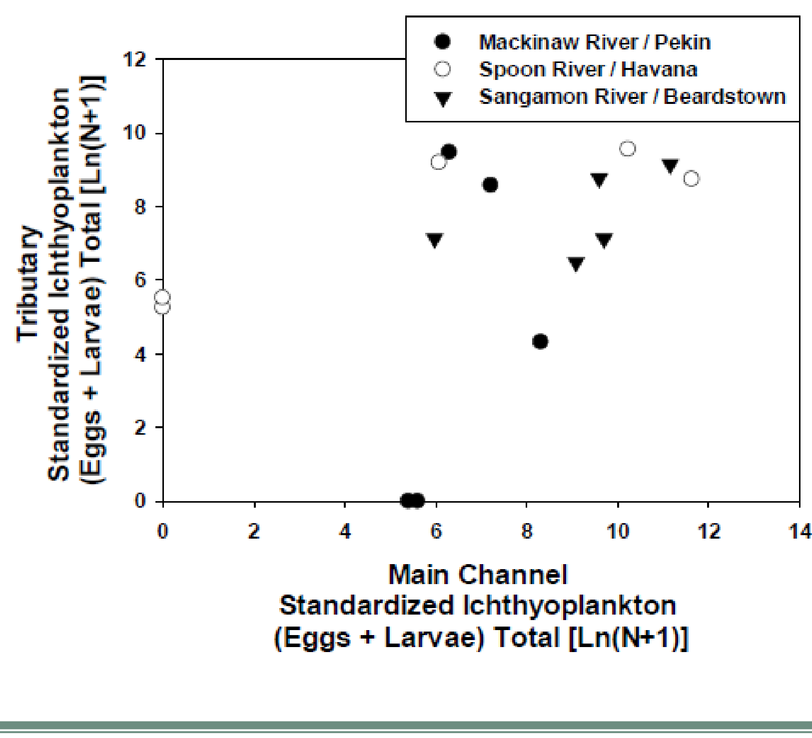
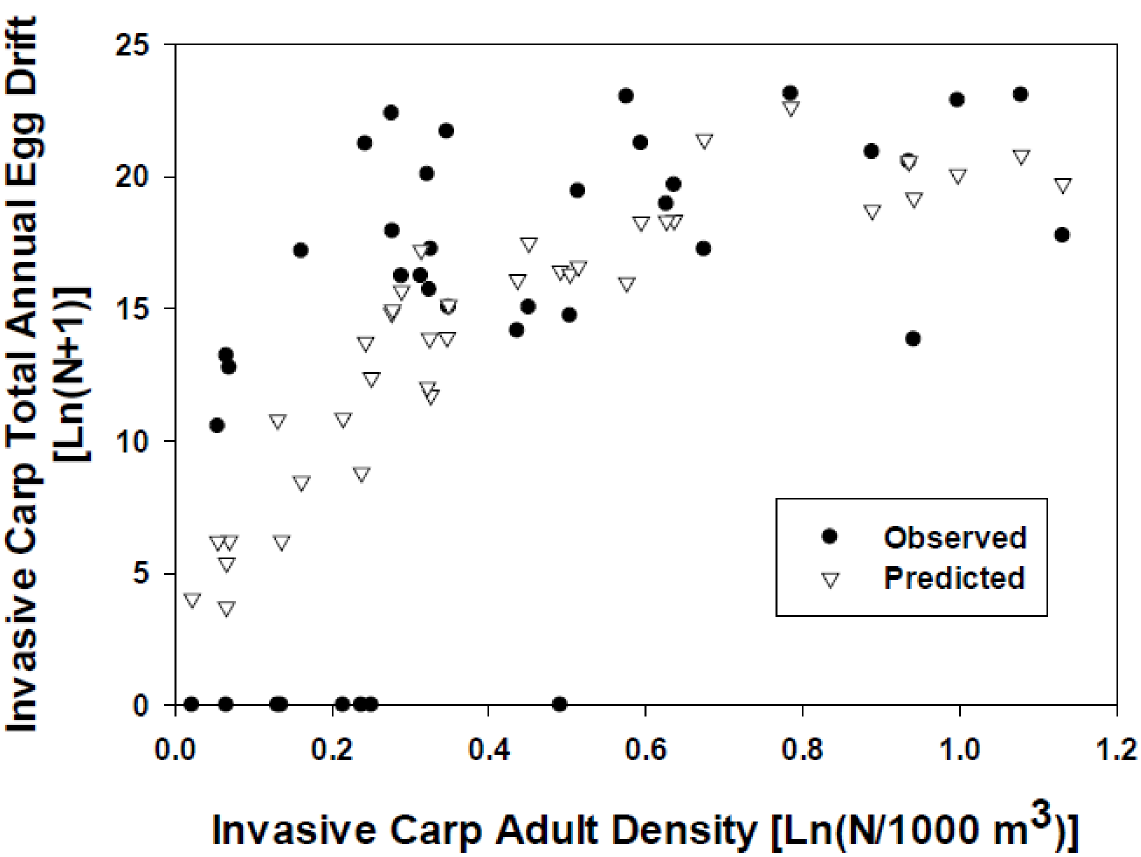


Figure 6. *Scatterplot of indices of total annual invasive carp egg and larval drift in three tributaries (Mackinaw, Spoon, and Sangamon rivers) versus adjacent main channel locations in the LaGrange Pool of the Illinois River (Pekin, Havana, and Beardstown) during 2021 through 2025. Indices of total annual egg and larvae drift were estimated by summing observed egg and larval densities standardized by site-specific discharge and scaled to 24-hour intervals across all sample dates within each year.*



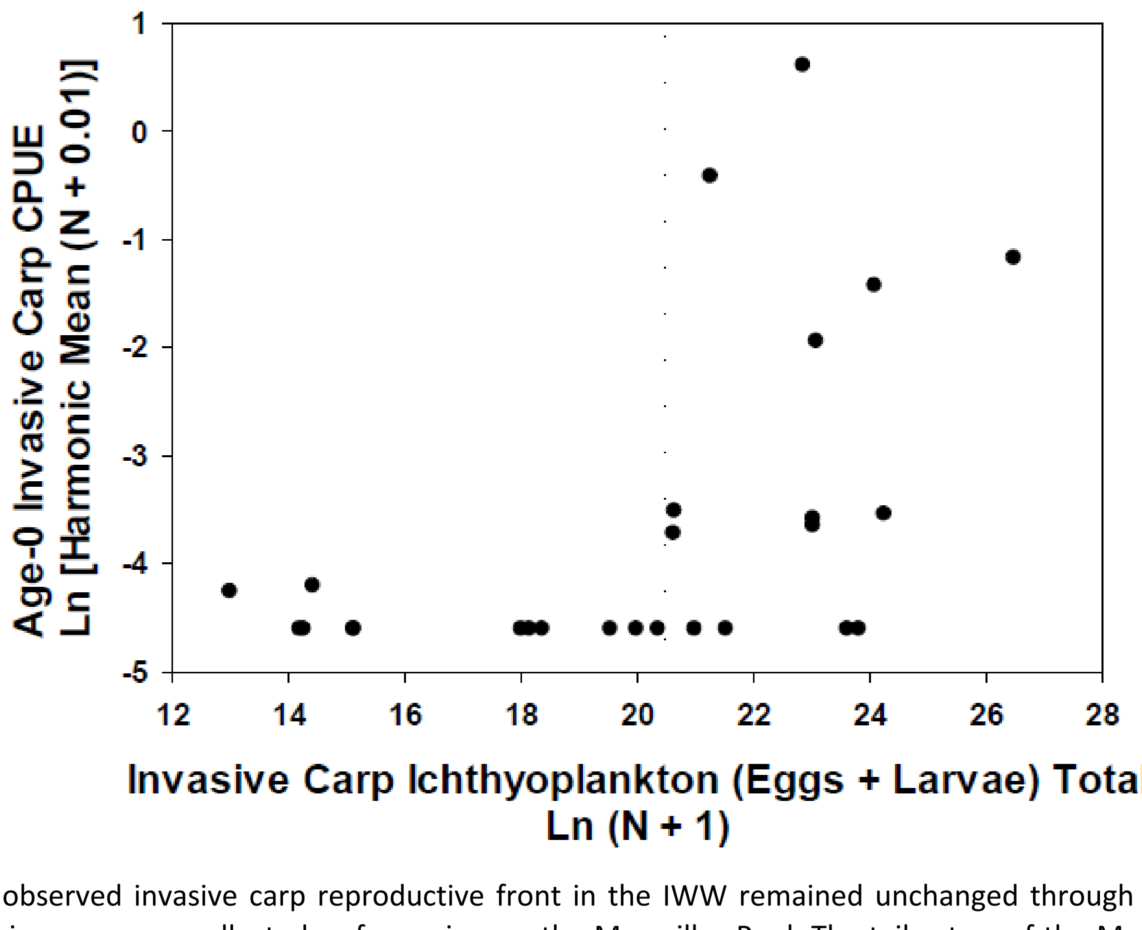
Updated analyses examining factors affecting invasive carp reproductive output found similar results to previous modeling efforts in that both adult invasive carp density and environmental conditions during the May through June period influenced spatiotemporal variation in the magnitude of invasive carp reproduction. A quadratic relationship between total annual egg drift and adult invasive carp density was more supported by the data than a linear relationship, and models that included adult invasive carp density were more supported by the data than those that only included environmental variables. The most supported candidate model included the quadratic relationship with adult density, mean daily discharge during May and June, and cumulative growing degree days through the end of May. Invasive carp egg drift was highest at sites that had intermediate densities of adults within and upstream of the pool containing the monitoring site (Figure 7) and during years with higher mean daily discharge during May and June and warmer water temperatures through the end of May.

Figure 7. *Observed invasive carp total annual egg drift (dark circles) and modeled predictions (open triangles) derived from a model including adult invasive carp density, mean daily discharge, and cumulative degree days through the end of May (base 18°C) plotted against associated invasive carp adult densities in navigation pools of the IWW during 2014 through 2025. Invasive carp total annual egg drift was calculated by summing observed egg densities standardized by site-specific discharge and scaled up over 24-hour intervals across all sampling dates within each year. Adult invasive carp densities were estimated from autumn hydroacoustic surveys in each navigation pool.*



Age-0 invasive carp catch rates were highly variable among years and between navigation pools. Combined estimates of age-0 invasive carp relative abundance in each pool were nonrandomly related to total annual invasive carp egg and larval drift (2DKS test: $D = 0.178$, $P = 0.0008$). During years when estimated total egg and larval drift were low ($X_{threshold} = 20.48$, $e^x = 786{,}615{,}403$ total eggs + larvae), subsequent juvenile abundances were also consistently low ($Y_{threshold} = -3.96$, $e^x = 0.02$ fish/15-minute effort). However, years with higher reproductive output produced highly variable juvenile abundances (Figure 8).

Figure 8. *Relationship between the harmonic means of age-0 invasive carp CPUE (N/15 minute effort) obtained by pulsed-DC electrofishing during LTRMP and LTEF sampling efforts across three time periods (Period 1 = June 15 to July 31; Period 2 = August 1 to September 14; Period 3 = September 15 to October 31) and total annual invasive carp egg and larval drift observed via ichthyoplankton sampling in the La Grange and Peoria pools of the Illinois River from 2012 to 2024. Invasive carp total annual egg drift was calculated by summing observed egg densities standardized by site-specific discharge and scaled up over 24-hr intervals. The vertical dashed line indicates* $X_{threshold}$, *the magnitude of total annual egg and larval drift at which the maximum change in variation in mean age-0 invasive carp CPUE occurs.*



The observed invasive carp reproductive front in the IWW remained unchanged through 2025, with invasive carp eggs collected as far upriver as the Marseilles Pool. The tailwaters of the Marseilles and Dresden Island dams appear to be likely spawning areas (Zhu et al. 2018), but other than three Silver

Carp larvae collected in the Dresden Island Pool in 2015, no potential evidence of invasive carp spawning upstream of the Dresden Island L&D has been observed to date. The bigheaded carp population front is currently located in the Dresden Island Pool, although sporadic captures of bigheaded carp in the Brandon Road Pool and the CAWS have occurred over the past decade (MRWG 2025). The lack of evidence of spawning in the Dresden Island Pool or in the Kankakee River may be attributable to poor-quality spawning habitat, less consistent environmental spawning cues, or extremely low detectability. The low numbers of adults upstream of the Dresden Island Dam would likely produce very low densities of drifting eggs, and the short water residence time of this pool may limit the presence of eggs within this pool to very brief time periods. Estimation of detection probabilities for invasive carp eggs, further FluEgg modeling using staged eggs collected in the Marseilles Pool, and increased sampling effort within the Dresden Island Pool may help to assess the likelihood of invasive carp spawning upstream of the Dresden Island Dam and the risks that this would pose to control efforts.

Illinois River tributaries exhibited a very different pattern from the main channel in 2025. In contrast to the repeated, low-magnitude spawning in the main channel, large spawning events appear to have occurred in tributaries on a very limited number of dates. In years with high region-wide spring and summer precipitation, when high flow events are common to all waterways, the timing and magnitude of invasive carp reproduction appear to be similar among tributaries and the mainstem Illinois River. During years with drier conditions and low water levels, localized rain events can have a much greater effect on the hydrographs of smaller river systems and, therefore, on invasive carp spawning activity in these rivers. Spawning by invasive carp in smaller tributary rivers appears to be widespread across their invaded range (Camacho et al. 2023; Hayer et al. 2023; Schaick et al. 2023). However, individual tributaries vary greatly in the consistency and magnitude of invasive carp reproductive output. Invasive carp spawning appears to consistently occur in the Spoon and Sangamon rivers, whereas the Mackinaw, Vermilion, and Fox rivers appear to offer less consistently favorable conditions for invasive carp reproduction. Tributaries with larger watersheds, higher discharge, greater turbidity, and higher temperatures have been found to produce higher abundances of invasive carp eggs (Schaik et al. 2023). Local habitat conditions and differences in spawning stock characteristics among tributaries also likely contribute to observed differences in reproductive output. The overall contribution of tributaries to main channel invasive carp egg and larval drift clearly varies over years, depending on the timing, magnitude, and distribution of precipitation and the subsequent effects on the hydrology of both the Illinois River and its sub-watersheds. The relative contribution of invasive carp eggs or larvae spawned in tributaries to later life stages is also unknown and could vary substantially depending on the proximity of each tributary to appropriate nursery habitats in the main channel.

The overall magnitude of invasive carp spawning activity has varied considerably over the years. Both warming and discharge variables have been found to affect the magnitude of invasive carp reproduction in the Illinois River (Parkos et al. 2023). Reproductive output was high during 2015, 2018, 2021, and 2024, when warmer springs coincided with high amounts of precipitation during the May to mid-July period. In contrast, years with cool and relatively dry springs, as occurred during 2022, 2023, and 2025, consistently fail to produce large spawning events. Although numerous invasive carp spawning bouts occurred over several months during 2025, all produced low numbers of eggs and larvae. Invasive carp are capable of spawning multiple times each year (Papoulias et al. 2006; Tucker et al. 2020; Lenaerts et al. 2023), but a substantial rise in flows within a window of appropriate water temperatures is necessary to synchronize the mass spawning events that produce high annual total egg and larval drift indices (Lohmeyer & Garvey 2009; Jiang et al. 2010; Li et al. 2013; Larson et al. 2017). Reproductive variation could also reflect changing densities of adult invasive carp, as harvest efforts appear to have reduced invasive carp abundances in the upper navigation pools in recent years.

The relationship between invasive carp spawning stock density and total annual egg drift continues to provide evidence of both diminished reproductive output at low adult abundances and density-limitation of reproductive output at very high densities of adults. This suggests that there is potential to reduce invasive carp adult densities enough to degrade their reproductive productivity, but there is also the potential for compensatory reproductive output if insufficient numbers of adults are removed. Reduced functional connectivity between navigation pools in the Upper IWW (Lubejko et al. 2017; Coulter et al. 2018; Zielinski et al. 2018) may contribute to a lack of compensatory reproductive response at low stock densities, thereby increasing the effectiveness of removal efforts of these more isolated invasive carp populations. However, immigration may complicate removal efforts downstream of Starved Rock L&D, where movement rates between navigation pools are likely higher (Coulter et al. 2018). Even if invasive carp reproductive potential is greatly reduced, the invasive carp stock-recruitment relationship remains unclear. Recruitment may vary considerably for a given magnitude of reproductive output. However, reproduction is a prerequisite for successful recruitment, and there is presumably some threshold of reproductive output below which density-dependent processes cannot compensate to produce even modest year classes.

The relationship between annual invasive carp ichthyoplankton totals and age-0 invasive carp relative abundance is encouraging, in that below a threshold of total egg and larval drift, juvenile abundances were also consistently low. Given that egg production is known to be reduced at lower adult spawner densities, it is reasonable to conclude that if adult densities are sufficiently reduced, production of juvenile invasive carp will likewise be limited. Hydrology is known to be a strong driver of invasive carp year-class strength (Gibson-Reinemer et al. 2017; Sullivan et al. 2018), but whether certain flow conditions contribute to recruitment failures due to lack of spawning, poor survival of eggs and larvae, and/or poor survival of juveniles has been uncertain. It appears that low production of eggs and larvae indeed results in similarly low production of juvenile invasive carp, but higher reproductive output also does not guarantee high juvenile abundances. Thus, multiple mechanisms operating across invasive carp early life history likely influence recruitment at least to the juvenile stage. Flood timing and duration have been suggested to be important factors regulating production and survival of invasive carp cohorts (Gibson-Reinemer et al. 2017; Sullivan et al. 2018). These factors may affect not only the magnitude and timing of spawning, but also areas of larval settlement and the duration of access to floodplain resources by juvenile invasive carp, which may contribute to the observed variability in juvenile abundances following high levels of ichthyoplankton production. However, hydrology is a factor that is difficult to control via management actions at the watershed scale, whereas adult abundances can be manipulated through harvest efforts. Additional investigation of relationships between invasive carp reproductive output, juvenile abundances, and year class strength is warranted to provide a clearer understanding of recruitment mechanisms, identify recruitment bottlenecks, assess potential compensatory responses among different life stages, and determine thresholds of adult population reduction that may serve as targets to achieve recruitment overfishing for invasive carp.

RECOMMENDATIONS

Ichthyoplankton sampling should continue to monitor for invasive carp reproduction, particularly upstream of the Peoria Pool, to evaluate any changes in the invasive carp reproductive front and assess the effects of invasive carp harvest activities on the reproductive potential of these populations. Current models allow for predictions of anticipated reproductive output given observed environmental conditions and assessed invasive carp densities. Deviation from predicted levels of reproduction could potentially allow for assessment of whether harvest efforts are diminishing the reproductive potential of invasive carp populations to levels that would support management objectives. A threshold level of reproductive productivity below which recruitment to the juvenile life stage appears to be consistently diminished has been identified. If adult invasive carp densities are reduced below a level sufficient to support this magnitude of reproduction, recruitment could potentially be substantially reduced. However, the relationship between reproduction and recruitment should be more thoroughly investigated, as the role of density-dependence at juvenile stages and the comprehensive stock-recruitment relationship for invasive carp species in the IWW remains unclear. Extremely episodic recruitment and high mobility of invasive carp among river systems make use of catch-at-age data for assessing recruitment within the Illinois River challenging. Alternative means of assessing year-class strength, such as relative abundance of age-1 individuals, may offer insight into more localized recruitment patterns. Identifying factors affecting linkages among all early life stages and those that most influence ultimate year class strength would provide a mechanistic understanding of invasive carp recruitment variation and thus facilitate development and refinement of control efforts for these invasive fishes. Further FluEgg modeling (Zhu et al. 2018) is also needed to determine the consistency of invasive carp spawning locations in the IWW and provide information to confirm the relevant adult spawner density for the assessment of stock-reproductive productivity and stock-recruitment relationships.

Ichthyoplankton sampling downstream of Starved Rock L&D should continue to monitor for potential Black Carp reproduction. Although adult Black Carp continue to be captured from the Illinois River, evidence of reproduction by this species remains elusive. Screening of ichthyoplankton samples for target DNA (Fritts et al. 2019; Butler et al. 2025) should allow for evaluation of whether collected samples contain target specimens and can be used to confirm incidences of Black Carp reproduction. If reproduction of Black Carp in the Illinois River is identified, FluEgg modeling could assist in determining spawning locations of this species, which may help to implement targeted removals, as effective harvest of Black Carp has thus far proven challenging.

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INVASIVE CARP eDNA SAMPLING AND PROCESSING

Participating Agencies: USFWS (lead), Cari-Ann Hayer (USFWS), Green Bay FWCO

Location: Lake Calumet, Little Calumet River, Powderhorn Lake

MRWG Work Group: Detection

Pools Involved: CAWS

INTRODUCTION AND NEED

Monitoring with multiple gears in the CAWS has been essential to determine the effectiveness of efforts to prevent self-sustaining populations of invasive carp from establishing in the Great Lakes. Since 2009, eDNA sampling has been conducted annually as a surveillance tool to monitor the genetic presence of Bighead Carp and Silver Carp in the CAWS and maintain vigilance above the EDBS. Beginning in 2013, eDNA results no longer automatically triggered any response action through the MRP. A low baseline level of invasive carp DNA signal has been consistently detected in the CAWS and attributed to a combination of vectors. This consistent level of minimal or zero positive eDNA detections annually and the limited captures of live Bighead Carp and Silver Carp by traditional sampling gears above the EDBS support the assumption that there is not a self-sustaining, reproducing population of these invasive carp above the barrier.

OBJECTIVES

Sample for Bighead Carp and Silver Carp DNA in targeted areas of the CAWS to maintain vigilance and complement other ongoing monitoring efforts above the EDBS.

PROJECT HIGHLIGHTS

- USFWS staff collected 1,040 samples upstream of the EDBS and 110 samples in Powderhorn Lake (control site).
- Positive detections were few and consistent with previous sampling years.

METHODS

USFWS staff from the Green Bay FWCO conducted spring and fall sampling above the EDBS in the CAWS in conjunction with SIM efforts. For each event, 330 samples (300 samples plus 30 field blanks) were collected in Lake Calumet, 110 samples (100 samples plus 10 field blanks) were collected in the Marine Services Marina on the Little Calumet River, and 80 samples (72 samples plus 8 field blanks) were collected in the Grand Calumet River (see maps beginning on page 41). Additionally, 110 samples (100 samples plus 10 field blanks) were collected in Powderhorn Lake in the spring. These followed the sample collection and processing procedures detailed in the 2025 Quality Assurance Project Plan (USFWS 2025a), except for Grand Calumet River samples, which were collected and processed differently due to access and river conditions that precluded the use of a boat. Field blanks were taken in addition to regular monitoring samples. Field blanks are a quality control measure and are not included when describing detection rates. All samples were analyzed for the presence of carp eDNA with three marker sets: Silver Carp only, Bighead Carp only, and non-specific invasive carp. The non-specific invasive carp marker set can detect either Bighead Carp or Silver Carp but is not specific enough to differentiate between the two species. This is reported as a non-specific "invasive carp" detection. If both species-specific markers are detected in a water sample, it is reported under the "bighead AND silver" category. The "invasive carp detection" category was added to the reported results in the 2021 field season. This marker set has always been used in lab analysis but was not publicly reported in previous years.

RESULTS AND DISCUSSION

In the spring sampling event, there were zero positive eDNA detections in the Grand Calumet River, zero positive eDNA detections in Powderhorn Lake, a 1.0 percent positive detection rate in Lake Calumet, and a 1.0 percent positive detection rate in Little Calumet Marina. In the fall sampling event, there were zero positive eDNA detections in the Grand Calumet River, a 1.0 percent positive detection rate in Lake Calumet, and a 1.0 percent positive detection rate in Little Calumet Marina. The detection rate in Lake Calumet and Little Calumet Marina is consistent with the results from previous surveys. Results can be viewed on the USFWS Bighead Carp and Silver Carp Environmental DNA Monitoring ArcGIS dashboard. (FWS Midwest and Northeast Regions FAC Bighead and Silver Carp eDNA Monitoring Dashboard)

RECOMMENDATIONS

eDNA sampling efforts in the CAWS are a long-standing part of the USFWS Invasive Carp eDNA Early Detection and Monitoring Program and will continue semi-annually for the foreseeable future. Therefore, it's recommended that USFWS continue to conduct eDNA monitoring in these locations, similar to previous years. The USFWS will continue to investigate how secondary vectors, such as birds, may contribute to DNA signals in the sampled water of the CAWS.

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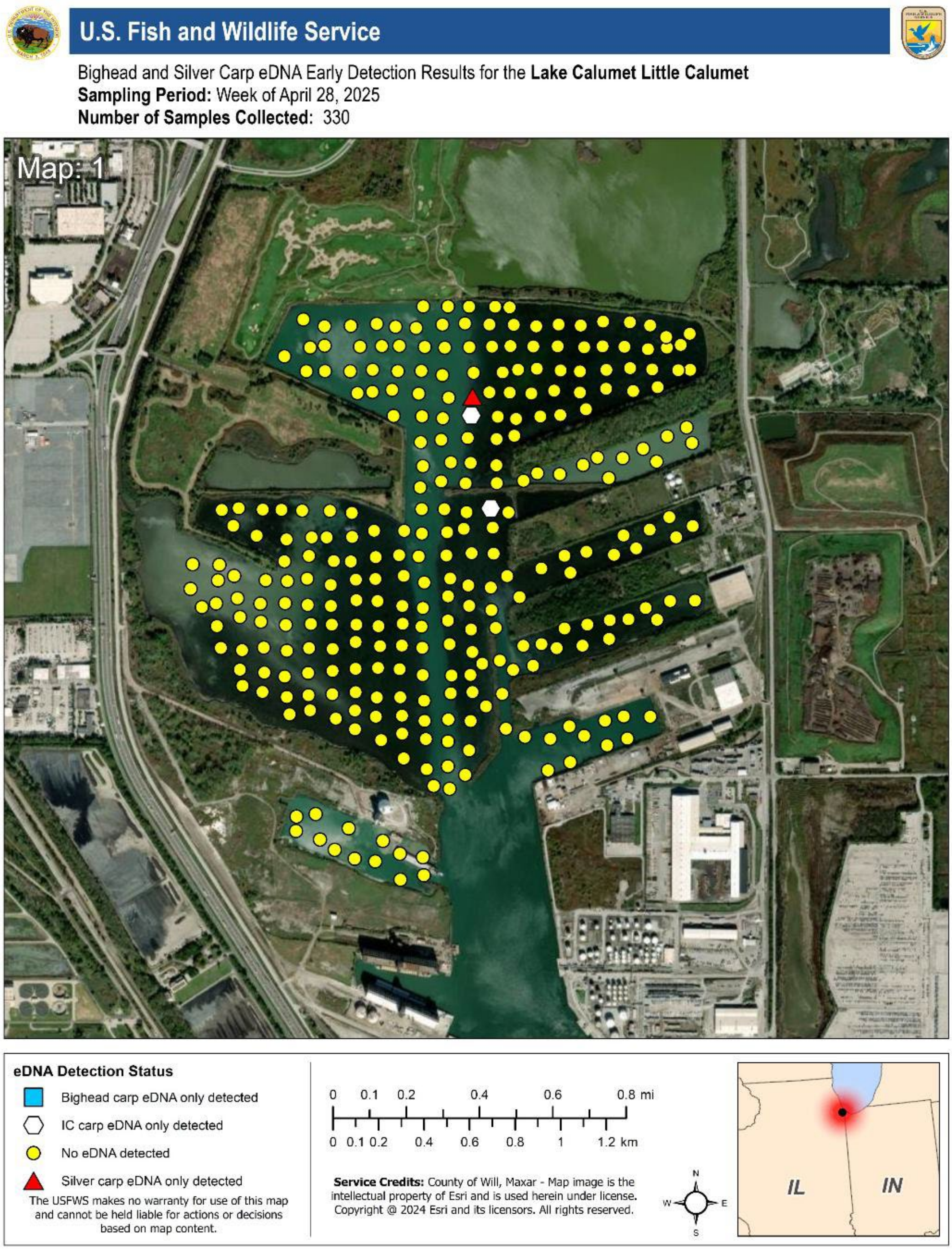
U.S. Fish and Wildlife Service
Bighead and Silver Carp eDNA Early Detection Results for the **Lake Calumet Little Calumet**
Sampling Period: Week of April 28, 2025
Number of Samples Collected: 330
Map: 1
eDNA Detection Status
Bighead carp eDNA only detected
IC carp eDNA only detected
No eDNA detected
Silver carp eDNA only detected
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.1 0.2 0.4 0.6 0.8 mi
0 0.1 0.2 0.4 0.6 0.8 1 1.2 km
Service Credits: County of Will, Maxar - Map image is the intellectual property of Esri and is used herein under license. Copyright @ 2024 Esri and its licensors. All rights reserved.
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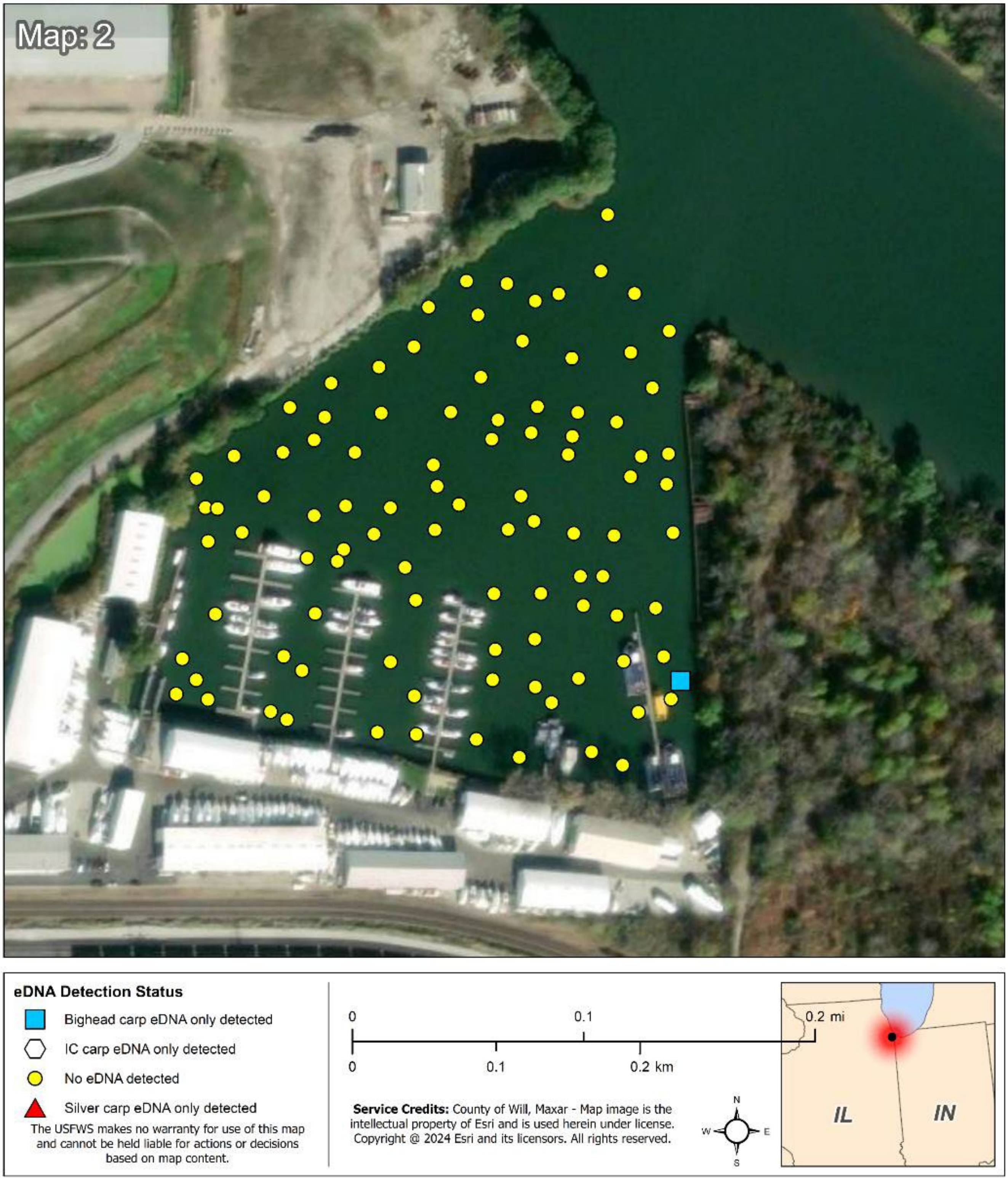
U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Lake Calumet Little Calumet**
Sampling Period: Week of April 28, 2025
Number of Samples Collected: 110



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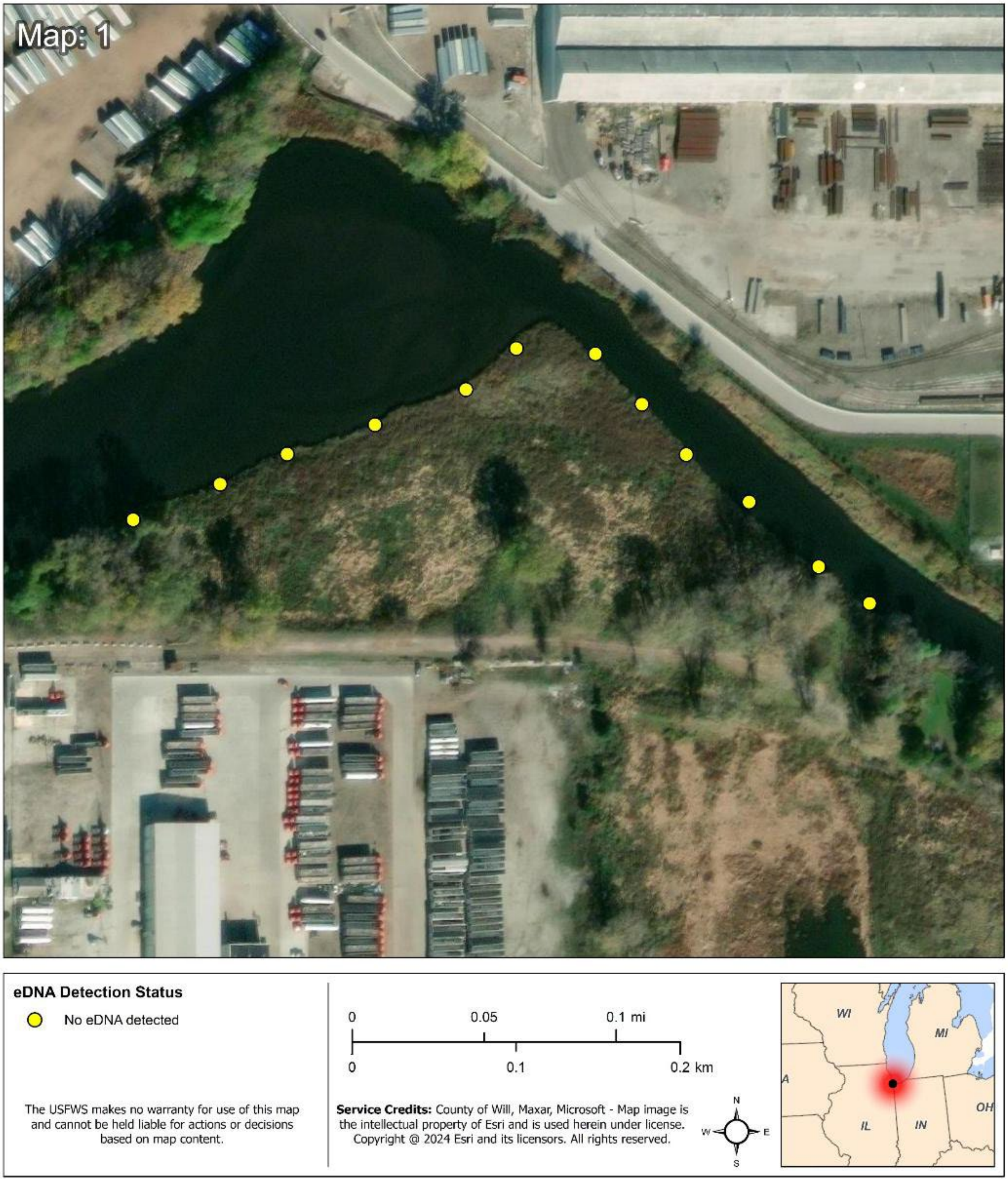
U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Grand Calumet River**
Sampling Period: Week of April 28, 2025
Number of Samples Collected: 14



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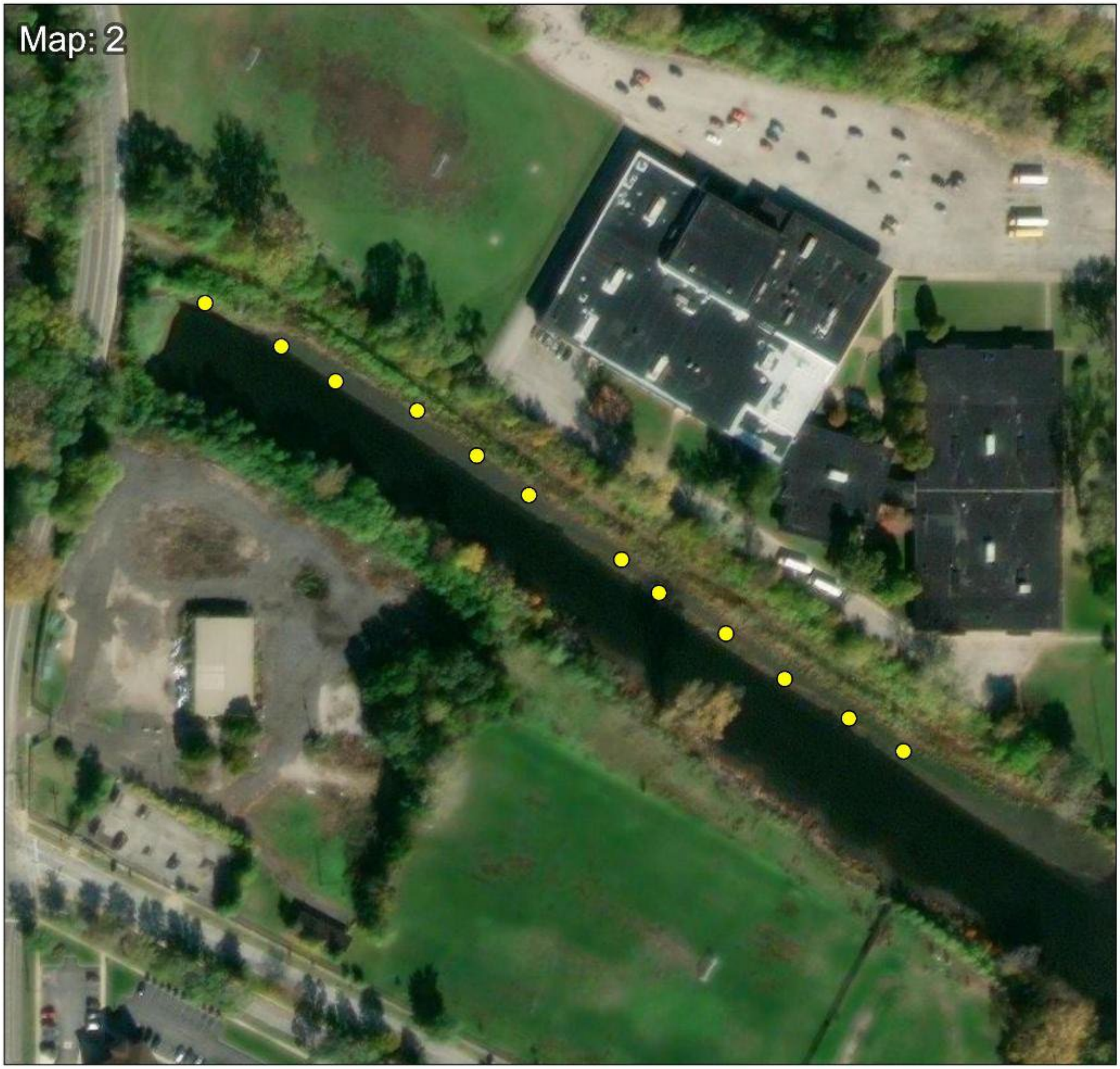
U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Grand Calumet River**
Sampling Period: Week of April 28, 2025
Number of Samples Collected: 13



eDNA Detection Status

No eDNA detected

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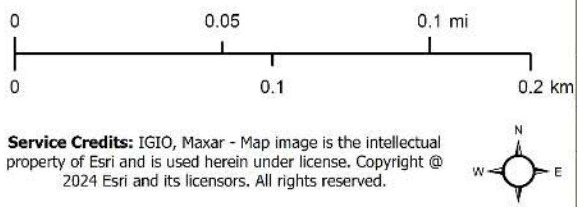

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U.S. Fish and Wildlife Service
Bighead and Silver Carp eDNA Early Detection Results for the Grand Calumet River
Sampling Period: Week of April 28, 2025
Number of Samples Collected: 33
Map: 3
eDNA Detection Status
No eDNA detected
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0
0.05
0.1
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U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Grand Calumet River**
Sampling Period: Week of April 28, 2025
Number of Samples Collected: 20

eDNA Detection Status

No eDNA detected

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0 0.1 0.2 0.4 km

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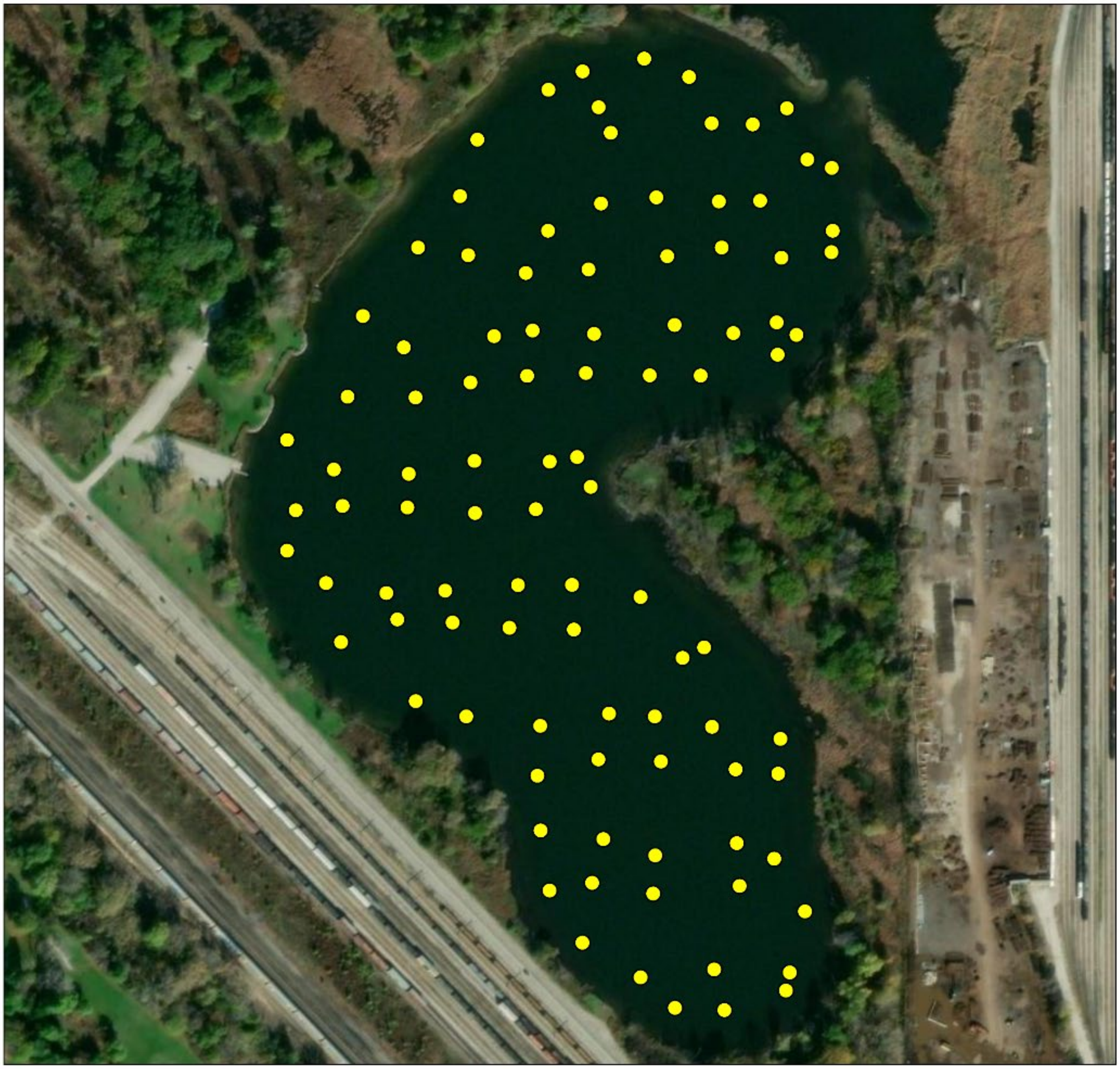
N W E S

U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Powderhorn Lake**
Sampling Period: Week of April 28, 2025
Number of Samples Collected: 110



eDNA Detection Status

No eDNA detected

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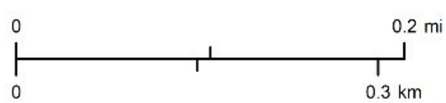

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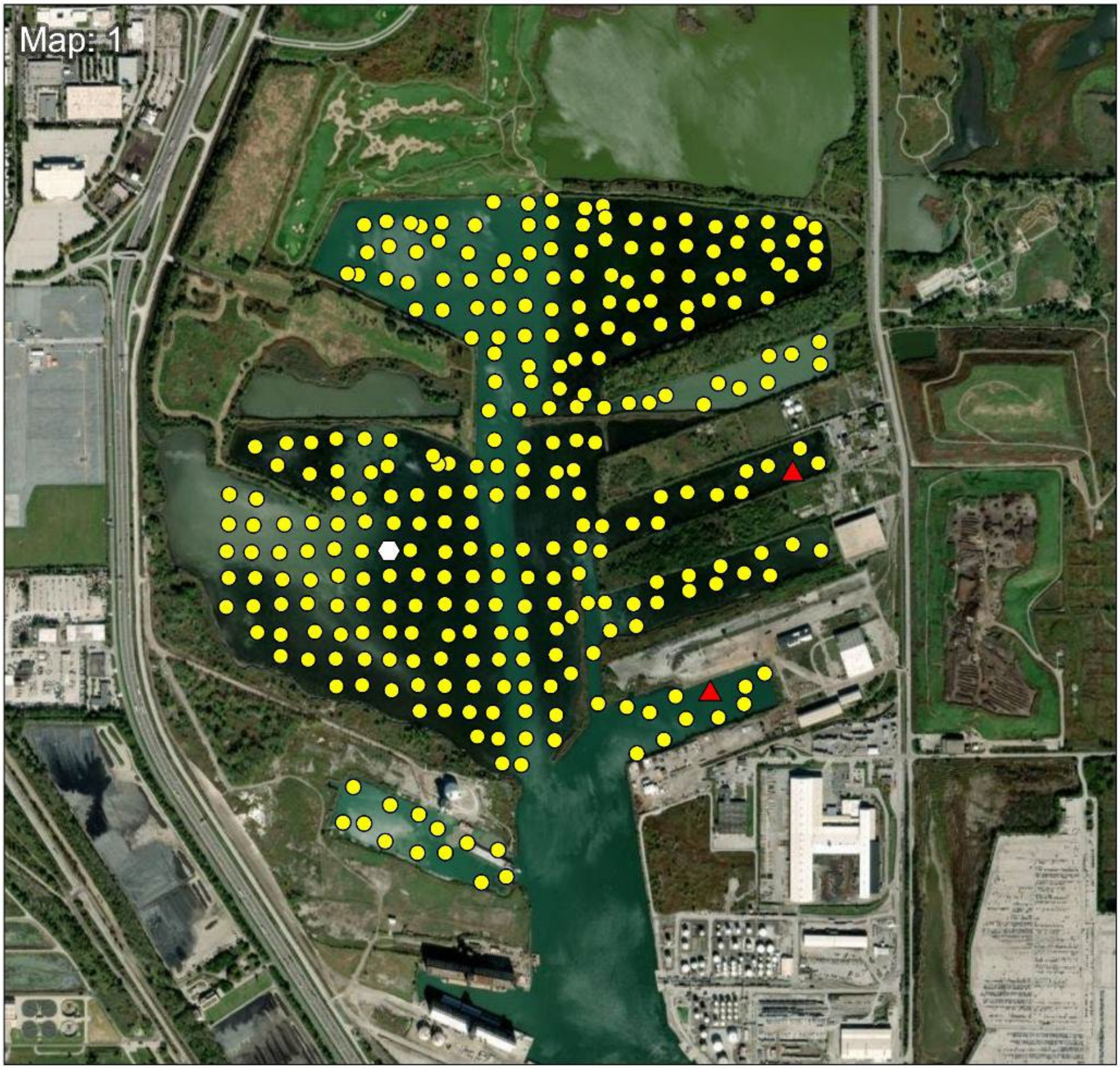
U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Lake Calumet Little Calumet**
Sampling Period: Week of September 22, 2025
Number of Samples Collected: 330



eDNA Detection Status

- Silver carp eDNA only detected
- IC carp eDNA only detected
- No eDNA detected

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0 0.1 0.2 0.3 mi
0 0.1 0.2 0.4 0.6 km

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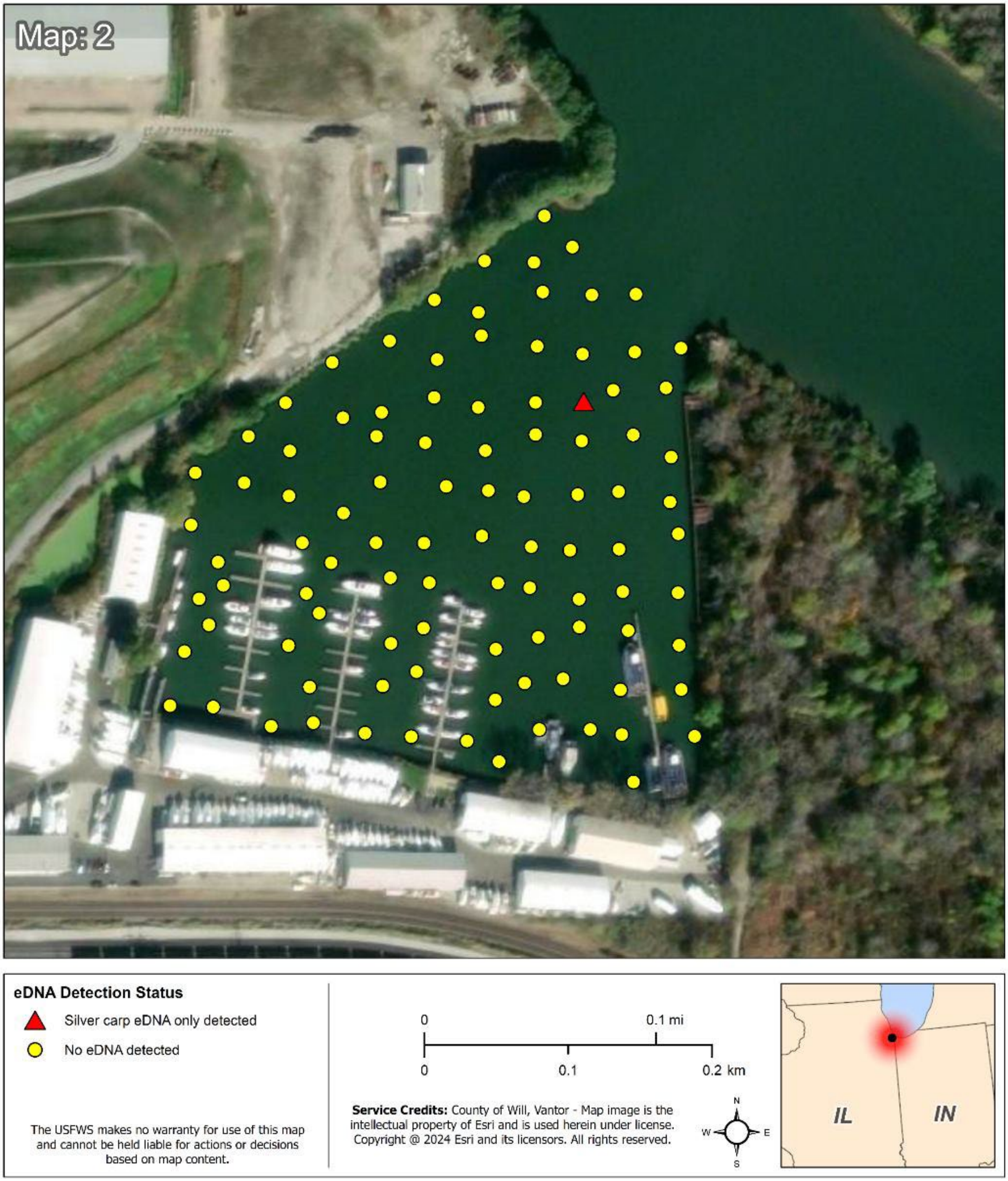
N W E S

U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Lake Calumet Little Calumet**
Sampling Period: Week of September 22, 2025
Number of Samples Collected: 110



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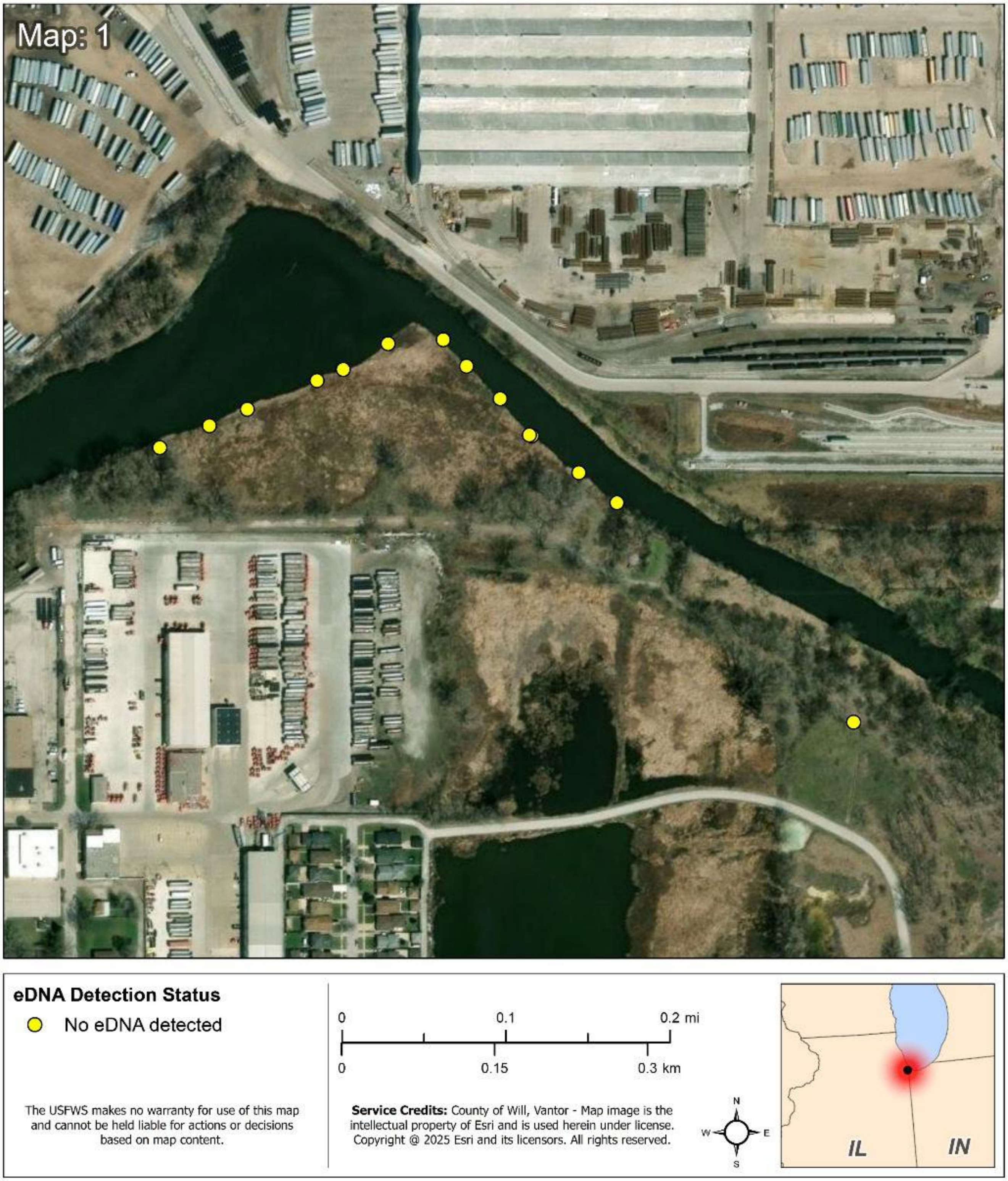
U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Grand Calumet River**
Sampling Period: Week of September 22, 2025
Number of Samples Collected: 14



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U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Grand Calumet River**
Sampling Period: Week of September 22, 2025
Number of Samples Collected: 13

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U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Grand Calumet River**
Sampling Period: Week of September 22, 2025
Number of Samples Collected: 33

eDNA Detection Status

- No detection data
- No eDNA detected

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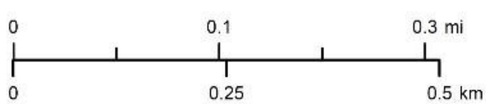

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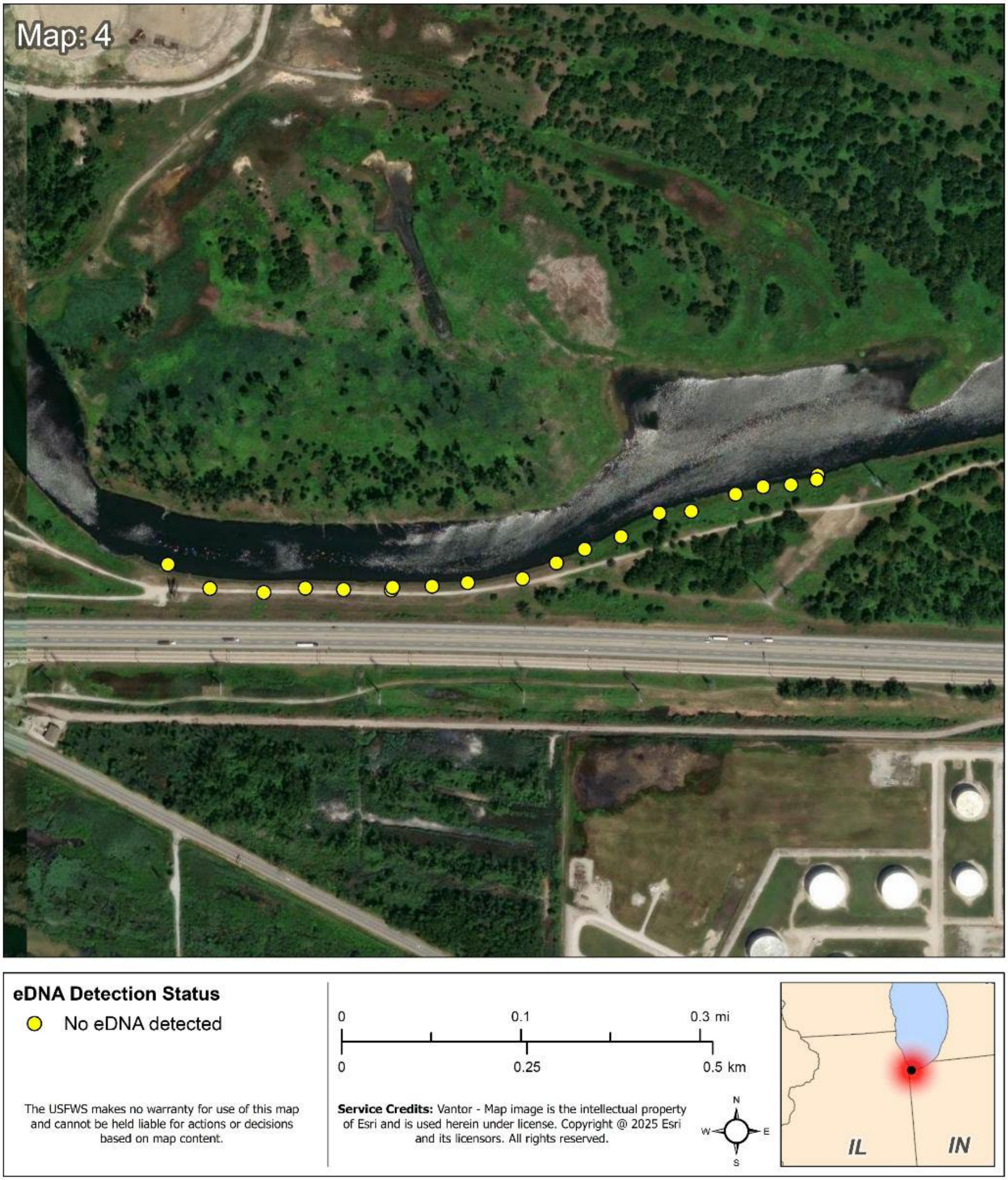
U.S. Fish and Wildlife Service

Bighead and Silver Carp eDNA Early Detection Results for the **Grand Calumet River**
Sampling Period: Week of September 22, 2025
Number of Samples Collected: 20



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ALTERNATE PATHWAY SURVEILLANCE IN ILLINOIS – LAW ENFORCEMENT

Participating Agencies: ILDNR (lead); Brandon Fehrenbacher (ILDNR)

MRWG Work Group: Detection

Pools Involved: N/A

INTRODUCTION AND NEED

The ILDNR ISU is a specialized law enforcement component of the ICRCC. Illegal activities within commercial fishing, aquaculture, transportation, bait, pet, aquarium, live fish market, and sport fishing industries increase the risk of invasive carp and other species being introduced into new waters. ISU investigates and apprehends individuals and businesses that violate regulations designed to protect Illinois waterways and those beyond the state. These cases demonstrate that human activities remain a foreseeable pathway for invasive species expansion. Accordingly, it is essential that local, state, and federal resource protection agencies establish and train specialized enforcement units. ISU provides subject-matter expertise and coordinates with law enforcement personnel from other agencies, non-law enforcement staff, and members of the public seeking guidance on invasive species issues.

OBJECTIVES

- Administer the enforcement phase of the GLFC Law Committee's *Least Wanted Aquatic Invasive Species* project targeting businesses selling aquatic invasive species online.
- Conduct commercial inspections of businesses most likely to possess or trade aquatic invasive species.
- Implement a minimum of five intelligence-based enforcement operations.

PROJECT HIGHLIGHTS

The enforcement phase of the Law Committee's *Least Wanted Aquatic Invasive Species* project was administered in 2025. Despite prior regulatory notifications, 10 businesses across the U.S. illegally sold prohibited species to undercover officers. These businesses were criminally charged, resulting in $2,250 in fines. The project also prompted changes within the pond and aquarium supply industries. Many companies added safeguards preventing customers in restricted states from viewing or purchasing prohibited species, while others updated websites with state-specific lists of banned products. This project demonstrates that regulatory agencies cannot rely solely on industry assurances of compliance. Strategic enforcement operations that provide accurate information and meaningful consequences are essential to protecting waterways.

METHODS

ISU enforcement activities included suspect surveillance, facility inspections, targeted enforcement operations, audits, internet monitoring, public complaints, and leads from government agencies.

RESULTS AND DISCUSSION

Commercial inspections within the aquatic organisms-in-trade industry revealed multiple violations and generated intelligence that supported targeted enforcement operations, including a successful case involving the illegal sale and interstate transportation of live invasive carp. Direct engagement with industry stakeholders improves communication and strengthens regulatory oversight by holding businesses and individuals accountable.

Snippets of the enforcement actions include:

- A joint operation between ISU and Wisconsin conservation officers began after live Grass Carp were discovered for sale in two Wisconsin ethnic grocery stores. Live Grass Carp are prohibited in Wisconsin food markets and are one of four invasive carp species. During surveillance in Chicago, ISU observed the Wisconsin store owners receiving Grass Carp from an out-of-state fish hauler. Wisconsin DNR officers later arrested both individuals when they returned to their stores with the fish. Several weeks later, a targeted fish truck inspection in Chicago revealed that the same hauler had illegally imported approximately 1,500 pounds of fish into Illinois, valued at about $13,000. The broader investigation determined the hauler had imported approximately 60,000 pounds of illicit live fish into Illinois over a 3.5-month period after his permit renewal was denied, valued at roughly $500,000. The Wisconsin store owners received approximately $4,000 in fines, and the Illinois Attorney General's Office Environmental Crimes Bureau is prosecuting the fish hauler on pending felony and misdemeanor charges.
- ISU investigated an email threat sent to natural resource agencies across the Great Lakes Basin, claiming live invasive carp would be released into Lake Michigan unless three Bitcoin (approximately $250,000) were paid. Search warrants for associated email accounts determined the perpetrators were operating outside the U.S. The Bitcoin account was also analyzed using federal and state law enforcement resources. The investigation ultimately concluded the message was a scam and did not represent a credible threat to the Great Lakes.
- ISU discovered live Asian swamp eels for sale in a Chicago ethnic grocery store. Asian swamp eels are listed as an injurious species in Illinois and cannot be possessed, purchased, sold, or transported alive. ISU confiscated and destroyed 33 pounds of live eels valued at approximately $400. Additional evidence collected included communications, bank records, shipping documents, and invoices. The out-of-state wholesaler who shipped the eels into Illinois faces felony state charges and federal charges under the Lacey Act for falsely labeling the shipment as live Dungeness crabs. The case was referred to the USFWS.

RECOMMENDATIONS

- Establish permanent Organisms in Trade Law Enforcement Units.
- Expand AIS training for CPOs to further bridge the gap between law enforcement and non-law enforcement personnel.
- Prioritize proactive enforcement to reduce the need for reactive responses.

MONITORING WORK GROUP PROJECTS

- Invasive Carp Demographics in the Illinois Waterway
- Multi-Agency Monitoring of the Illinois River for Decision Making

INVASIVE CARP DEMOGRAPHICS IN THE ILLINOIS WATERWAY

Participating Agencies: USFWS Columbia FWCO (lead); USFWS Carterville- Wilmington FWCO; USFWS- Carterville FWCO; INHS and ILDNR; Edward Sterling, Bryon Rochon, Jahn Kallis, Jason Goeckler (USFWS Columbia FWCO)

MRWG Work Group: Monitoring

Pools Involved: Alton, La Grange, Peoria, Starved Rock, Marseilles, Dresden Island, Brandon Road, Lockport; Illinois River

INTRODUCTION AND NEED

Detection and monitoring of invasive carp (Bighead Carp, Black Carp, Grass Carp, and Silver Carp) populations in the Illinois River is critical for achieving management goals. To address this important information need, natural resource agencies collaborate to implement a standardized multiple-gear sampling approach; the Multi-Agency Monitoring of the Illinois River for Decision Making project. This standardized multi-gear sampling approach provides an accurate, comparable, and representative understanding of invasive carp distribution and abundance throughout the Illinois River. Additionally, incorporating age data collections into these efforts provides the information needed (e.g., age structure) to inform stock assessment models used to quantify the success of control efforts.

The USFWS's Invasive Carp Demographic project is collaborative with the MAM and the Support for Early Detection of Invasive Carp in the Upper Illinois Waterway project. This project includes bolstered age structure collections from electrified dozer trawl and standard electrofishing (i.e., fisheries-independent), commercial fishers (i.e., fisheries-dependent), and laboratory processing of age structures. Please see the *MAM* ISR for electrified dozer trawl sampling methodology, and the *Support for Early Detection of Invasive Carp in the Upper Illinois Waterway* ISR for standard electrofishing methodology. The physical capture data from this project is summarized in the *MAM* and *Support for Early Detection of Invasive Carp in the Upper Illinois Waterway* ISRs and, hereafter, is not discussed. The focus of this report is solely on age structure results.

OBJECTIVES

In addition to the MAM project objectives, the objectives of the Invasive Carp Demographics project include:

- Coordinate with the MAM project to provide an additional gear type (i.e., electrified dozer trawl) to existing standardized sampling protocols to complete field sampling, data processing, analysis, and reporting to achieve MAM project objectives.
- Provide Silver Carp age structure results in pools of the Illinois River.

PROJECT HIGHLIGHTS

- From 2018 to 2025, over 6,100 lapilli otolith aging structures were collected and processed from six pools of the Illinois River, providing pool-specific age structure metrics.

METHODS

The USFWS-Columbia, Carterville, and Wilmington-substation FWCOs collected fisheries-independent data, including age, size, and sex, in the Alton, LaGrange, Peoria, Starved Rock, Marseilles, Dresden Island, Brandon Road, and Lockport pools using a random design stratified by habitat type (i.e., backwaters, island side channels, main-channel borders). Sampling was conducted using the electrified dozer trawl (Hammen et al. 2019; Drews 2020). Further details describing fish collection procedures are provided in the *MAM* ISR.

During time period three of the MAM event (September 15 to October 31), lapilli otoliths were extracted from the first 200 Silver Carp captured in each river reach (i.e., Lower Pools: Alton, LaGrange, and Peoria pools; Upper Pools: Starved Rock, Marseilles, and Dresden Island pools), with a maximum of 20 Silver Carp per electrified dozer trawl transect. These data represent the age structure of the population. Additional fisheries-independent age structures were collected, when available, in pools with low Silver Carp abundance (i.e., Marseilles and Dresden Island pools) through electrified dozer trawl sampling and standard electrofishing associated with the Early Detection of Invasive Carp project. Further details describing fish collection procedures are provided in the *Support for Early Detection of Invasive Carp in the Upper Illinois Waterway* ISR.

To help characterize the age structure of the fishery, additional lapilli otoliths were collected from invasive carp (200 invasive carp/pool) in six pools (i.e., Alton, LaGrange, Peoria, Starved Rock, Marseilles, and Dresden Island pools) of the Illinois River using fisheries-dependent (i.e., commercial gillnets) methods. These additional collections were necessary to help inform the population age structure that is exploited by commercial fishers and to help provide inputs for the statistical catch-at-age model. Fishery-dependent age structures were provided through collaboration with ILDNR, INHS, and the USFWS-Wilmington substation.

Lapilli otoliths collected from this sampling effort were aged by personnel from the USFWS-Columbia FWCO. One otolith per fish was prepared by sanding on a transverse plane until reaching the nucleus. Prepared otoliths were mounted in putty, submerged in glycerol, illuminated with a fiber optic light, and viewed using a dissecting scope. Three independent readers aged each otolith, and a final age was recorded using a minimum of 2/3 consensus (Maceina and Sammons 2006; Seibert and Phelps 2013). If a 2/3 consensus could not be reached, the otolith was omitted from the dataset.

RESULTS AND DISCUSSION

Field collection summary results coinciding with objective one are described in the MAM ISR.

Summary results addressing objective two are reported to provide Silver Carp age structure results for pools of the Illinois River. The age structure collection included collaboration with the MAM project, the Early Detection of Invasive Carp project, and the Contracted Commercial Fishing Below the Electric Dispersal Barrier project to build a large age structure dataset using lapilli otoliths. These data are critical for determining population age structure, estimating growth, and parameterizing stock assessment models, such as catch-at-age models.

Results from 2021 to 2024 collections were updated with 2025 data. Age structure collections have been associated with the MAM project since 2023, and methods for age structure collections during 2021 to

2022 can be found in the 2022 Demographics ISR (Project: Invasive Carp Demographics). Laboratory age data have been shared with the MRWG to be incorporated into the overall MRWG database. This data will be used by the MRWG Modeling Work Group as important inputs for SCAA models recommended by the Quantitative Fisheries Center at Michigan State University.

In 2025, 795 invasive carp (785 Silver Carp) were captured, and lapilli otolith age structures were removed, primarily during the fall period (N = 784) in the lower six pools of the Illinois River. No invasive carp were captured in Brandon Road or Lockport pools. In total, 326 age samples were collected with electrified gears (i.e., electrified dozer trawl and standard electrofishing), and 469 age samples were collected with fisheries-dependent gears (i.e., gillnet).

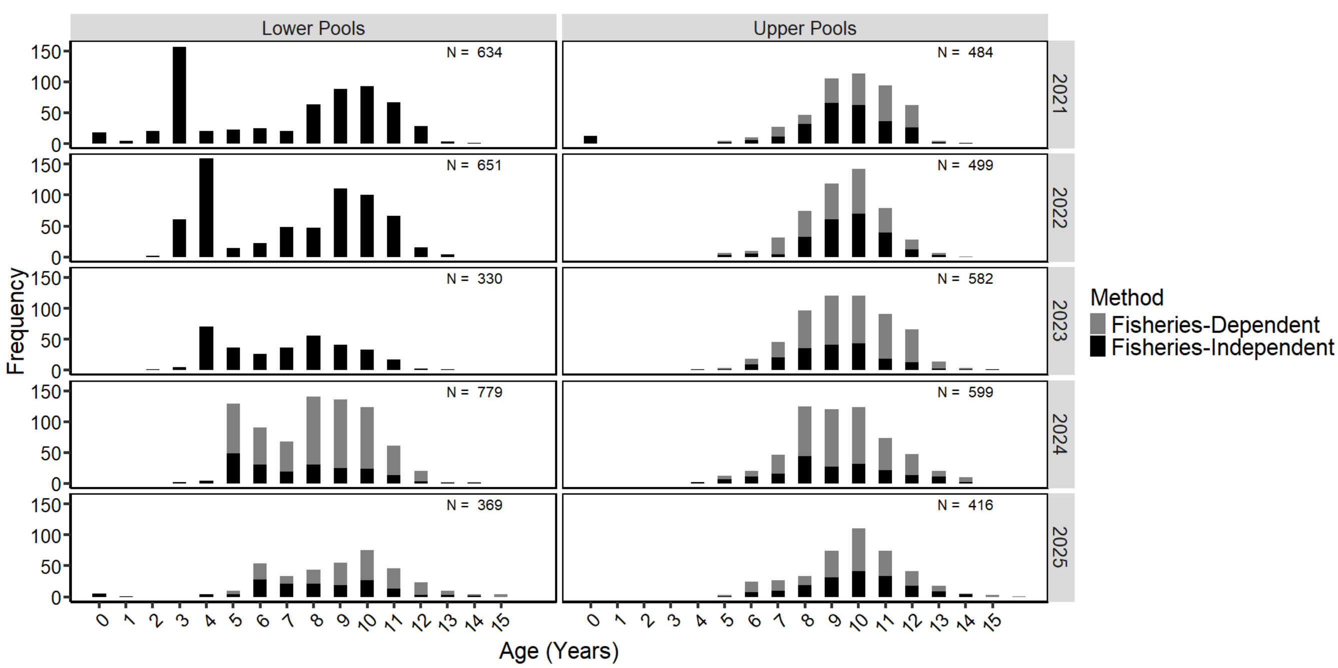
Table 1. *Fall 2025 age collection summary data, including Silver Carp total catch (number fisheries-independent, number fisheries-dependent), Bighead Carp total catch (number fisheries-independent, number fisheries-dependent), total length (TL) range, and age (years) range of invasive carp captured.*

Pool	Silver Carp (#)	Silver Carp (#)	Bighead Carp (#)	Bighead Carp (#)	TL Range (mm)	Age Range (years)
-	**Independent**	**Dependent**	**Independent**	**Dependent**	-	-
Dresden Island	15	0	0	0	654-967	6-14
Marseilles	66	48	1	1	667-1191	6-16
Starved Rock	93	194	0	5	580-852	5-16
Peoria	80	218	0	3	130-901	0-15
La Grange	46	0	0	0	545-809	4-14
Alton	25	0	0	0	556-705	5-13

Age-frequency histograms provided insights into recruitment patterns and the relationship between age and upstream movement. Although young, immature fish (< age-5) were common throughout the years in the lower three pools, these age classes were largely unrepresented in the upper pools, with the exception being 13 age-0 fish captured in Starved Rock Pool in 2021. Age structure of older fish (> age-5) was similar between lower and upper pools (Figure 1). Strong 2018- and 2019-year classes were observed in the lower pools, which were age-6 and -7 in 2025 (Figure 1). Studies have documented a large 2019 cohort in the Mississippi and Missouri river basins, which could be the source of the cohort identified through our work (MICRA 2023). These two young cohorts were observed in Alton, LaGrange, and Peoria pools, but have yet to disperse to the upper pools in appreciable numbers. However, during 2025, we encountered a high proportion of age-6 fish in the Peoria Pool, which is immediately downstream of Starved Rock Lock and Dam, increasing the likelihood that they will start contributing to populations in the upper pools. Additionally, age structure in the lower pools began to trend toward younger ages in 2023 compared to 2021 and 2022. This could indicate that the large 2018 and 2019 cohorts observed are displacing older fish in the lower pools to distribute upstream, while the upper pools continue to maintain a generally older, migrant population (Figure 1).

Fishery-dependent and fishery-independent age data provide complementary insights for stock assessment – dependent sources offer extensive, cost-effective coverage but are biased toward harvested sizes and often miss early life stages critical for detecting recruitment patterns, whereas independent surveys deliver unbiased population structure, including juveniles, at higher cost and logistical complexity. The fisheries-dependent age structure appears similar to the fisheries-independent collections in the upper pools, providing confidence that our fisheries-independent sampling is describing the same portion of the population that is being targeted for removal (Figure 1). However, the lower pools appear to have a discrepancy between fisheries-independent and fisheries-dependent age and length structure, with fisheries-dependent collections being skewed toward larger and older fish (Figures 1). This could mean that our fisheries-independent sampling is biased toward smaller size classes, or that commercial catch is biased toward larger size classes. As stated, commercial fisheries generally target larger size classes; therefore, we presume that the discrepancy may indicate that either commercial fishers are not using mesh sizes that adequately exploit the dominant length modes in the population, or that our fisheries-dependent age structure collection is not from a representative sample of the entirety of the commercial catch in the lower pools.

Figure 1. *Pool-specific (Lower pools - Alton, La Grange, and Peoria* pools; *Upper pools - Starved Rock, Marseilles, and Dresden Island* pools) *Silver Carp age frequency data in the lower six pools of the Illinois River. Fisheries-independent samples collected during fall 2021 through 2025 using the electrified dozer trawl and standard electrofishing are indicated in black, and fisheries-dependent age structures collected during fall 2021 through 2025 are indicated in gray.*



RECOMMENDATIONS

Biological systems are inherently complex and respond unpredictably (Coulter et al. 2018). Collections of high-quality demographic data enable managers to understand population responses to harvest, thus providing tools to inform management and control efforts. Herein, we described results from years of fisheries-independent age structure collections and recently increased fisheries-dependent collections. We recommend continued monitoring through fisheries-independent and fisheries-dependent age structure collections to inform demographic information of Silver Carp populations in the Illinois River. Demographic rates provide important information to evaluate Silver Carp effects on native species, trigger response actions (e.g., contingency plan), evaluate control efforts, and explore alternative management and harvest scenarios using model-based tools. Our continued collaboration with the MAM and Early Detection of Invasive Carp projects to provide efficient, high-quality fisheries-independent data and the Contracted Commercial Fishing Below the Electric Dispersal Barrier project to provide fisheries-dependent age structure collections is essential for modeling efforts. We also recommend continued coordination with MRWG workgroups to address monitoring objectives, increase efficient demographic data collections, and provide high-quality data to support ICRCC and MRWG needs.

Finally, in subsequent years, we will adapt fisheries-dependent age structure collection methods in the lower pools to ensure a random sample from several commercial fishers over time. We suspect that discrepancies found between age structure collection methods could be size bias from commercial fishers or a bias from low sample size and deriving most age structure collections from a small number of fishers. To ensure the accuracy of age structure estimates, we will work with the commercial fishers in the lower pools to improve fisheries-dependent age structure collections and provide a representative age structure of the commercial catch in those pools.

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MULTI-AGENCY MONITORING OF THE ILLINOIS RIVER FOR DECISION MAKING

Participating Agencies: ILDNR, INHS (co-leads); USACE – Chicago District (field support)

MRWG Work Group: Monitoring

Pools Involved: Lockport, Brandon Road, Dresden Island (includes a portion of the Kankakee River), Marseilles, Starved Rock (includes a portion of the Fox River), Peoria, La Grange, Alton pools of the Illinois River below the EDBS (Figure 1).

INTRODUCTION AND NEED

Detection and monitoring populations of invasive carp (Bighead Carp, Black Carp, Grass Carp, and Silver Carp) in pools below the EDBS are pertinent to understanding their upstream progression and minimizing the risk of establishment above the EDBS. Surveillance is particularly important in pools directly upstream for each invasive carp species known expanse: Bighead Carp and Silver Carp are within Dresden Island Pool, Grass Carp is within the CAWS, and Black Carp is within Peoria Pool. Extensive monitoring also provides managers with the ability to evaluate the impacts of management actions (e.g., contracted removal) and collect data to assist other projects (e.g., SEICarP). Data collected from a standardized multiple-gear sampling approach has been used to create accurate and comparable relative abundance estimates of specific species and detect the presence of previously unrecorded invasive species (Ickes et al. 2005). A standardized multiple-gear approach was used here to create a comprehensive dataset that provided an understanding of the current geographic range of invasive carp across all pools downstream of the EDBS, their abundances, and the threat they pose to enter Lake Michigan and to begin evaluating impacts of current invasive carp management.

OBJECTIVES

- Monitor the geographic distribution and abundance of adult and juvenile invasive carp in pools below the EDBS downstream to Alton Pool.
- Provide comparable data capable of detecting spatial and temporal changes in populations of invasive carp and the native fish community throughout the entire IWW between the EDBS and Alton Pool.
- Provide other projects (e.g., Contracted Invasive Carp Removal, Telemetry Monitoring, SEICarP model, etc.) with necessary Silver Carp demographic and fish community data to inform management decisions.

PROJECT HIGHLIGHTS

- In 2025, 180 hours of electrofishing, 1,006 hoop netting net nights, 449 minnow fyke netting net nights, 102 standard fyke netting net nights, and 45 hours of dozer trawling were completed.

- In 2025, 299,176 fish were captured, representing 101 species, 6 hybrid species, and 12 unknown species from family groups (e.g., small individuals from Cyprinidae, Catostomidae, Centrarchidae, etc.)
- Zero invasive carp (large or small) were captured in Lockport and Brandon Road pools in 2025.
- The leading edge of the Bighead Carp and Silver Carp detections retreated from around RM 281 (north of I-55 Bridge within the Dresden Island Pool near the Rock Run Rookery) in 2024 to around RM 263 (a backwater just upstream of Morris, Illinois) in 2025.
- 1,657 small Silver Carp (less than 6 inches or 152.4 mm) were captured during MAM sampling in 2025 in the lower three pools of the Illinois River. This represents a significant increase in spawning over 2023 and 2024, but still a relatively minor spawning pulse in the historical context of longer-term La Grange Pool sampling.

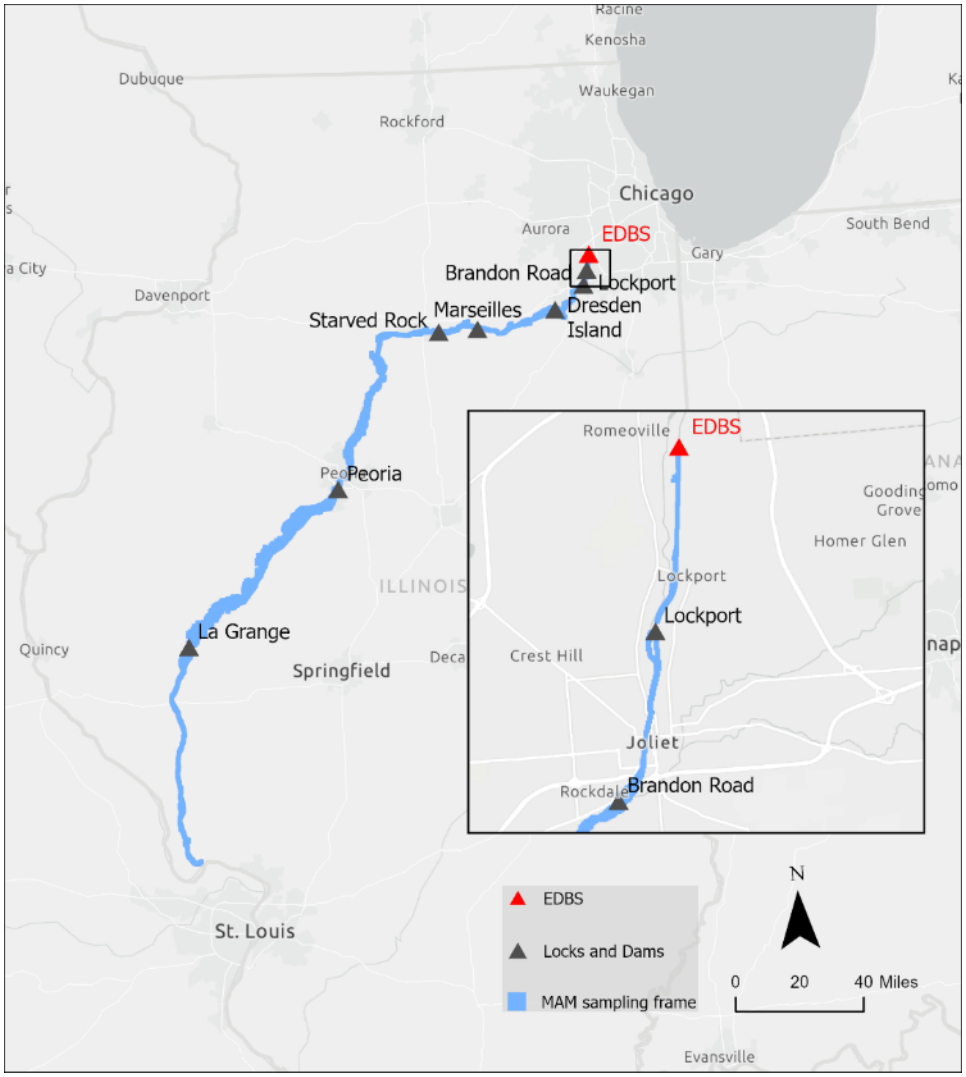
METHODS

The MAM of the Illinois River for Decision Making used the standardized, multi-gear approach developed by the USACE's Upper Mississippi River Restoration Program (Ratcliff et al. 2014) to monitor invasive carp populations in the IWW below the EDBS. This approach utilized daytime boat pulsed-DC electrofishing, standard fyke netting, minnow (hereafter mini) fyke netting, and paired large and small hoop netting in a stratified random approach. Detailed descriptions of gear specifications and sampling protocol can be found in Ratcliff et al. (2014).

Data collected external to the invasive carp MRWG MRP were incorporated due to the standardized nature to create a comprehensive dataset that included all pools of the Illinois River. USGS and INHS provided data outside of the MRWG MRP. Data were provided in the preliminary format to meet the need for timely best science on the condition that neither USGS, INHS, nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the data.

Overall relative abundance indices and pool-specific relative abundance indices within each pool below the EDBS were generated for each invasive carp species within each gear type from the comprehensive dataset. Calculating absolute abundance requires extensive data collection and a probability-based array, which can be extremely costly and time-consuming (Hayes et al. 2007). A relative abundance index is considerably easier, less expensive, and less time-consuming, all while directly relating to the absolute abundance (Pope et al. 2010). The relative abundance index of CPUE was calculated as the number of fish per hour for electrofishing and dozer trawling and the number of fish per net night (24 hours) for fyke net, mini fyke net, and hoop net samples. When drawing comparisons across active gears, CPUE was calculated as the number of fish per 'deployment,' which represents the standard time that gear is typically deployed per sampling protocols (15 minutes for electrofishing and 5 minutes for dozer trawling).

Figure 1. *Map depicting sampling coverage for MAM sampling in 2025.*



RESULTS AND DISCUSSION

Electrofishing Effort and Catch

Total sampling effort included 180 hours of boat electrofishing (hereafter, electrofishing; 722 transects) downstream of the EDBS in 2025. Electrofishing yielded 104,024 individual fish representing 89 species, 4 hybrid species, and small, unknown individuals from 3 family groups (Cyprinidae, Catostomidae, etc.) for a CPUE of 576.3 fish per hour. In 2025, the electrofishing catch was dominated by Gizzard Shad (31.8 percent; n = 33,104), Emerald Shiner (24.8 percent; n = 25,849), Bluegill (8.4 percent; n = 8,717), Spotfin Shiner (4.7 percent, n = 4,844), and Bluntnose Minnow (3.6 percent, n = 3,704). The percentage (1.6 percent) of electrofishing catch comprised of Silver Carp in 2025 was similar to 2024 (1.6 percent) and 2023 (1.3 percent) but much less than 2021 (8.0 percent). A total of 1,688 Silver Carp were captured using electrofishing in 2025, which is similar to the previous 3 years of MAM sampling (2022 = 1,764; 2023 = 1,411; 2024 = 1,231). The overall CPUE of Silver Carp in 2025 was 9.4 per hour, a slight uptick following a previous decreasing trend since 2021 (2021 = 41.6 per hour, 2022 = 10.3 per hour, 2023 = 8.5 per hour, 2024 = 6.8 per hour). Silver Carp CPUE was highest in Peoria Pool, with slightly lower CPUE in the upstream Starved Rock Pool and downstream through the lower Illinois River pools (Figure 1), with only one Grass Carp and no Bighead Carp or Silver Carp captured during electrofishing in the pools nearest to the EDBS (Dresden Island, Brandon Road, and Lockport pools) in 2025. Zero Silver Carp were captured using electrofishing in Dresden Island Pool from 2022 to 2025, but three Silver Carp were captured there in 2021. In 2025, one large (>153 mm [6 inches]) Bighead Carp was captured during electrofishing in Peoria Pool, and 80 Grass Carp were captured from Starved Rock (n = 6), Peoria (n = 38), La Grange (n = 31), and Alton (n = 1) pools. Of the Silver Carp captured in 2025 during electrofishing, among all the pools, 4.9 percent (82 of 1,688) of individuals were small (<153 mm [6 inches]), and the remaining 95.1 percent were large (>153 mm [6 inches]). In comparison, during a high-reproduction year, 79.3 percent (n = 5,740) of Silver Carp captured in 2021 were small.

Mini Fyke Netting Effort and Catch

Total sampling effort included 449 mini fyke nets downstream of the EDBS in 2025. Mini fyke netting yielded 82,682 fish representing 71 species, 0 hybrid species, and small, unknown species from 5 family groups (Cyprinidae, Catostomidae, etc.) for a CPUE of 184.1 fish per net night. Most of the mini fyke catch was comprised of Bluegill (26.4 percent; n = 21,792), Emerald Shiner (24.7 percent; n = 20,440), Bluntnose Minnow (12.6 percent; n = 10,428), Spotfin Shiner (8.1 percent; n = 6,686), and unidentified Cyprinidae (3.6 percent, n = 2,941); 83 Silver Carp were also captured in mini fyke nets in 2025. All 83 Silver Carp were small (<153 mm [6 inches]), of which 5 were captured in Peoria Pool, 11 in La Grange Pool, and 67 in Alton Pool. In comparison to previous Silver Carp catches in mini fyke nets, 338 Silver Carp were captured in 2024, 2 small Silver Carp were captured in 2023, 0 Silver Carp were captured in 2022, and 50,619 Silver Carp were caught in 2021 (predominantly small individuals). One Grass Carp was captured from La Grange Pool, and it was small.

Hoop Netting Effort and Catch

Total sampling effort included 503 hoop nets (1,006 hoop net nights) downstream of the EDBS in 2025. Hoop netting yielded 7,340 fish representing 40 species, 1 hybrid species, and small, unknown species from 1 family group (Cyprinidae, Catostomidae, etc.) for a CPUE of 7.3 fish per net night. Channel Catfish comprised the largest proportion of hoop net catch (54.5 percent; n = 4,001), followed by Smallmouth Buffalo (17.6 percent; n = 1,290), Common Carp (11.2 percent; n = 824), Bluegill (5.9 percent; n = 434), and Freshwater Drum (2.51 percent; n = 184). No invasive carp were captured in Lockport, Brandon Road, Dresden Island, or Marseilles pools during hoop netting in 2025, but invasive carp (only large individuals) were captured in the other downstream pools. Those captures included 23 Silver Carp, 21 Grass Carp, and 3 Bighead Carp. The catch of invasive carp in hoop nets has been similar since 2019.

Fyke Netting Effort and Catch

Total sampling effort included 102 fyke nets downstream of the EDBS in 2025. A total of 4,555 fish representing 42 species, 2 hybrid species, and small unknown individuals from 1 family group (Catostomidae) were captured during fyke netting, with a CPUE of 44.7 fish per net night. Fyke net catch in 2025 was dominated by Bluegill (53.9 percent; n = 2,457), Shortnose Gar (6.4 percent; n = 290), Brown Bullhead (5.1 percent; n = 230), Pumpkinseed (3.9 percent; n = 178), and White Crappie (3.9 percent; n

= 176). Three Bighead Carp, three Grass Carp, and three Silver Carp were captured during fyke netting; none of those individuals were small. All invasive carp captured during fyke netting were collected from Peoria Pool downstream, although no fyke net samples were collected in Lockport, Brandon Road, or Alton pools due to a lack of suitable connected backwater habitat for this gear. Since 2021, higher catch rates of invasive carp have been found in the lower river pools of Peoria and La Grange compared to the upper river.

Dozer Trawl Effort and Catch

Total sampling effort included 45 hours of dozer trawling (540 transects) downstream of the EDBS in 2025. A total of 100,575 fish representing 69 species, 2 hybrid species, and small, unknown individuals from 3 family groups (Catostomidae, Centrarchidae, Cyprinidae, etc.) were captured during dozer trawling, with a CPUE of 2,235.0 fish per hour. Dozer trawl catch in 2025 was dominated by Gizzard Shad (80.0 percent; n = 80,411), Emerald Shiner (6.4 percent; n = 6,408), Silver Carp (6.3 percent; n = 6,345), Threadfin Shad (1.6 percent; n = 1,622), and Smallmouth Buffalo (0.9 percent; n = 944). Eight Bighead Carp, 21 Grass Carp, and 6,345 Silver Carp were captured during dozer trawling. All Bighead Carp and Grass Carp were large individuals. About 39 percent (n = 2,467) of all Silver Carp captured were small (<153 mm [6 inches]), coming from Peoria, La Grange, and Alton pools. Invasive carp were captured as far upstream as Starved Rock Pool and the Fox River, though not further upstream than MAM had detected them in earlier years.

Comparisons of Adult Invasive Carp Catch

Among the two active gears – daytime electrofishing and dozer trawling – CPUE was highest below Marseilles Pool (Figure 2). Mean relative abundance of adult Silver Carp from electrofishing samples showed slight increases in most non-zero pools from 2024 to 2025, with the only exception being Alton Pool (Figure 3). Most of these increases are within the margin of error, except for Peoria Pool, which increases significantly and has been trending up since monitoring began in 2019. Most other pools show longer-term decreases since harvest efforts began in each pool. Silver Carp in the Dresden Island Pool remained undetected for the fourth straight sampling year. Most interannual differences in mean CPUE are likely not statistically significant, but visualizing longer-term trends can give a better sense of the trajectory of these pools' Silver Carp populations. Annual differences in dozer trawl sampling were more variable, but dozer trawl samples confirmed the uptick in Peoria Pool seen in electrofishing samples (Figure 4). Dozer Trawl also detected a large increase in the Fox River tributary, albeit with a large confidence interval. With 3 years of pool-wide relative abundance estimates from dozer trawl, it is more challenging to place annual differences in the context of longer-term variability. Continued dozer trawl sampling should improve its utility as a sentinel of change and provide an important long-term complement to electrofishing. While both gears intend to provide pool-wide estimates of relative abundance, enabled by the statistically robust and stratified-random sampling design of the MAM program, each gear samples slightly different habitats and likely has different catchability characteristics. As with all gears, it remains critical to consider gear-specific context dependencies when evaluating data across these two gear types.

Figure 2. *A comparison of mean (+- 95% CI) CPUE of adult Silver Carp captured using electrofishing and dozer trawling in 2025 among the various pools of the IWW and its tributaries. CPUE is calculated as fish per deployment, where a typical deployment is a 15-minute electrofishing run or 5-minute dozer trawl run. Adult Silver Carp are defined as >= 153mm (6 in) in total length. Empty circles indicate values of zero. Missing circles indicate no sampling.*

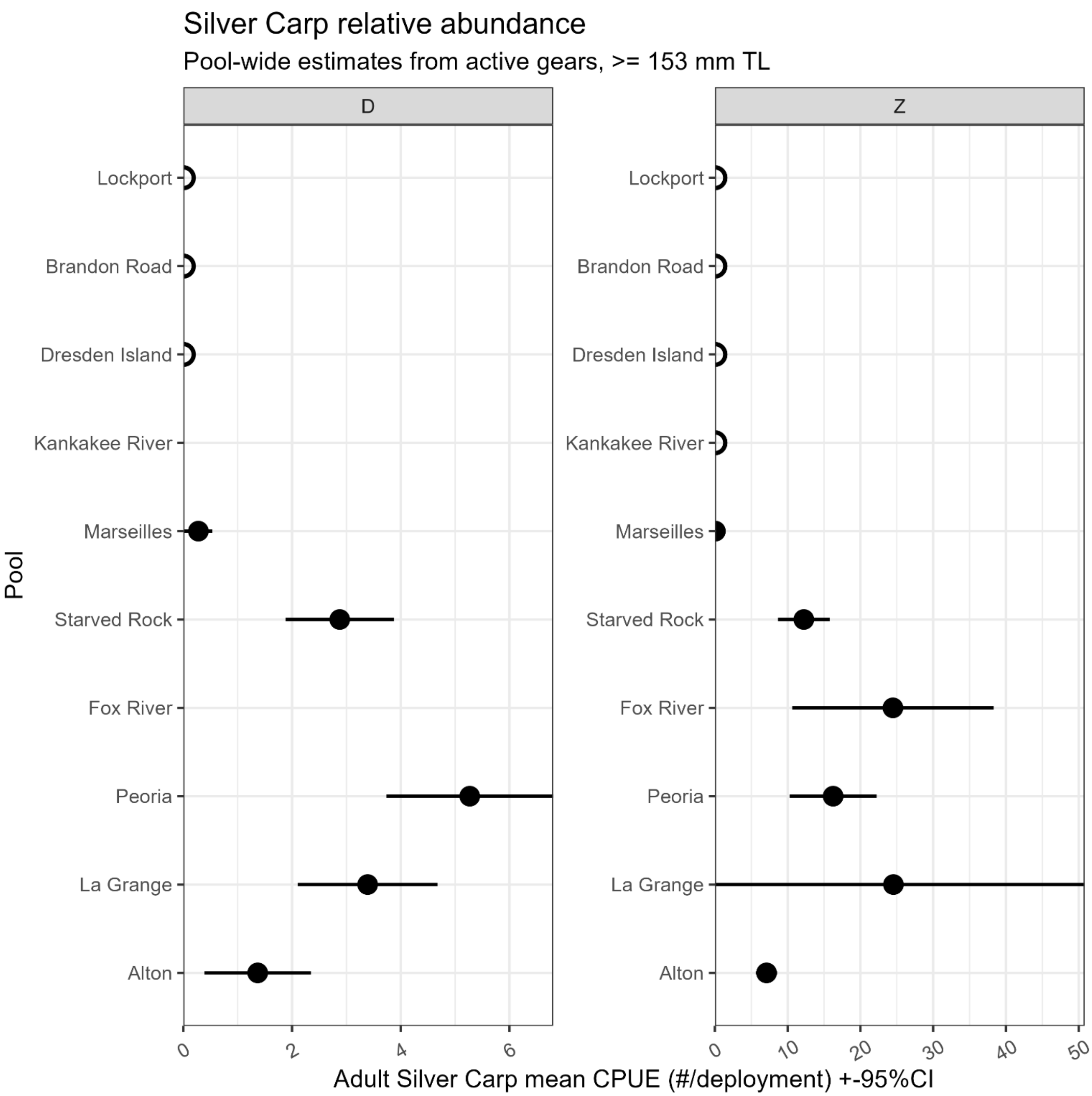


Figure 3. *A comparison of mean (+- 95% CI) CPUE of adult Silver Carp captured using electrofishing among the various pools of the IWW from the inception of the MAM program (2019) through 2025. CPUE is calculated as fish per hour of electrofishing. Adult Silver Carp are defined as >= 153mm (6 in) in total length. Empty circles indicate values of zero.*

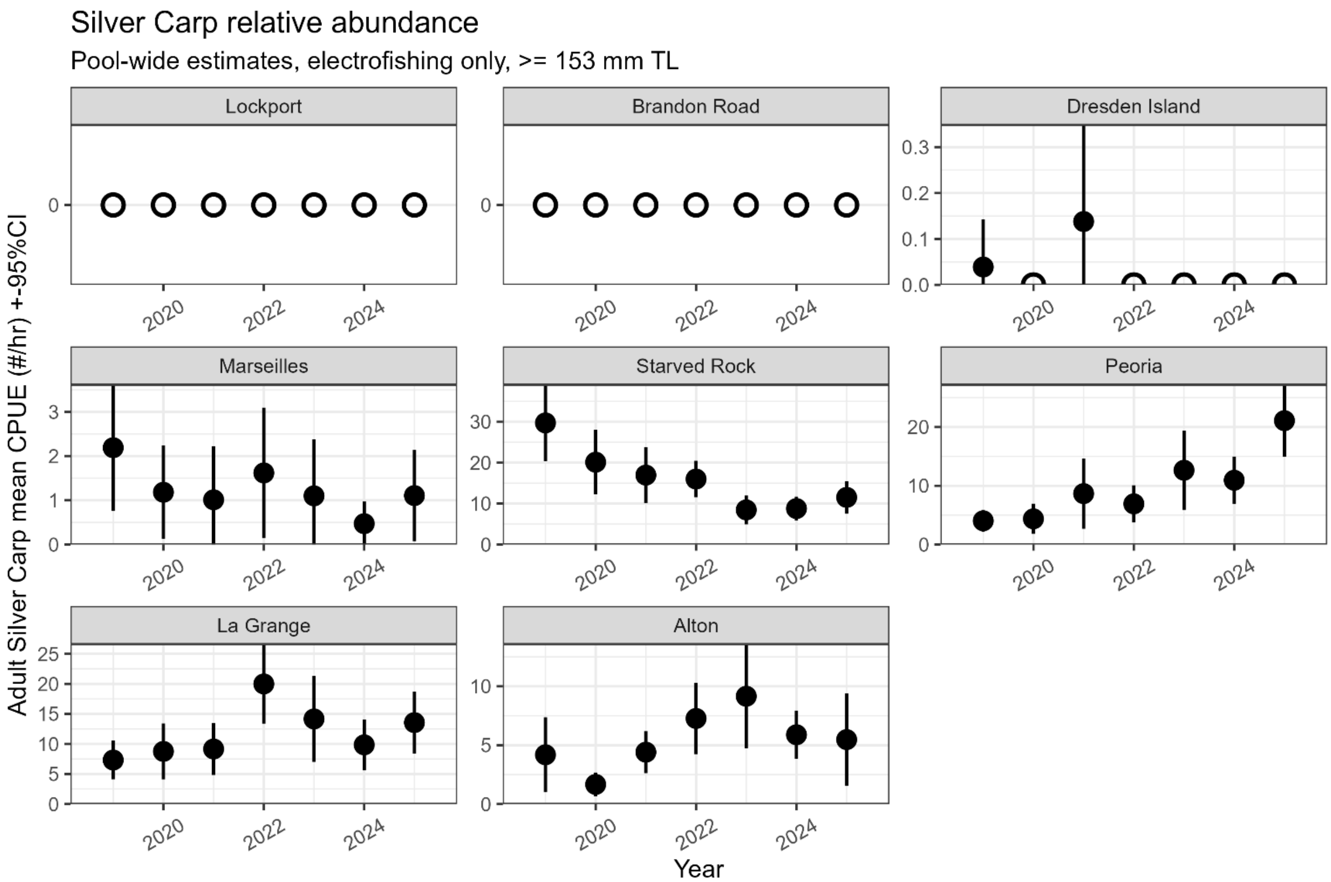
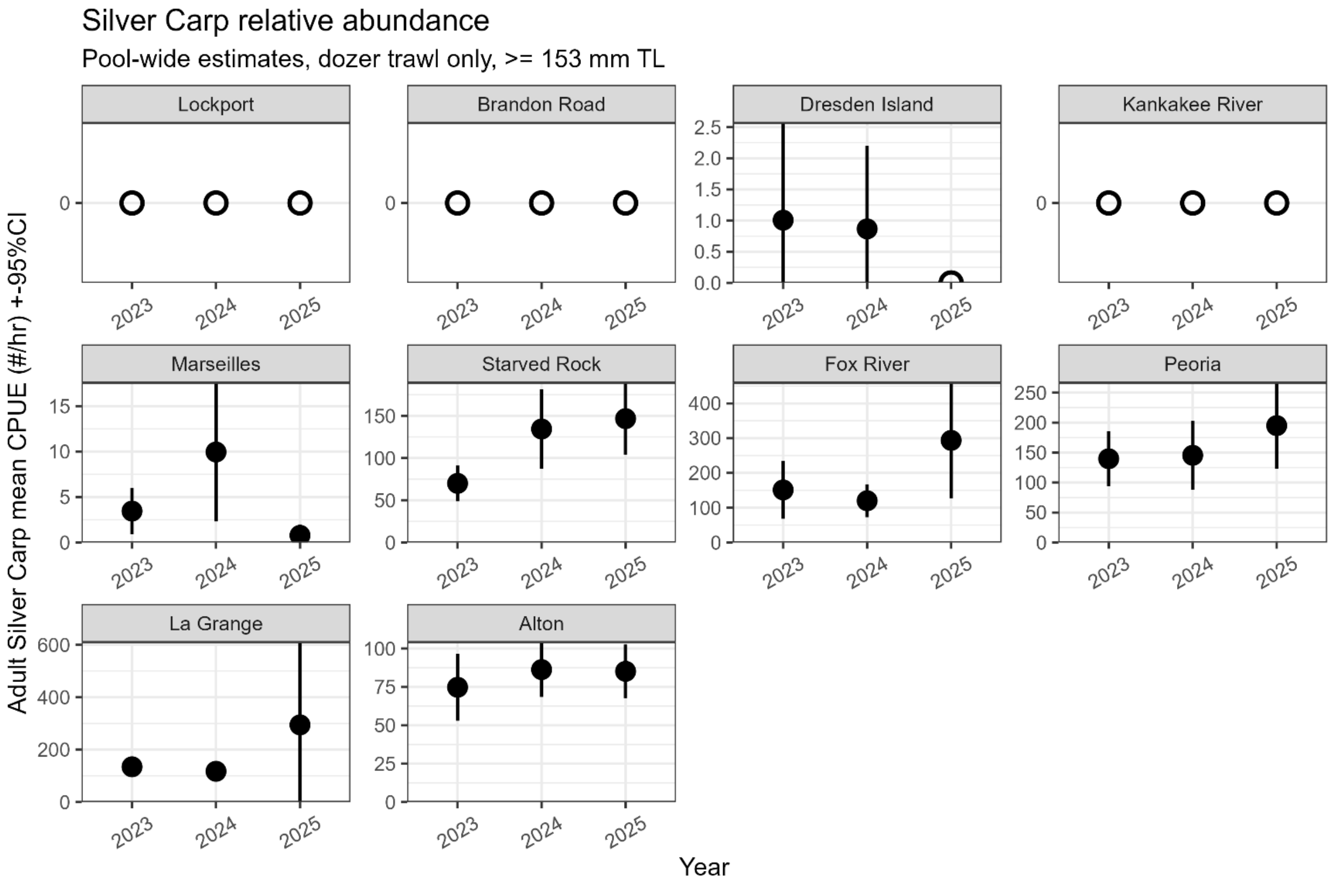


Figure 4. *Overall size structure distribution of Silver Carp captured in all pools of the Illinois River and Fox River tributary. All gear types (electrofishing, electrified dozer trawl, fyke netting, hoop nets, and mini fyke nets) were aggregated together.*



Size Structure

Across gears, Bighead Carp catches were between 370 and 1,010 mm total length (n = 15), Grass Carp catches were between 20 and 1,117 mm (n = 130), and Silver Carp catches were between 10 and 970 mm (n = 7167) in 2025. Mean Silver Carp length was larger in upper river reaches compared to lower river reaches (Figure 5). Size structures of adult Silver Carp in 2025 across the river remained relatively static as compared to 2024 (Figure 6). Juvenile Silver Carp, defined as being <153 mm [6 inches] in total length, were detected in the three lower reaches of the river (Figure 4). These individuals represent a very small portion of the total kernel density distribution of Silver Carp individuals, and they likely represent a minor recruitment pulse as compared to the strong recruitment class of 2021 (Figure 6).

Figure 5. *Frequency of total length in captured Silver Carp individuals less than (left) and greater than or equal to (right) 153 mm [6 inches], a rough cutoff for juveniles and adults, in 2025. Individuals are from all MAM gears.*

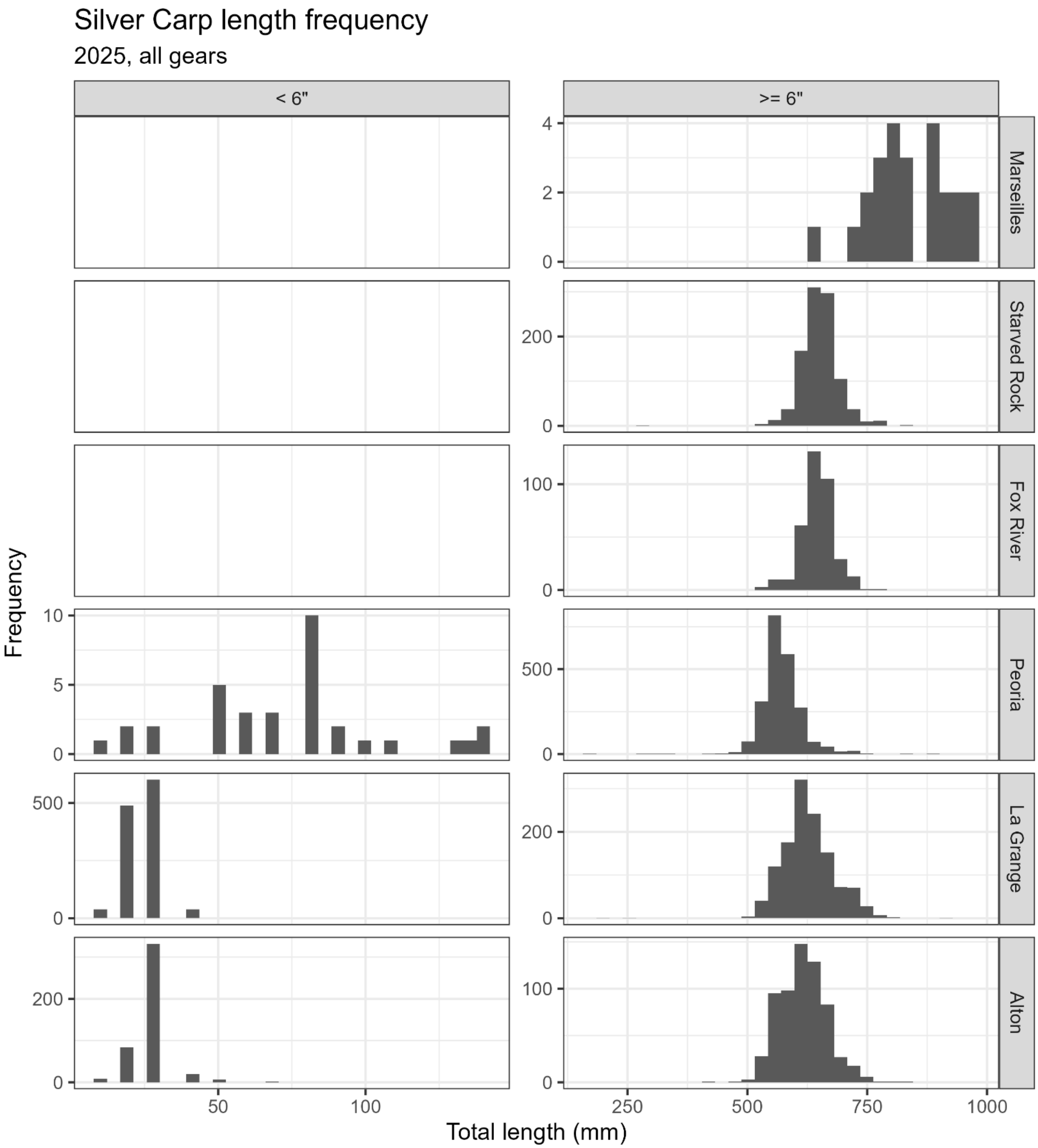
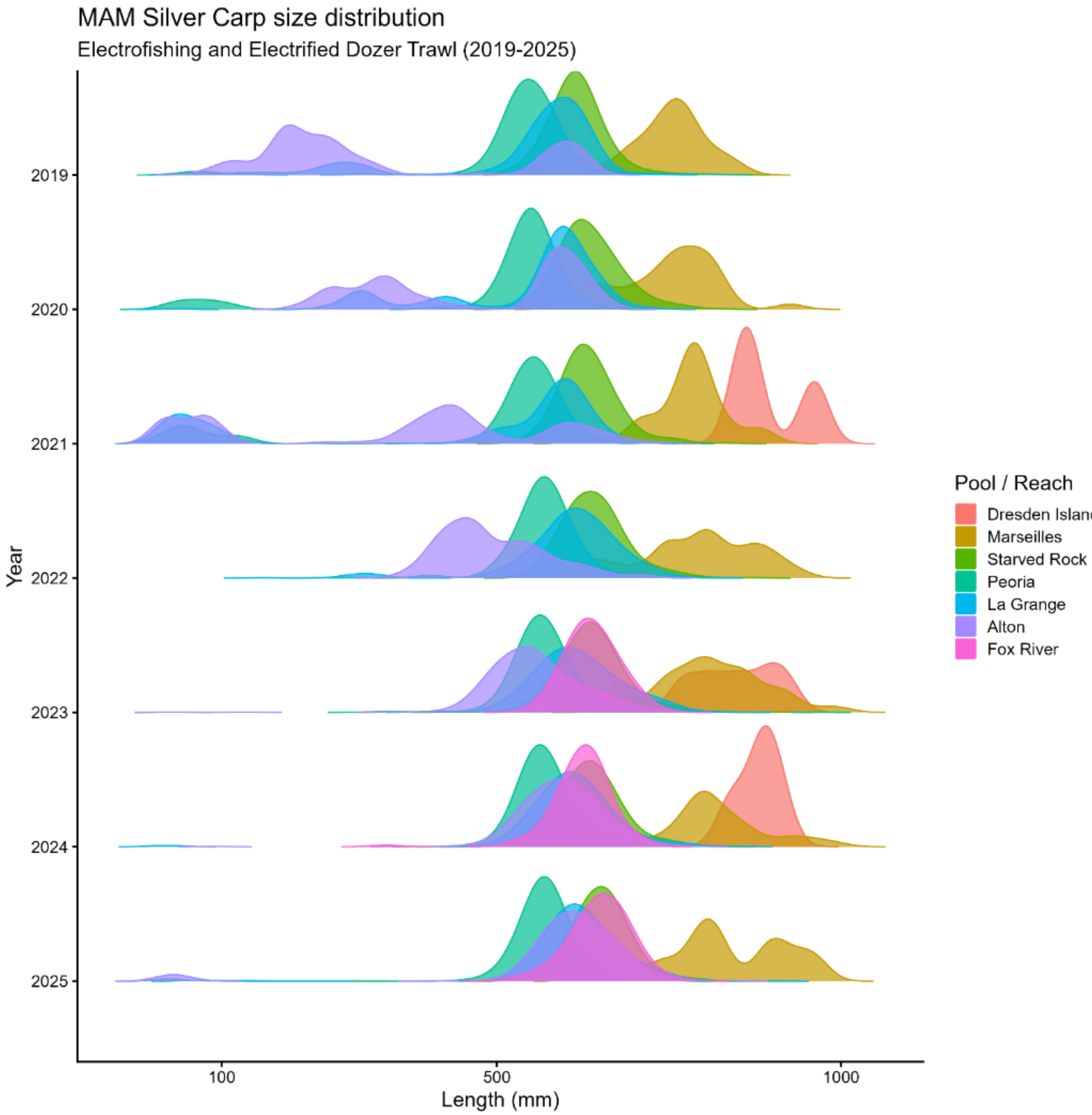


Figure 6. *Kernel density of total length among Silver Carp individuals captured from 2019 to 2025 from both active gears, electrofishing and dozer trawl.*



Adaptive Monitoring

Monitoring the leading edge of the invasion is critical for assessing the spread of the population and potential pressure on the EDBS. Low relative abundances in the Dresden Island Pool likely approach the detection sensitivity thresholds of our monitoring gears, making precise estimates of relative abundance difficult to calculate. The MAM programs' strength lies in its stratified-random sampling design that enables robust estimators of relative abundance, useful for spatial and temporal comparison at the pool-wide scale, and changes to that sampling design compromise long-term trend monitoring. However, carefully adapting the program to allocate some targeted sampling effort at the invasion front could help boost detection frequencies and thereby increase precision around estimates of relative abundance locally. This added precision may be critical for obtaining the statistical power to detect relatively small population changes, which have outsized importance at the leading edge of the invasion. While targeted sampling adds little value to the program's pool-wide metrics, it may add utility for characterizing areas of highest priority. Strategically allocating some sampling effort while retaining the broader stratified-random sampling framework – an act of 'Adaptive Monitoring' – can help achieve dual goals: maintaining the program's ability to monitor long-term, pool-wide trends in invasive carp populations while flexibly answering the most pressing, management-relevant questions at smaller spatial and temporal scales.

To guide this targeted sampling, we integrated historical sampling data from MAM and other sources of sampling near the invasion front. These historical detection data, along with anecdotal evidence from field crews, informed the creation of a targeted sampling grid where invasive carp detections may be most likely (Figure 7). This 'Carp Likely' stratum of the river will receive continued monitoring, offering an adaptation of the MAM program to maintain its core sampling design (and importantly, backwards compatibility with data already collected) while attempting to boost precision in areas where small changes have outsized management implications. In 2024 and 2025, we randomly selected 63 sites for electrofishing within this 'Carp Likely' grid near the confluence of the Dresden Island Pool and the Kankakee River (Figure 8). No invasive carp were captured in these 63 'Carp Likely' samples in 2024, though carp were observed in the water visually at 2 out of 63 sites, indicating that imperfect catchability may be hindering detection rates. In 2025, 63 more random sites were selected, and this time, electrofishing power parameters were increased to improve catchability, but still no captures were made. Targeted effort is planned to continue within this supplemental sampling grid in 2026.

Figure 7. *The Dresden Island Pool and Kankakee River confluence area where adaptive monitoring took place in 2025 to try and improve precision around Silver Carp relative abundance estimates at the upstream leading edge of the invasion. Circles indicate historical Silver Carp detection data from partner agencies (red = detection, white = non-detection). White squares indicate the newly established grid of possible sampling sites.*

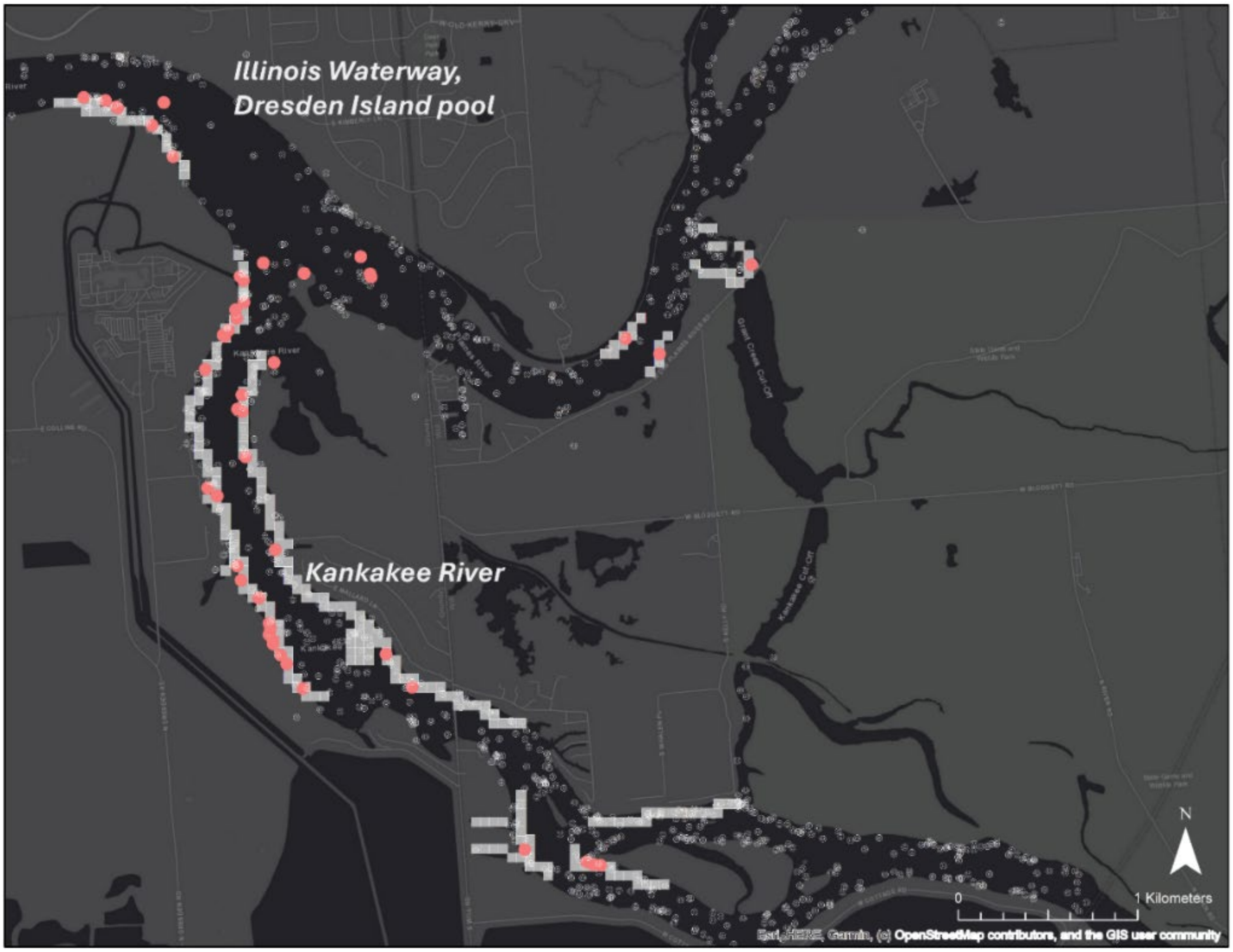
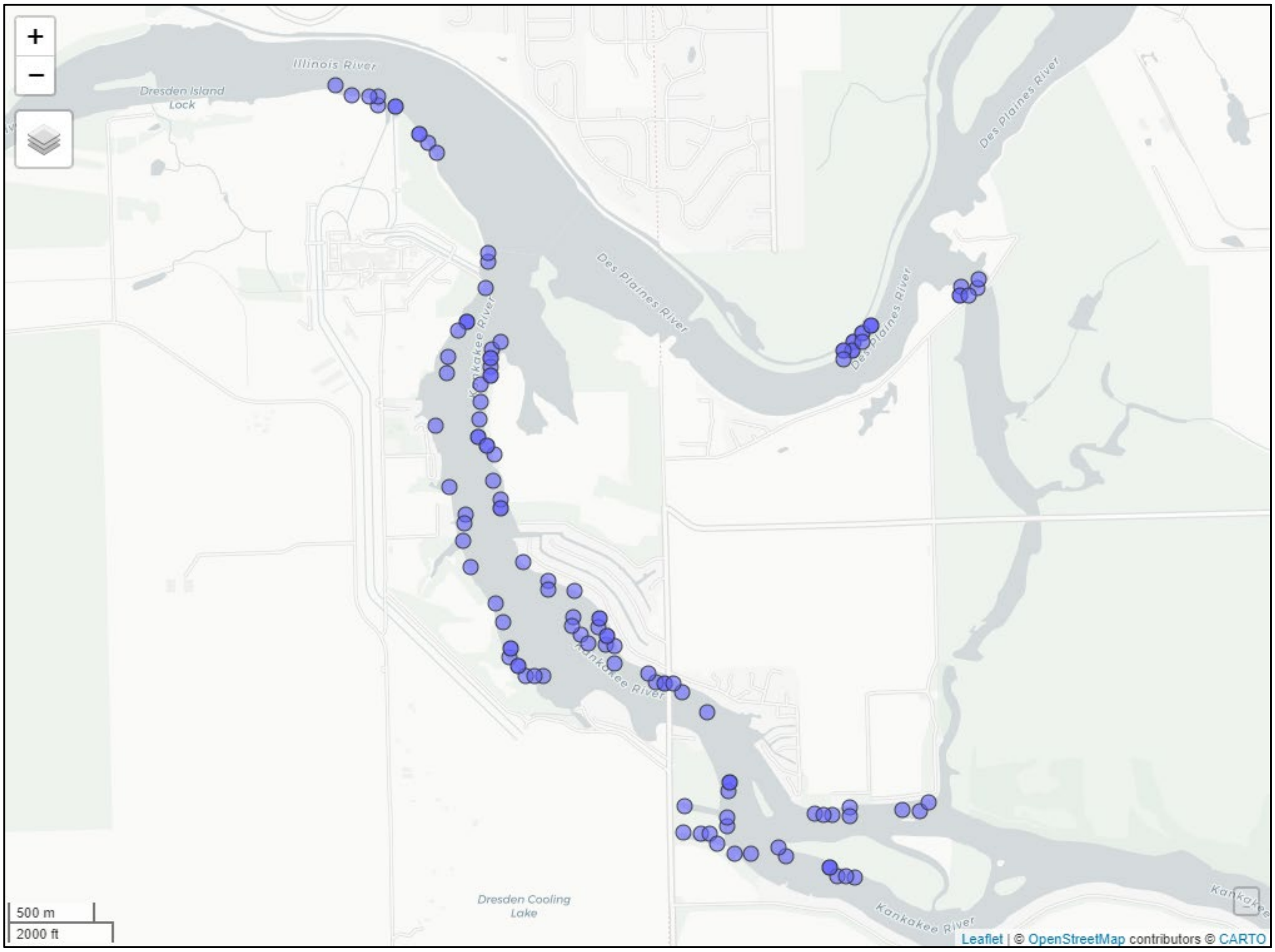


Figure 8. *Electrofishing site locations sampled as part of the 'Carp Likely' supplemental sampling grid at the Dresden Island Pool and Kankakee River confluence area. Zero invasive carp were captured across these 63 samples.*



RECOMMENDATIONS

Implementing a standardized multi-gear sampling approach has created a comparable and comprehensive picture of invasive carp dynamics throughout the entire IWW, allowing for a holistic assessment. Standardization continues to allow monitoring projects outside of the MRP to be incorporated (e.g., dozer trawl from USFWS this year), amplifying the robustness of the picture of invasive carp status and detections in the IWW. The leading edge of invasive carp within the IWW does not appear to have encroached closer to the EDBS, with Bighead Carp and Silver Carp remaining in Dresden Island Pool. Despite no invasive carp detections in 2024 or 2025, a pilot study that combines targeted and random sampling approaches will continue in 2026 to gain further precision on mean CPUE estimates of invasive carp in Dresden Island Pool, at the leading edge of the invasion, to allow greater statistical power in detecting relatively small interannual changes to CPUE. One Black Carp was detected during Black Carp monitoring in the Alton Pool. The numbers and catch rates of small invasive carp (less than 6 inches) were less than what was found in 2024, and far less than what was found in 2021, the last recorded large spawning event, indicating that 2025 may have been a poor reproductive year, with no major spawning event. The invasive carp caught smaller than 6 inches (n = 1,662) were caught in the lower three pools, with the vast majority (n = 1,624) caught in the lowest two pools. We recommend continued sampling below the EDBS using a multi-gear approach that includes electrofishing, fyke netting, hoop netting, mini fyke netting, and dozer trawling. Minimally, the same level of effort should occur, and future effort levels should follow statistical power analyses when reasonable. Finally, data collected from projects outside using the same standardized methods of the MRP should continue to be incorporated into this dataset when allowed and appropriate. The inclusion of these data allows for formulating the most comprehensive picture of invasive carp expansion and response within the IWW

There is growing evidence that the monitoring program can be a tool used to assess the performance of invasive carp harvest as a management tool. Integrating fisheries-dependent and -independent data sources can derive management insights not easily inferred from either data stream alone. For example, comparison of 2019 to 2025 data from both the monitoring and removal work groups, we see pool-specific mismatches in the size distributions of harvested fish (fisheries-dependent data) and the overall population (fisheries-independent data; Figure 9). This may point to harvest gear-selectivity inefficiencies that could be holding back the potential of harvest as a management tool in pools with smaller Silver Carp. Furthermore, mean length-at-age data from the Monitoring Work Group paired with fisheries-dependent size distribution data reveal that in all pools, 95 percent of harvested fish are likely age 5+ (Figure 10), suggesting that harvest is impacting only a small proportion of the overall age structure of the invasive carp population, and that fisheries-dependent signals of population growth from recruitment may exhibit lags of several years. More and higher-quality fisheries-dependent effort, length, and age data are recommended for collection in 2026 to further investigate these insights.

Figure 9. *Length frequency of adult Silver Carp from three pools of the Illinois River across two data sources – fisheries-dependent (harvest) and fisheries-independent (MAM) – reveal a mismatch in the size distributions of fish being harvested vs. available fish.*

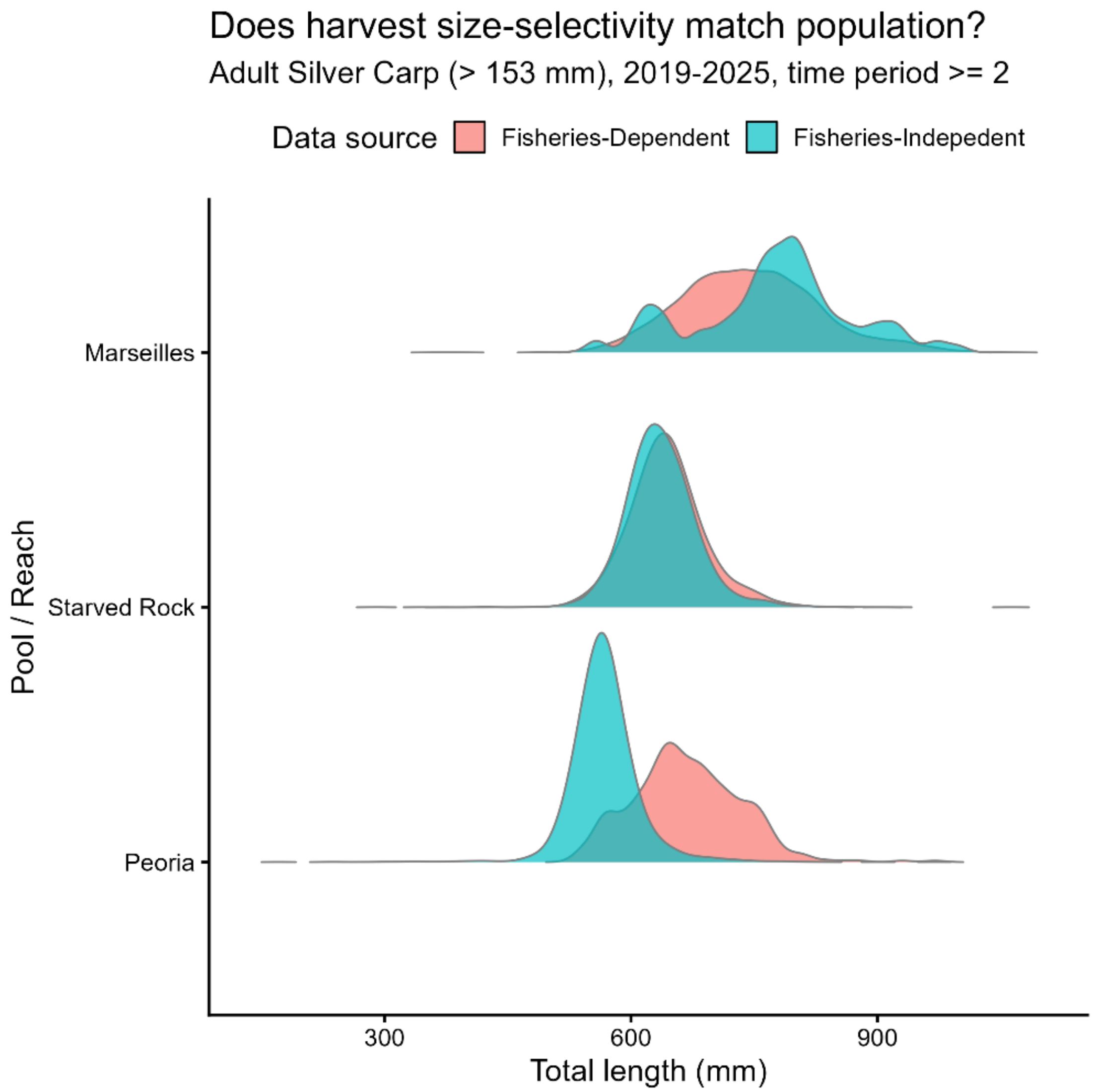
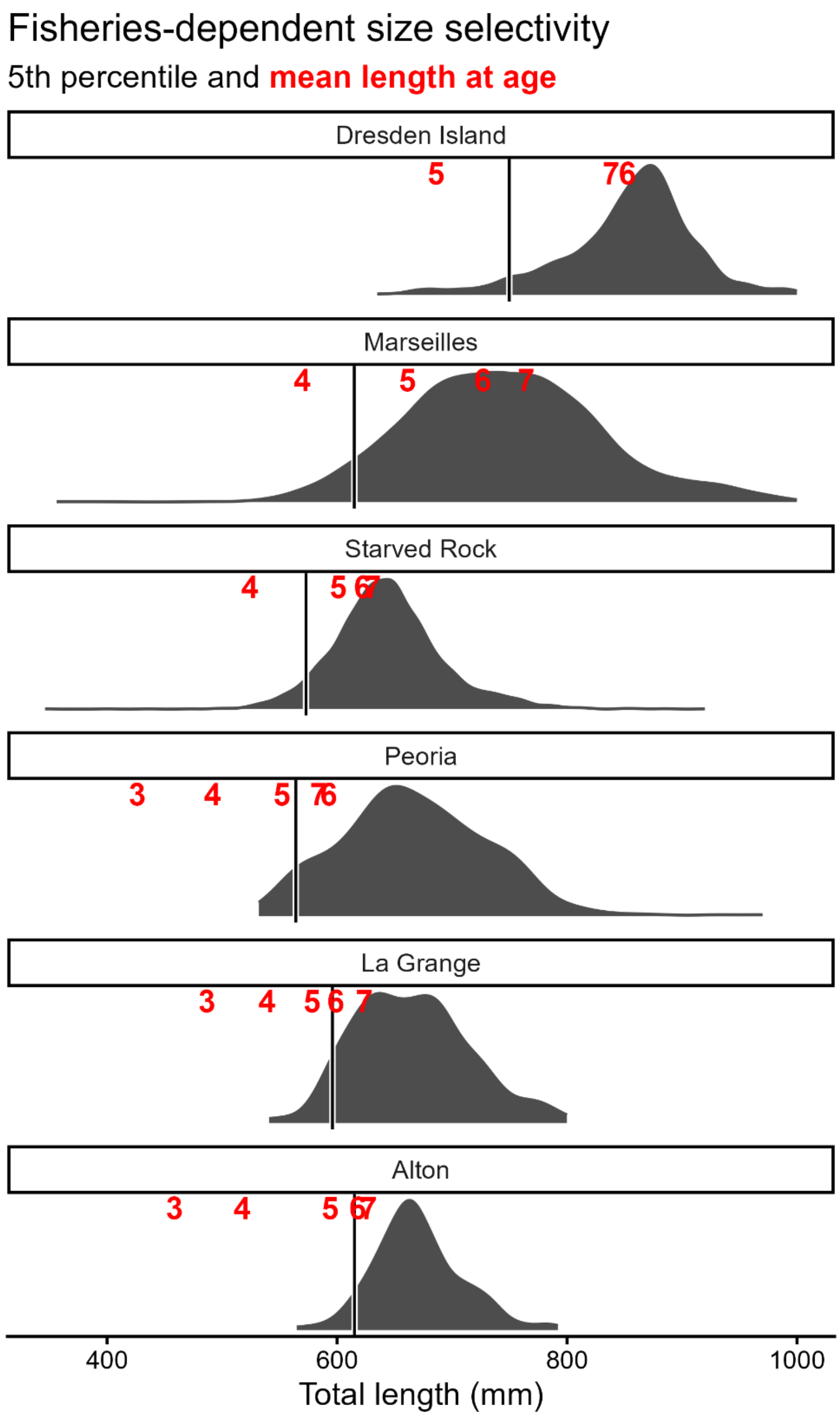


Figure 10. *Length frequency distributions of adult Silver Carp from fisheries-dependent data, with mean length-at-age for each pool indicated by age numbers (red) at their respective mean length values. Black lines indicate 5th percentile of each size distribution.*



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HYDROACOUSTICS WORK GROUP PROJECTS

- Invasive Carp Stock Assessment in the Illinois River
- Illinois Waterway Hydroacoustics

INVASIVE CARP STOCK ASSESSMENT IN THE ILLINOIS RIVER

Participating Agencies: SIU (lead); additional assistance from/collaboration with ILDNR, USACE, USGS, INHS, USFWS; David Coulter, Cameron Davis, Jim Garvey, Tanya Fendler, Joseph Mruzek (SIU)

MRWG Work Group: Hydroacoustics

Pools Involved: Dresden Island, Marseilles, Starved Rock, Peoria, La Grange, Alton

INTRODUCTION AND NEED

Management goals for bigheaded carp in the Illinois River focus on limiting upstream dispersal through monitoring, assessing movement barriers, and reducing abundance through contracted harvest. Bigheaded carp spatial distributions vary seasonally and annually; quantifying how spatial distributions change through time will help target contracted harvest to maximize removal efforts and minimize costs. Additionally, long-term information on bigheaded carp population characteristics, distributions, and movements, especially along the population front in the upper Illinois River, can provide data to parameterize population models. These models simulate the effects of various management actions (e.g., harvest scenarios and locations of enhanced deterrent technologies) to determine what options are most likely to achieve management goals.

Since 2012, SIU has been monitoring bigheaded carp densities via hydroacoustic sampling throughout the Illinois River (Alton to Dresden Island pools). This monitoring continues to be a useful metric to evaluate long-term changes in bigheaded carp abundance. By monitoring densities across multiple years throughout the river, long-term trends can be identified and related to environmental conditions, reproduction, or management actions. Broad-scale density estimates also help inform management actions in the upper river near the invasion front. It is currently unclear the extent to which bigheaded carp in the Illinois River exhibit density-dependent effects on reproduction, condition, growth, and movement. Collecting long-term data, particularly density and movement data, will also help quantify these patterns that will better inform management decisions, ensure sufficient surveillance efforts, and improve models predicting population response to management actions.

While annual monitoring provides a snapshot to document long-term trends in bigheaded carp abundance, seasonal surveys can be used to help improve removal by identifying and directing harvest efforts to high-density locations. Dresden Island Pool represents the current population front for the adult bigheaded carp invasion in the Illinois River, while Marseilles Pool is the most upstream pool where YOY have been found. Frequent hydroacoustic surveys of bigheaded carp densities in these pools identify locations where bigheaded carp aggregate to inform harvest efforts.

The SEICarP model of bigheaded carp in the Illinois River assesses how bigheaded carp populations respond to various management actions (e.g., location and intensity of harvest; location and effectiveness of deterrent technologies). This model draws on a variety of data, including bigheaded carp densities and movement data. Collaborations between MRWG Modeling and Telemetry Work Groups have identified data needs, primarily with a better understanding of inter-pool movements. To this end, model support consisted of maintaining the Illinois River stationary telemetry array to quantify inter-pool movements and deployment of additional acoustic telemetry tags in bigheaded carp (numbers set based on Telemetry Work Group determinations). Movement information from telemetry efforts is also critical for maintaining sufficient surveillance efforts to detect potential changes in bigheaded carp spatial distributions (e.g., upstream movements), especially in supporting surveillance efforts with real-time acoustic telemetry receivers.

OBJECTIVES

- Quantify invasive carp densities every other month in Dresden Island and Marseilles pools using mobile hydroacoustic surveys to pinpoint high-density areas that can be targeted during contracted removal.
- Conduct hydroacoustic surveys at standardized sites from Alton to Dresden Island pools during the fall to assess long-term density trends.
- Maintain SIU's extensive acoustic telemetry array currently in place in the entire Illinois River, used to collect movement information and maintain adult surveillance efforts. Share collected data with Telemetry and Modeling Work Groups.

PROJECT HIGHLIGHTS

- Repeated hydroacoustic surveys in Dresden Island and Marseilles pools identified areas of high bigheaded carp density and showed how these locations changed over time. These data helped direct contracted removal efforts.
- The 14th year of standardized monitoring of bigheaded carp densities was completed in 2025 from Alton to Dresden Island pools. This data allow for long-term assessments and comparisons of density trends across space and through time.
- Maintaining the stationary acoustic telemetry receiver array throughout the Illinois River ensured sufficient surveillance efforts occurred to detect adult movements among pools and toward the invasion front.

METHODS

Hydroacoustic Surveys – Bi-monthly Heat Maps and Fall Standardized Surveys

Repeated hydroacoustic surveys in the upper Illinois River (Dresden Island and Marseilles pools) were completed in April 2025. Final surveys in these pools and throughout other Illinois River pools (Starved Rock through Alton pools) were completed in the fall of 2025. These full river scans are conducted at 49 predetermined transects, covering a variety of river microhabitats. All hydroacoustic sampling methods, designs, and analyses followed those outlined in MacNamara et al. (2016). Surveys were completed before the fall Unified Method event in Dresden Island Pool to inform removal about density hotspots prior to harvest and to assess the impacts of removal on the population.

Telemetry – Adult Movements

Utilizing an array of 51 Vemco 69-kilohertz stationary receivers maintained by SIU (Abeln 2018), as well as stationary receivers maintained by partner agencies (USGS, USACE, USFWS, and MDC), the movements of Silver Carp and Bighead Carp implanted with internal transmitters (Vemco V16 transmitters) were monitored from Alton Pool upstream through Dresden Island Pool. Additional stationary receivers were deployed and maintained by other agencies in the Telemetry Work Group in other locations of the IWW. Additionally, other fish species implanted with 69-kilohertz transmitters by other members of the Telemetry Work Group can be detected by this array. Stationary receivers were downloaded in May and November of 2024, with data initially checked to remove false detections, and uploaded to the USGS FishTracks database. Receivers were downloaded in 2025 and the data has been uploaded to RAFT. The fish passage analysis is in process. Additional acoustic telemetry tags were deployed, n = 161, to replace expiring tags.

RESULTS AND DISCUSSION

Hydroacoustic Surveys – Bi-monthly Heat Maps and Fall Standardized Surveys

Repeated mobile hydroacoustic surveys in Dresden Island and Marseilles pools identified colocations where bigheaded carp aggregated and determined how these locations changed throughout the year. Density maps (Figure 1) were provided to MRWG members, which helped focus contracted harvest efforts. This sampling was conducted every other month from May until November. Mobile hydroacoustic sampling was completed in October 2025 from Alton through Dresden Island pools to inform long-term population monitoring. Data through Fall 2024 have been processed in the upper (Figure 2) and lower (Figure 3) Illinois River. These data show variation in the density of ensonified carp targets across river macrohabitat, with the greatest density in main and side channels (Figure 4). Peoria Pool was additionally surveyed with hydroacoustics four times in March, May, July, and August, similarly finding that carp densities were higher in the backwater and lake habitats relative to the main navigation channel (Figure 5). Processing of these 2025 fall density data is ongoing.

Telemetry – Adult Movements

In 2025, 161 tags were implanted into bigheaded carp in Alton. These additional tags will maintain sufficient adult surveillance efforts (e.g., early detection of movements past real-time receivers). SIU stationary receivers were retrieved and downloaded from Dresden Island Pool through Alton Pool. All detection data downloaded from stationary receivers were screened to remove false fish detections and submitted for inclusion in the USGS-managed FishTracks telemetry database. Dam passages were most common in the lower river pools (Table 1).

Figure 1. *Example heatmap displaying bigheaded carp spatial distributions in the lower portion of Dresden Island Pool sampled in October 2024 with mobile hydroacoustic sampling. Densities were observed using mobile hydroacoustic surveys.*

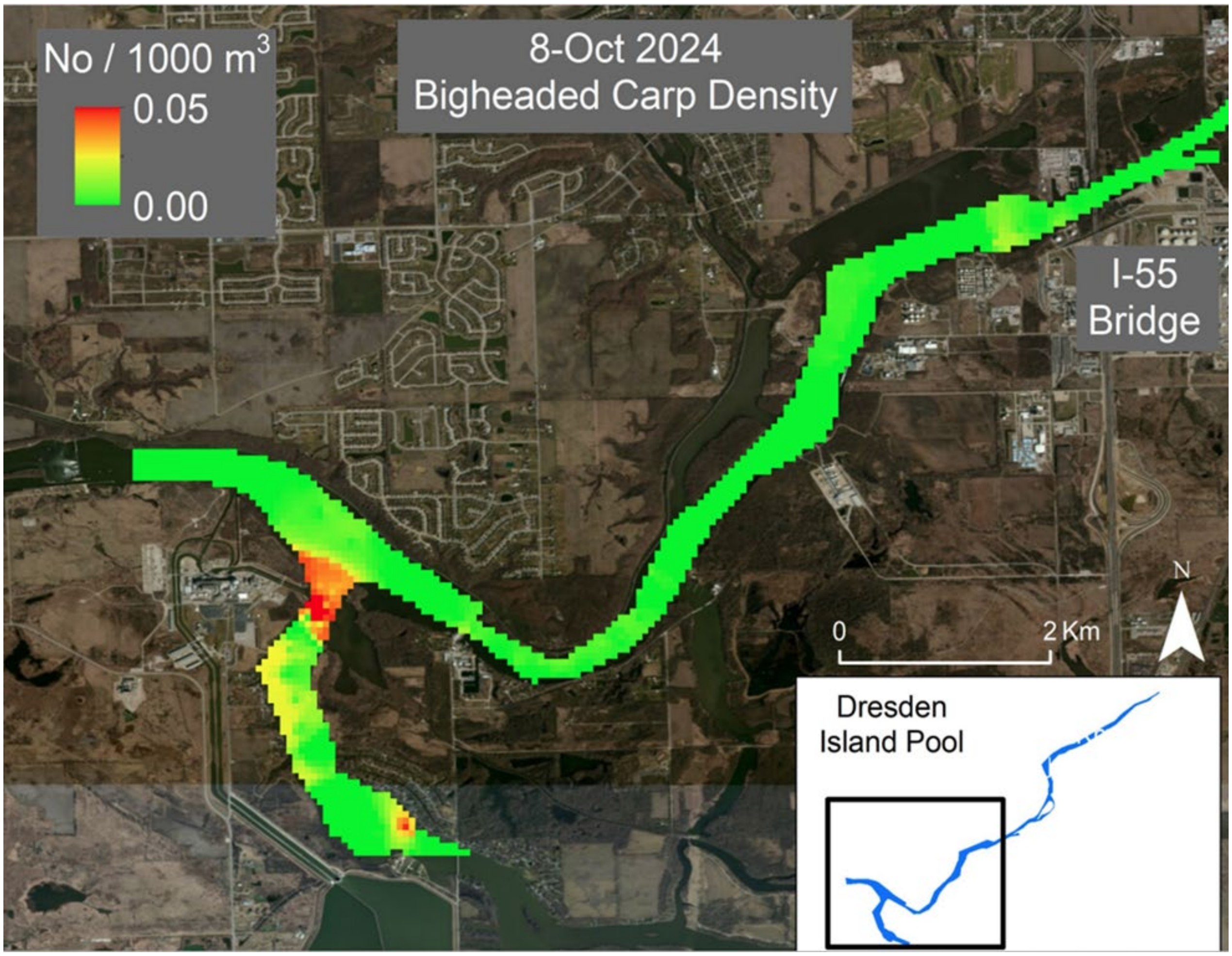


Figure 2. *Densities of bigheaded carp in the upper Illinois River during falls 2012 through 2024 as estimated from standardized hydroacoustic surveys in each pool.*

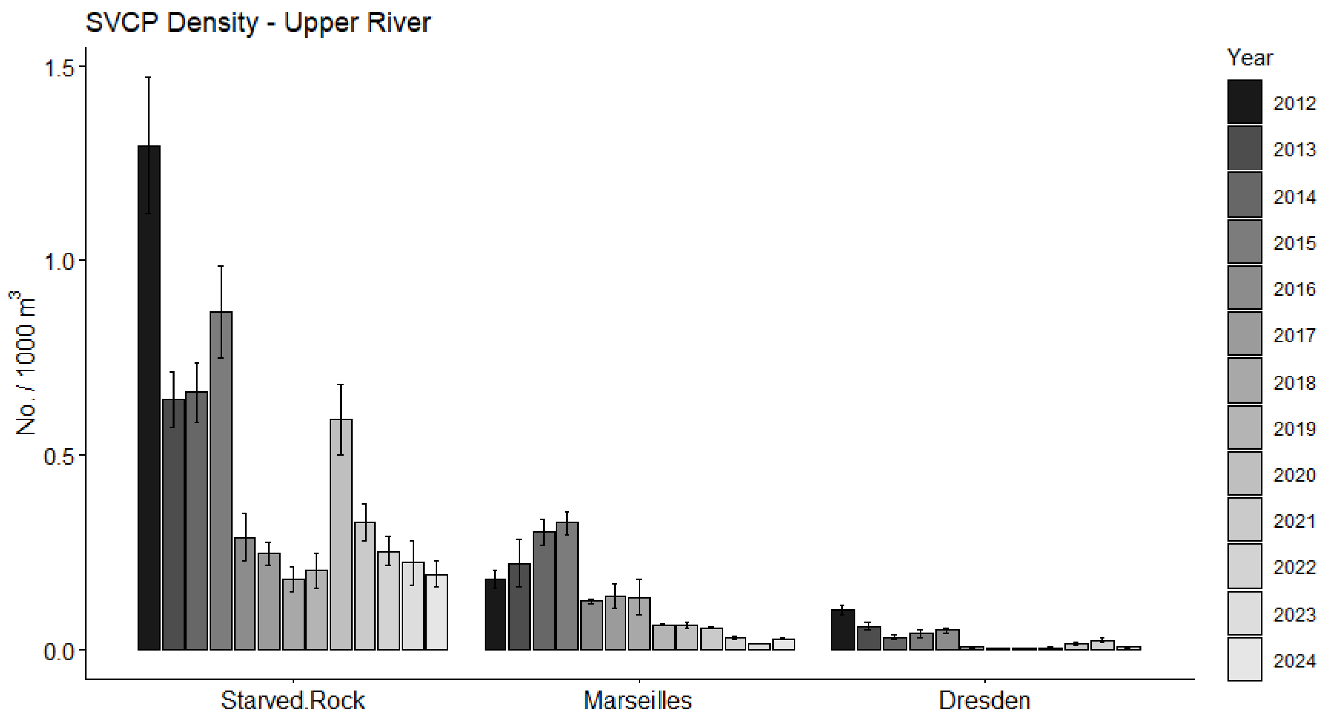


Figure 3. *Densities of bigheaded carp in the lower Illinois River during falls 2012 through 2024 as estimated from standardized hydroacoustic surveys in each pool.*

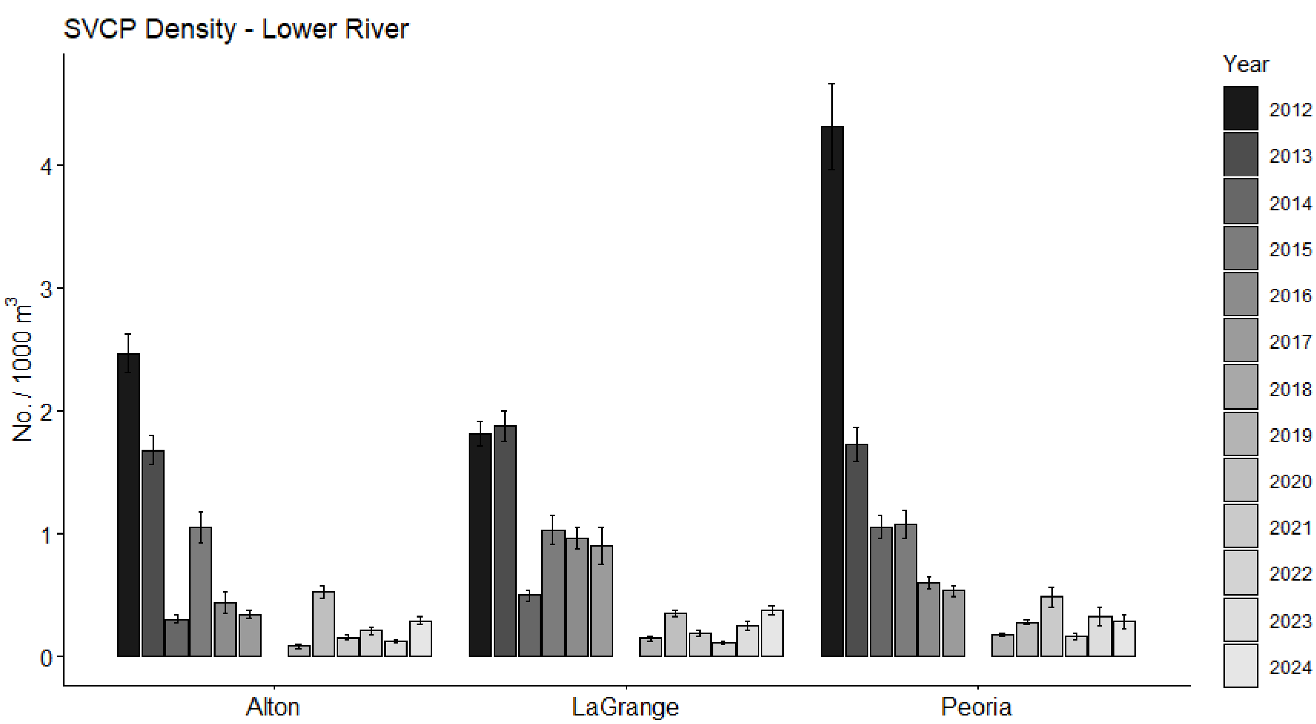


Table 1. *Table summarizing unique bigheaded carp upstream and downstream dam passages in 2024 (a) and 2025 (b). Tag data from SIU, USACE, MDC, Purdue, KDFWR, USGS-UMESC, USFWS Wilmington, and USFWS LaCrosse were used in these summaries.*

2024 (a)	Upstream	Downstream	2025 (b)	Upstream	Downstream
La Grange	2	53	La Grange	51	45
Peoria	29	11	Peoria	27	18
Starved Rock	54	58	Starved Rock	0	0
Marseilles	0	0	Marseilles	0	0
Dresden	0	0	Dresden	0	0

Figure 4. *Density of carp targets across surveyed river macrohabitat in October 2024. MC refers to the main navigation channel of the pool, and BW refers to backwater habitats, which include tributaries, harbors, and side channels. Peoria Lake was not surveyed in October of 2024.*

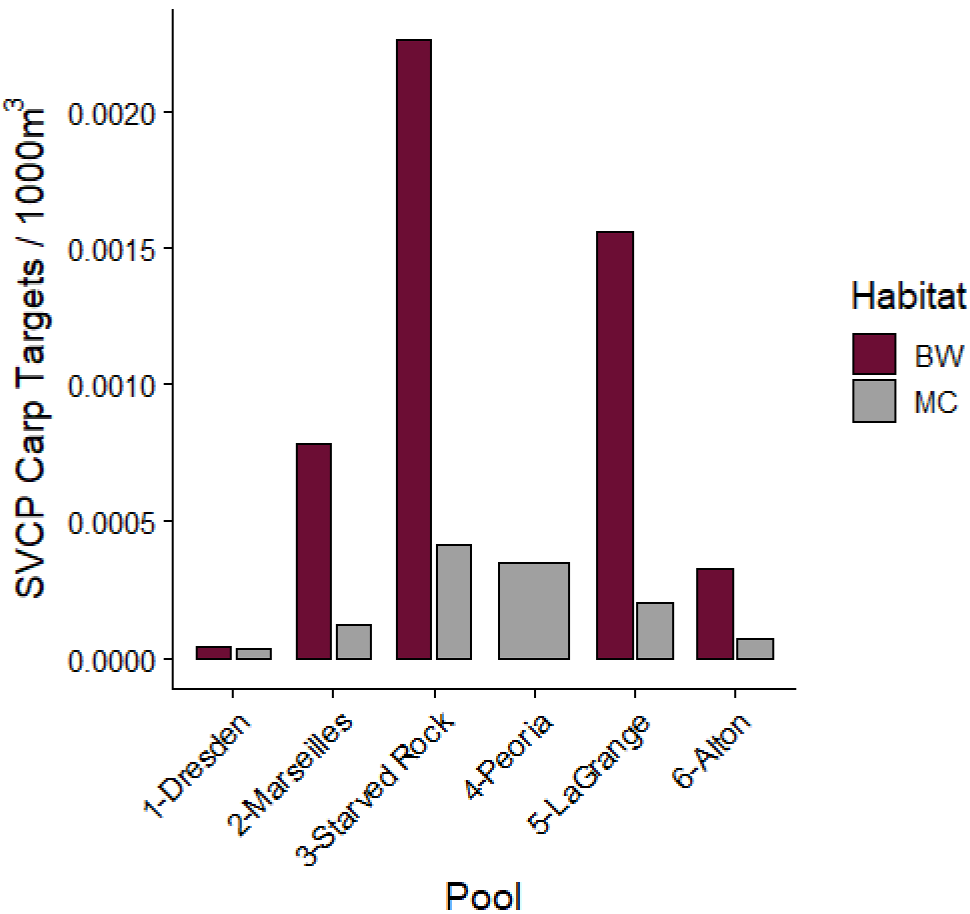


Figure 5. *Peoria Pool was surveyed four addition times in 2024, in March, May, July, and August. Similar to the full river survey in October, we found much higher carp densities in the backwater and lake habitats relative to the main navigation channel.*

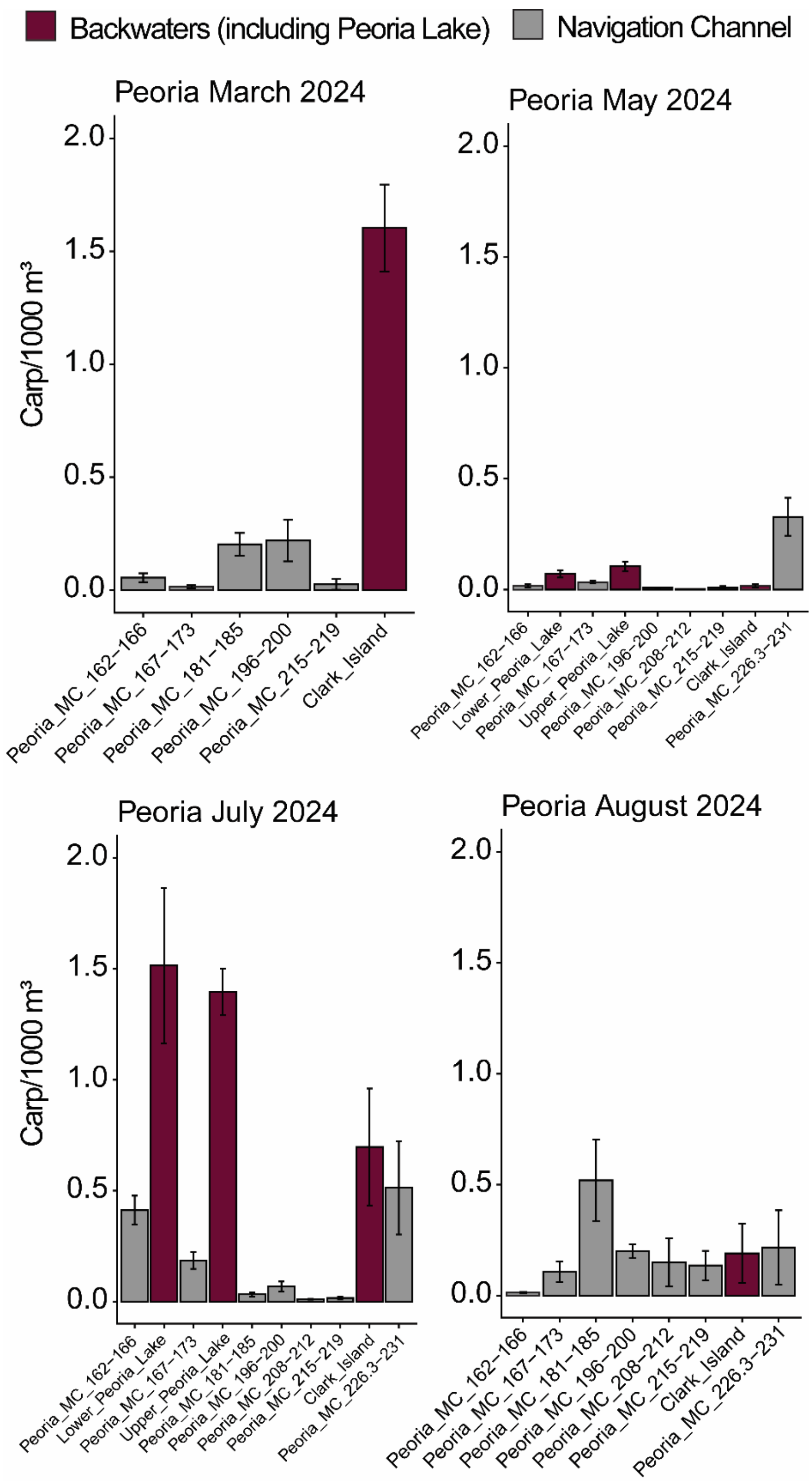
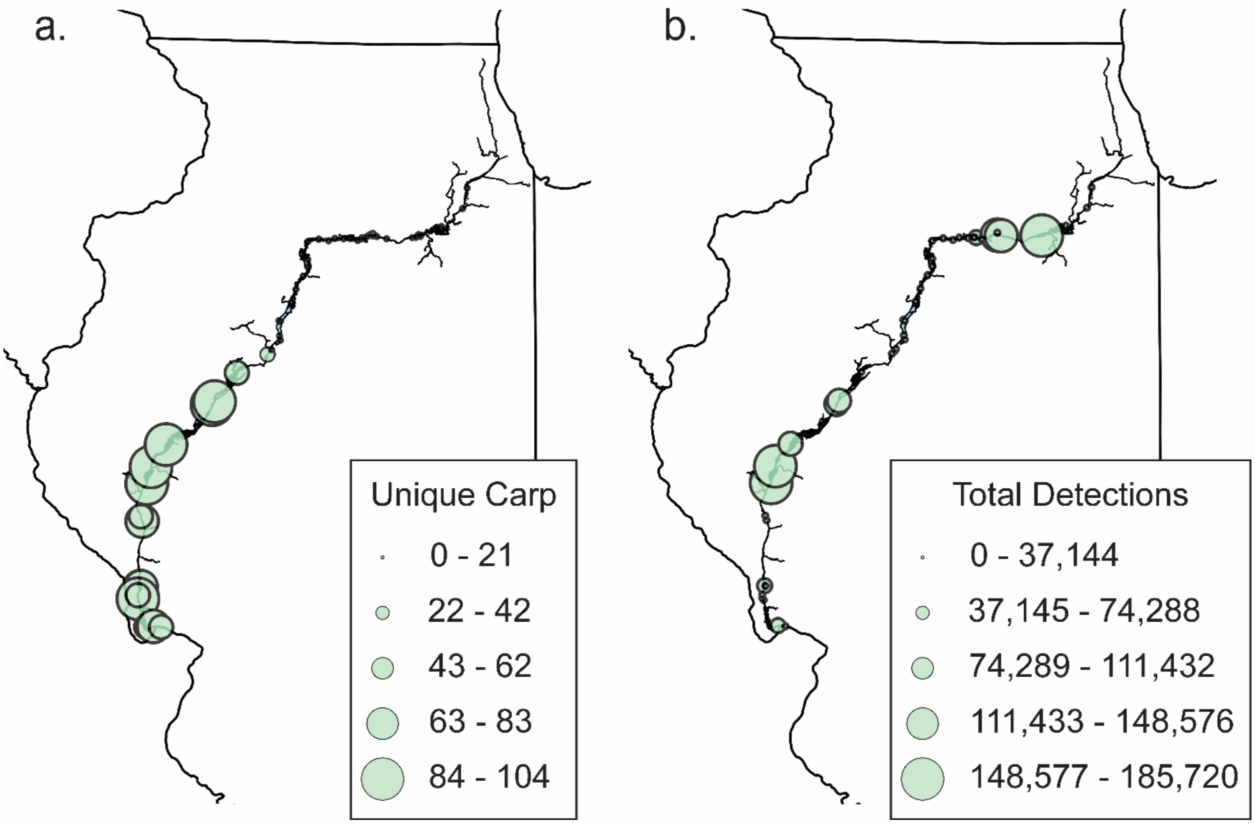


Figure 6. *Map of the passive receiver array (green dots) in the Illinois River (SIU and partner agency receivers). Dot size is scaled by the number of unique individuals tagged Silver Carp (a) and by the total number of detections (b) recorded in 2025. Detections shown include both SIU tagged carp as well as carp tagged by other agencies.*



RECOMMENDATIONS

Hydroacoustic surveys are needed to inform (via spatial distribution maps) contracted removal and Unified Method events in the upper Illinois River pools, as the resulting data can increase harvest efficiency. Bigheaded carp spatial distributions change over time and are not consistent across years, necessitating repeated surveys in Dresden Island and Marseilles pools to direct harvest efforts to appropriate locations. Standardized fall hydroacoustic surveys from Alton through Dresden Island pools are also needed to monitor long-term population trends that act as an additional surveillance tool and can assist in making management decisions.

Continued collection of telemetry movement data will serve to maintain sufficient adult surveillance efforts for detecting movement among pools, including possible movement toward the invasion front. Movement data will also be needed to improve and update movement models used in the SEICarP model. It will also be important to continue to assess annual variation in dam passages and how passage rates vary as densities of bigheaded carp change throughout the Illinois River (e.g., due to removal efforts and reproduction in lower river pools).

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ILLINOIS WATERWAY HYDROACOUSTICS

Participating Agencies: USFWS Carterville FWCO (lead) and USACE Chicago District (field and logistical support)

MRWG Work Group: Hydroacoustics

Pools Involved: Dresden Island, Brandon Road, Lockport

INTRODUCTION AND NEED

The EDBS, located within the CSSC, operates to prevent the inter-basin transfer of fish between the Mississippi and Great Lakes basins (USACE 2010; USACE Chicago District n.d.). Observational evidence from previous studies suggests fish may bypass the electric barrier by swimming alongside metal-hull barges or by being involuntarily dragged by barges (Parker et al. 2015). Having a greater understanding of the spatial and temporal patterns of fish abundance within and below the EDBS is important to barrier management, as it allows operational and maintenance decisions to be made in sync with an understanding of potential risk. To determine these periods of elevated risk, split-beam hydroacoustic surveys were performed within and below the EDBS monthly throughout 2025. Split-beam hydroacoustic surveys of the Lockport, Brandon Road, and Dresden Island navigation pools of the upper IWW were also conducted to evaluate the potential for the upstream spread of invasive carp and increased pressure on the EDBS from the pools immediately downriver.

Understanding fish assemblage dynamics throughout the upper IWW allows the findings from a range of other research activities at the EDBS to be put into a system-wide context, enabling more refined interpretations of results and allowing managers to make informed decisions.

OBJECTIVES

- Enumerate fish within and directly below the EDBS monthly throughout the year to inform contingency response and barrier management.
- Determine the density of fish in the three upper navigation pools within the upper IWW.
- Identify changes in large fish density and distribution that could indicate the potential risk of further upstream spread of invasive carp.

PROJECT HIGHLIGHTS

- Completed review and reprocessing of historical barrier scan data to facilitate comparisons among years and identify population trends.
- Large target densities in mobile hydroacoustic surveys conducted in Lockport, Brandon Road, and Dresden Island pools in 2025 were lower than the previous year.

METHODS

Acoustic Fish Surveys at the EDBS

Horizontal, split-beam hydroacoustic surveys were conducted monthly at the CSSC EDBS from January 28 through December 9, 2025, to provide regular monitoring of large target abundance and distribution patterns. Survey transects began approximately 1.2 kilometers below the EDBS at 41.629521 N, -88.061659 W. The survey vessel followed a path close to the east wall, traveling north with the side-looking hydroacoustic transducers aimed toward the west wall. Each transect continued through the EDBS, paused briefly to allow bubbles and wake to disperse, turned south, and then traveled closely along the west wall back to the survey start point. Three consecutive replicate hydroacoustic samples took place on each survey date.

Survey equipment consisted of a pair of Biosonics® 200-kilohertz split-beam transducers mounted in parallel on the port side of the research vessel, 0.4 meter below the water surface on a dual-axis mechanical rotator. Transducer sampling angles were set and monitored in each survey to maintain values of approximately -3.3˚ and -9.9˚ below the water surface to maximize coverage, minimize beam overlap, and allow targets oriented with the flow to be pinged near side-aspect. Split-beam acoustic data were collected using Visual Acquisition v.6.4® at a range of 0 to 50 meters from the transducer face, with a ping rate of 5 pings per second and a 0.4-millisecond pulse duration. Data collected less than 1 meter from the transducer face were removed during post-processing to avoid near-field interference. The water temperature was measured and input into Visual Acquisition v.6.4® prior to all data collection. After each barrier scan, a tungsten carbide calibration sphere was used for on-axis calibration of the split-beam acoustic transducers following methods from Demer et al. (2015).

Split-beam hydroacoustic data were post-processed in Echoview® v. 14.0. Data were loaded into a mobile survey template to identify and estimate the size and location of single fish targets based on target strength and angular position. Data post-processing followed standard methods outlined in Bouska et al. (2023). The analysis template followed the general methods reported in MacNamara et al. (2016), and single targets were detected using parameter values from Parker-Stetter et al. (2009). Data collected outside of the analysis bounds (analysis bounds: between 41.629521 N and the Demonstration Barrier's upper parasitic structure) were removed from further analysis, a bottom line was digitized and checked by hand, areas of bad data caused by air bubbles and other sources of acoustic noise were removed, and fish tracks were identified using the "single target detection – split-beam (method 2)" algorithm within the Echoview Fish Tracking Module®. Large targets were classified as those with a total strength greater than or equal to -28.7 decibels (≥12 inches [30.5 centimeters] total length based on the mean temperature-compensated side-aspect total strength of a fish) (Bouska et al.2023). Each individual large target was also spatially located within the water column using the split-beam transducer's capabilities, assigned X, Y, and Z positional coordinates, and classified as "within EDBS" or "below EDBS" based on location.

IWW Pool Surveys

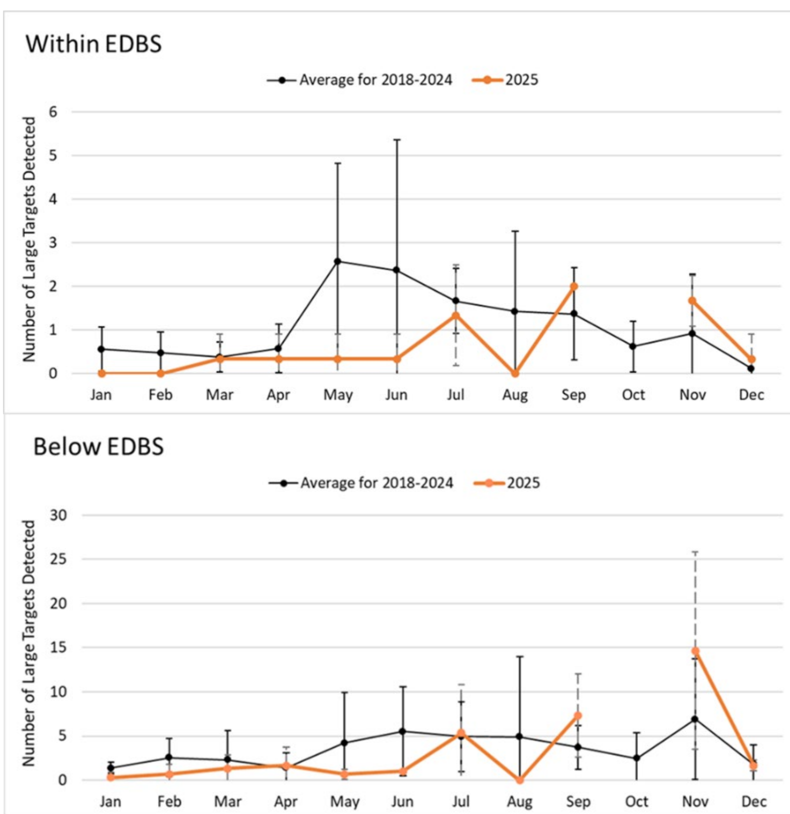
To quantify the density and spatial distribution of the fish community in the upper IWW, hydroacoustic surveys were conducted in Dresden Island, Brandon Road, and Lockport navigation pools in September 2025. The surveys were conducted using the same equipment, collection techniques, and analysis methods as were employed during the hydroacoustic surveys at the EDBS. Within each navigation pool, upstream and downstream transects were sampled near the channel margin, with transducers facing outwards toward the middle of the channel. An additional pool scan was conducted in Dresden Island on March 25, 2025, to inform local harvesters of the density and spatial distribution of large targets, and potentially invasive carp, for removal efforts.

RESULTS AND DISCUSSION

Fish Surveys Within and Below the EDBS

Results from the hydroacoustic surveys conducted within the EDBS indicated the regular presence of multiple large targets greater than 12 inches within the EDBS from January to December 2025 (mean = 0.61 large targets detected per survey; the range was 0 to 2 large targets across 2025; Figure 1 [A]). Patterns of large targets detected within and below the EDBS were similar to previous years (Figure 1). No scan was done in the month of October due to the government shutdown.

Figure 1. Average *number of large targets (greater than or equal to -28.7 decibels) observed within (A) and immediately downstream (B) of the EDBS during split-beam hydroacoustic surveys conducted from January through December 2025 compared with the average for past surveys from 2018 to 2024.*



IWW Pool Surveys

To compare density trends over time, we used historical data from split-beam echosounder data collected in September. We removed data collected during other months to remove seasonal variation from the dataset to better evaluate long-term temporal trends. The month of September was chosen to align with fall pool scans completed by partner agencies. Results from hydroacoustic surveys conducted in Dresden Island, Brandon Road, and Lockport pools in 2025 illustrated a lower large target density compared to 2024, but higher than in earlier years. Both Dresden Island and Brandon Road had a density of 0.10 large targets/1,000 m^3, and Lockport had a density of 0.01 large targets/1,000 m^3 (Figure 2). This apparent decrease from 2024 could result from increased harvest efforts. More data are needed to evaluate the relationship between density estimates and harvest efforts.

An additional hydroacoustic survey of Dresden Island was conducted on March 25, 2025. A heatmap of the location and density of large targets was produced and given to local commercial fishers to assist in their invasive carp removal efforts (Figure 3). A total of 60 large targets were detected in 2,188,601 m^3 of water. The large target density was 0.03 large targets/1,000 m^3.

Figure 2. *Density of large targets (greater than or equal to -28.7 decibels) from split-beam hydroacoustic surveys conducted in the Dresden Island, Brandon Road, and Lockport pools during September 2018 to 2025. Large target density was calculated by dividing the number of observed large targets by the water volume sampled during the survey. Years lacking data indicate that a survey was not completed in the month of September during that year.*

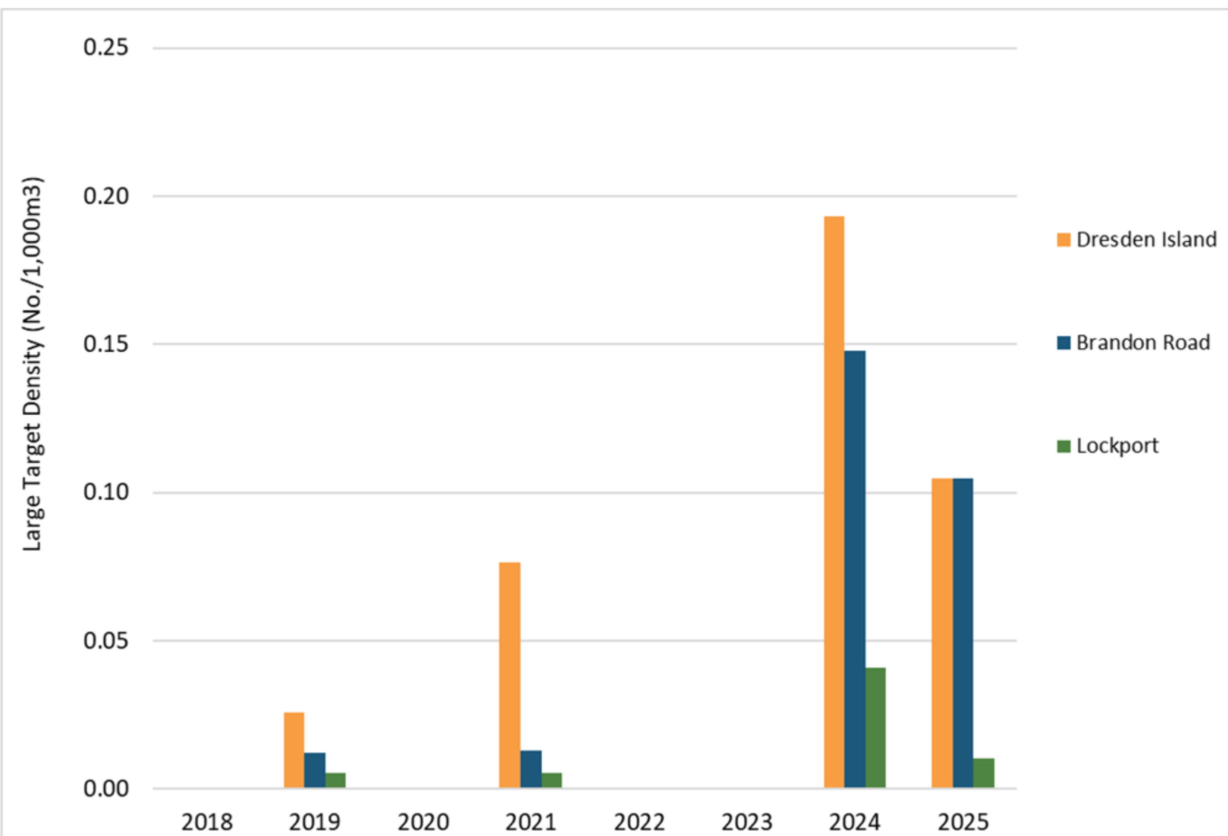
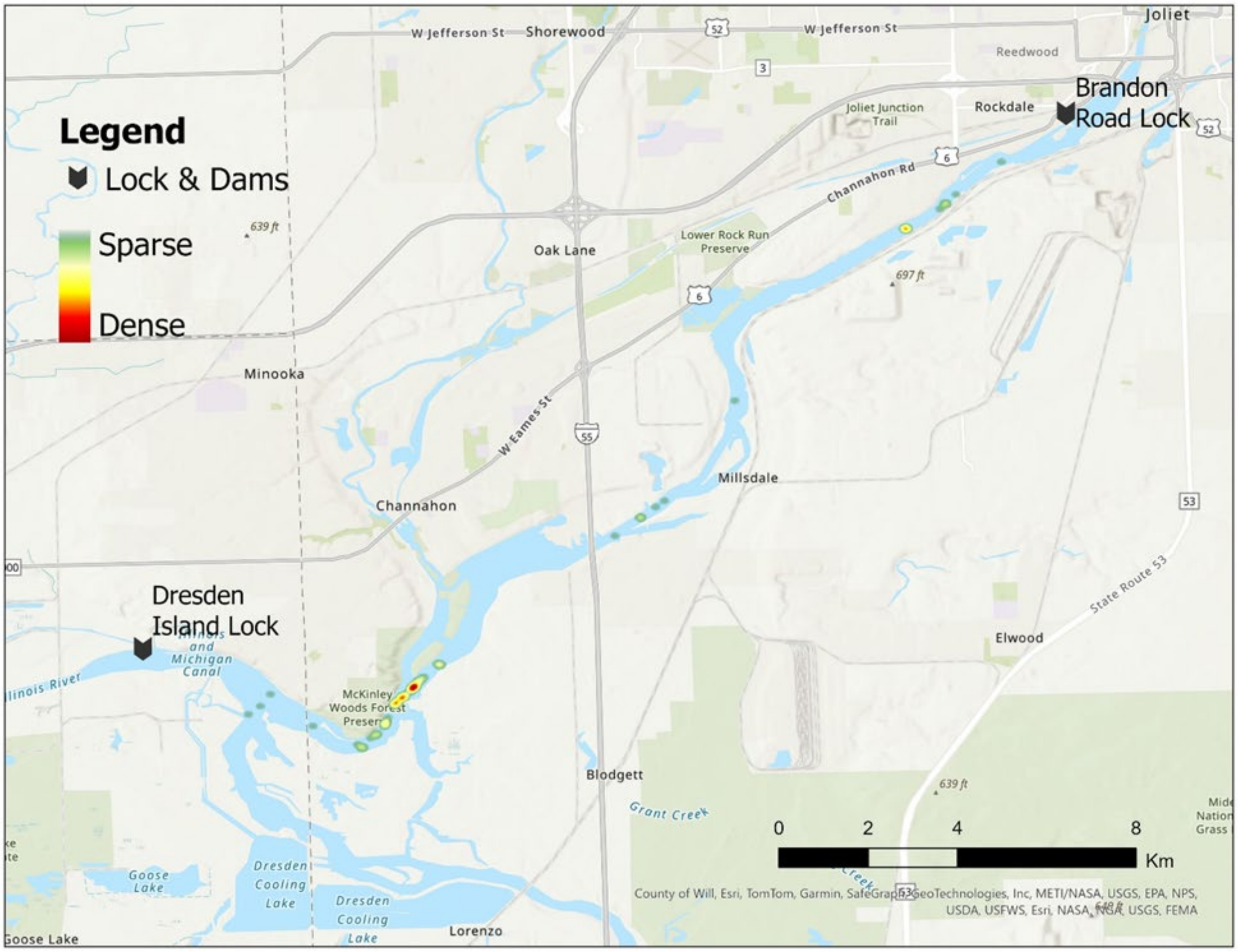


Figure 3. *Heatmap of large targets (greater than or equal to -28.7 decibels) from split-beam hydroacoustic surveys conducted in Dresden Island Pool on March 25, 2025.*



CONCLUSION

Overall, the IWW Hydroacoustics project accomplished its objectives in 2025 by providing insights into trends in the number of large fish near and immediately downstream of the EDBS and at the leading edge of invasive carp expansion (Invasive Carp Problem 2022). Pool scans conducted in September 2025 showed a decrease in large target density compared to 2024. Scans at the barrier showed similar trends both within and below the EDBS compared to previous years. While one dead invasive carp was observed in Lockport in August of 2025, after investigation, it was determined that the fish had been pushed into Lockport from downstream by a barge. These findings suggest that sufficient measures are currently being implemented to prevent the upstream movement of invasive carp.

RECOMMENDATIONS

- Continue to conduct monthly mobile hydroacoustic surveys at the EDBS in 2026.
- Conduct a hydroacoustic pool scan during September 2026 in Dresden Island, Brandon Road, and Lockport pools in coordination with SIU hydroacoustic efforts.

- Continue to evaluate the most effective deployment strategies for side-looking hydroacoustic evaluation of invasive carp populations in the IWW.

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TELEMETRY WORK GROUP PROJECTS

- Acoustic Telemetry to Support Population Modeling
- SIU Longitudinal Receiver Array and Tagging
- Acoustic Telemetry Monitoring Near the Invasion Front and EDBS
- Telemetry Support for the Spatially Explicit Invasive Carp Population Model (SEICarP)

ACOUSTIC TELEMETRY TO SUPPORT POPULATION MODELING

Participating Agencies: USGS (lead), SIU, USACE, ILDNR, USFWS, INHS; Marybeth Brey, Jessica Stanton, Doug Appel, and Andrea Fritts (USGS, Upper Midwest Environmental Sciences Center); Ryan Jackson (USGS, Central Midwest Water Science Center)

MRWG Work Group: Telemetry

Pools Involved: Alton, La Grange, Peoria, Starved Rock, Marseilles, Dresden Island, Lockport, CAWS, Des Plaines River

INTRODUCTION AND NEED

Tagging and tracking bigheaded carp (i.e., Bighead Carp and Silver Carp) and surrogate fish species with acoustic transmitters has become an invaluable management tool in the upper IWW (i.e., upper Illinois River, lower Des Plaines River, and the CAWS). For example, movement probabilities between adjacent navigation pools need to be estimated to parameterize population models being developed to answer specific management questions, such as the SEICarP model—a population model previously used in scenario planning by the MRWG to evaluate alternative management actions (Kallis et al. 2023), the Metapopulation Integral Projection Model (MetaIPM) extension of the SEICarP model and the current SCAA model being developed by the USFWS. Movement probabilities are estimated from the telemetry data obtained from a longitudinal network of strategically placed receivers that detect bigheaded carp that have been implanted with acoustic transmitters (i.e., tagged). In addition, fish removal by contracted fishers has become the primary method of controlling bigheaded carp in the upper Illinois and lower Des Plaines rivers. Variable patterns in bigheaded carp distribution, habitat, and movement, influenced by seasonal and environmental conditions, make targeting bigheaded carp for removal and containment challenging and costly. Understanding these movement patterns for bigheaded carp through modeling and real-time telemetry applications informs removal efforts and facilitates monitoring and contingency actions based on fish movements.

To develop a better understanding of fish movement dynamics to meet management objectives, an existing network of real-time and data-logging acoustic receivers in the upper IWW is collaboratively managed by a multi-agency team (see Participating Agencies section above; Figure 1). The MRWG established the Telemetry Work Group to ensure the multi-agency telemetry efforts are coordinated to efficiently and effectively meet the MRWG goals. This work group plans and executes the placement of receivers, tagging of bigheaded carp with acoustic transmitters, and manages the telemetry data. After the establishment of a standardized telemetry database (the RAFT Network, moved to the USGS Database project in 2020), two primary objectives for the USGS telemetry and tagging projects to meet the MRWG goals remained. These include (1) providing movement probabilities and telemetry data for population modeling efforts (currently, the SCAA model) and (2) deploying, maintaining, and serving data from real-time acoustic receivers to inform contingency planning and fish removal. The specific objectives of the group are assessed annually, and each partner agency has its own tasks. The 2025 USGS-specific objectives are outlined here.

OBJECTIVES

Telemetry in Support of Population Modeling

- Coordinate collection of multi-agency telemetry data to prepare for updating the movement probabilities for the Illinois River from 2026 to 2027. Summarize multi-agency data as requested or appropriate for movement or population modeling.
- Use external tagging and/or acoustic telemetry to estimate fishing mortality, population size, and tag retention rates for Silver Carp in the Starved Rock Pool of the Illinois River.
- Estimate immigration and emigration rates: Use telemetry data from the multi-agency Telemetry Work Group to assess the timing and duration of Silver Carp immigration into and emigration out of the Illinois River (at Alton).
- Explore the inclusion of additional parameters and predictor variables in a comprehensive invasive carp movement model. USGS, in coordination with the Modeling Work Group, will explore the ability to use existing or collect supplemental telemetry data to parameterize population models that could incorporate fish density, variable environmental parameters (e.g., river flow conditions), or individual-level parameters (e.g., fish length and weight).

Real-time Telemetry in Support of Barrier Evaluations and Contingency Planning

- Maintain real-time receiver network: Deploy, maintain, and serve data from real-time acoustic receivers to inform decisions on contingency actions and the USACE barrier evaluation.

PROJECT HIGHLIGHTS

- *Movement Probability Model:* In 2025, the Telemetry Work Group tagged 334 Silver Carp in the Illinois River and Mississippi River confluence. In total, 726 unique Silver Carp were detected in the Illinois River in 2025. Movement of these and previously tagged fish will be used to estimate movement between the lower river (Alton, La Grange, and Peoria pools) and upper river (Starved Rock, Marseilles, and Dresden Island pools) to inform the SCAA model being developed by the USFWS.
- *Estimating Fishing Mortality and/or Population Size of Silver Carp:* A manuscript (Stanton et al. 2025) was published on an approach to estimate fishing mortality of invasive species. This approach was used to develop a study plan to externally mark 2,000 Silver Carp per year in the Starved Rock Pool to estimate population size, fishing mortality, and tag retention rates.
- *Immigration and Emigration of Silver Carp:* In 2025, 63 Silver Carp tagged outside the Illinois River were detected in the Illinois River as far upstream as the Peoria Pool.
- *Real-time Receiver Network and Alert System*: Six real-time receivers were maintained in the upper IWW in 2025. A simplified alert system for bigheaded carp detections in areas of management interest was maintained in 2025. No bigheaded carp were detected on real-time receivers upstream from Brandon Road L&D (Table 1, No. 3) or downstream from Brandon Road L&D (Table 1, No. 4) in 2025.

Figure 1. *Locations of 69 kHz acoustic telemetry receivers in 2025 on the IWW (dark blue = SIU, light blue = USFWS, green = USGS, red = USACE, and green squares = USGS maintained real-time receivers).*

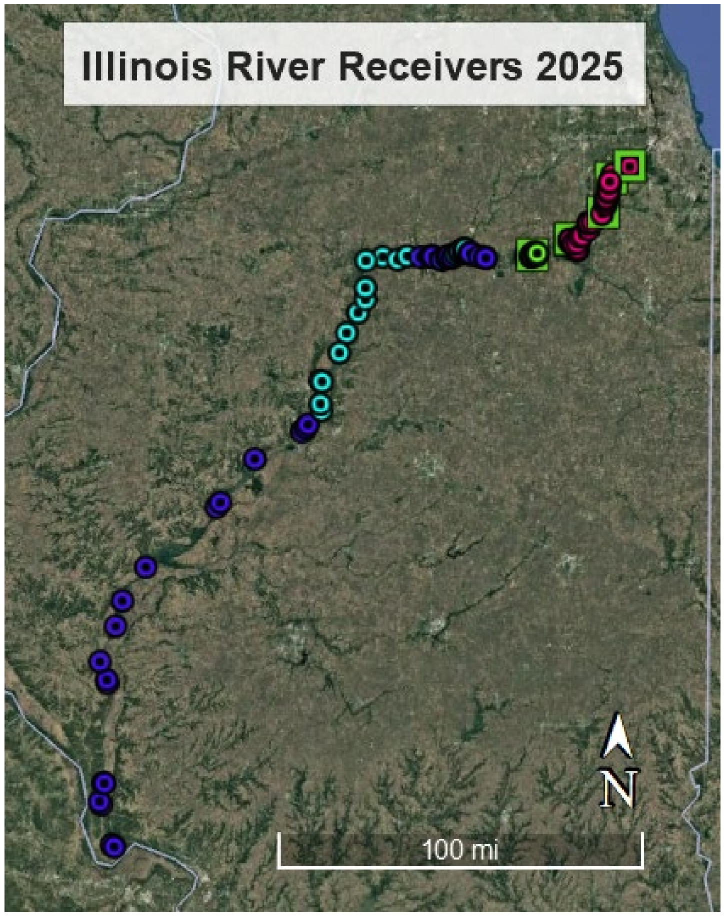

Table 1. *Locations of real-time receivers on the Upper IWW. Available at:* https://cm.water.usgs.gov/data/Fish_Tracks_Real_Time/

No.	Station	Location
1	Chicago Sanitary and Ship Canal above the EDBS	Lemont, IL
2	Chicago Sanitary and Ship Canal below the EDBS	Romeoville, IL
3	Des Plaines River above Brandon Road L&D	Rockdale, IL
4	Des Plaines River below Brandon Road L&D	Rockdale, IL
5	Dresden Generating Station outfall	Minooka, IL
6	Illinois River above Dresden Island L&D	Minooka, IL

METHODS

Movement Probability Model. The USGS, in collaboration with personnel from the Telemetry Work Group and Modeling Work Group, developed a Bayesian multi-state movement model to estimate inter-pool movement probabilities that were necessary for SEICarP. The model will be modified and re-run in 2026 to estimate the movement of invasive carp between the upper and lower Illinois River using all available data. These estimates will be used in the SCAA model being developed by the USFWS.

Estimating fishing mortality and/or population size using mark-recapture and/or acoustic telemetry data. The USGS, USACE, and ILDNR externally marked 1,010 Silver Carp in the Starved Rock Pool in 2025. Recaptures of these tagged fish and contract removal numbers will be used to estimate the population size, fishing mortality, and tag retention of Silver Carp in the Starved Rock Pool. The study is expected to run for 2 years.

Immigration and Emigration of Silver Carp. Acoustic telemetry data from receivers located in the Alton and La Grange pools of the Illinois River, at the confluence of the Illinois and Mississippi rivers, and within Pool 26 of the Mississippi River, will be used to evaluate the movement of Silver Carp between the Illinois and Mississippi rivers. Data from Silver Carp tagged both within and outside the Illinois River will be included in an extension of the Bayesian multi-state model (Stanton et al. 2024) to estimate immigration and emigration of these fish.

Real-time Receiver Network and Alert System. USGS crews redeployed and maintained a network of six real-time receivers in the upper IWW in the spring and summer of 2025. Data access for these receivers was maintained online. Real-time alerts were provided to key personnel via email, as requested by partner agencies. An alert system, developed in 2023, was maintained to summarize daily or weekly detection data into one email alert. Users can now request alert summaries for detections on individual receivers or for all receivers. Updates for the real-time receiver located below the EDBS are also shared monthly with the corresponding USFWS hydroacoustic survey data.

RESULTS

Telemetry in Support of Modeling

Movement probability model. The new model was developed and successfully run on the 2012 to 2019 dataset of tagged Silver Carp and Bighead Carp in the Illinois River. A manuscript describing the model and results has been published. Data collection and fish tagging (334 Silver Carp) continued with partner agencies through 2025, with a focus on increasing the number of tagged fish in the lower Illinois River. In 2025, the multi-agency partnership detected 726 active 69-kHz acoustic transmitters (i.e., “tags”) from Silver Carp in the Illinois River. These fish were tagged by one of nine agencies or groups throughout the Mississippi River Basin (Illinois River [n = 663] and outside the Illinois River [n = 63]).

Feasibility study to estimate fishing mortality from existing telemetry and tag-return data from the Illinois River. USGS worked with USFWS to create a model to guide managers in tag-return studies to estimate fishing mortality. The manuscript has been accepted for publication. Following the manuscript guidelines, the USGS and USACE developed a study plan to estimate the population size, fishing mortality, and tag retention rates for Silver Carp in the Starved Rock Pool of the Illinois River using externally marked fish over a 2-year period. This study began in the fall of 2025 and will continue into 2027.

Immigration and Emigration of Silver Carp: In 2025, 246 Silver Carp were detected on receivers located in Mississippi River Pool 26 or in the Alton Pool of the Illinois River. Of those, 76 Silver Carp were detected in both pools. Sixty-three Silver Carp tagged outside the Mississippi River were detected in the Illinois River in 2025. Estimates for the 3-year (2023 to 2025) immigration and emigration rates will be available in late 2026.

Real-time Receiver Network

USGS personnel monitored, downloaded, and maintained data from five real-time receivers in the upper IWW in 2025. One additional receiver, located in the Marseilles Pool, is also maintained by the USGS but is funded by another project. Locations of the six real-time receivers in the upper IWW are shown in Table 1. Data from receivers are used to alert partner agencies when bigheaded carp tagged with ultrasonic transmitters are detected. Four real-time receivers are in areas of management concern (upstream of the bigheaded carp invasion front in upper Dresden Island Pool; receiver locations one through four in Table 1). Receivers No. 1 through 4 did not detect any confirmed bigheaded carp in 2025. All the receivers were accessed remotely, and the data were made available online. Detection data and summaries were shared with partners throughout the year.

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SIU LONGITUDINAL RECEIVER ARRAY AND TAGGING

Participating Agencies: SIU (lead); additional assistance from/collaboration with ILDNR, USACE, USGS, INHS, USFWS; David Coulter, Cameron Davis, Jim Garvey, Tanya Fendler, Joseph Mruzek (SIU)

MRWG Work Group: Telemetry

Pools Involved: Dresden Island, Marseilles, Starved Rock, Peoria, La Grange, Alton

INTRODUCTION AND NEED

Management goals for bigheaded carp in the Illinois River focus on limiting upstream dispersal through monitoring, assessing movement barriers, and reducing abundance through contracted harvest. Bigheaded carp spatial distributions vary seasonally and annually; quantifying how spatial distributions change through time will help target contracted harvest to maximize removal efforts and minimize costs. Additionally, long-term information on bigheaded carp population characteristics, distributions, and movements, especially along the population front in the upper Illinois River, can provide data to parameterize population models. These models simulate the effects of various management actions (e.g., harvest scenarios and locations of enhanced deterrent technologies) to determine what options are most likely to achieve management goals.

The SEICarP model of bigheaded carp in the Illinois River assesses how bigheaded carp populations respond to various management actions (e.g., location and intensity of harvest; location and effectiveness of deterrent technologies). This model draws on a variety of data, including bigheaded carp densities and movement data. Collaborations between the Modeling and Telemetry Work Groups have identified data needs, primarily with a better understanding of inter-pool movements. To this end, model support consisted of maintaining the Illinois River stationary telemetry array to quantify inter-pool movements and deployment of additional acoustic telemetry tags in bigheaded carp (numbers set based on Telemetry Work Group determinations). Movement information from telemetry efforts is also critical for maintaining sufficient surveillance efforts to detect potential changes in bigheaded carp spatial distributions (e.g., upstream movements), especially in supporting surveillance efforts with real-time acoustic telemetry receivers.

OBJECTIVES

- Continue tagging invasive carp to replace those tags that expire or are lost due to natural mortality. This maintains effective coverage of movement patterns of invasive carp.
- Expand tagging in the lower Illinois River to improve models of movement in these pools and the Mississippi River.
- Maintain SIU's extensive acoustic telemetry array currently in place in the entire Illinois River, used to collect movement information and maintain adult surveillance efforts. Share collected data with Telemetry and Modeling Work Groups.

PROJECT HIGHLIGHTS

- Maintaining the stationary acoustic telemetry receiver array throughout the Illinois River ensured sufficient surveillance efforts occurred to detect adult movements among pools and toward the invasion front.

METHODS

Utilizing an array of 51 Vemco 69-kilohertz stationary receivers maintained by SIU (Abeln 2018), as well as stationary receivers maintained by partner agencies (USGS, USACE, USFWS, and MDC), the movements of Silver Carp and Bighead Carp implanted with internal transmitters (Vemco V16 transmitters) were monitored from Alton Pool upstream through Dresden Island Pool. Additional stationary receivers were deployed and maintained by other agencies in the Telemetry Work Group in other locations of the IWW. Additionally, other fish species implanted with 69-kilohertz transmitters by other members of the Telemetry Work Group can be detected by this array. Stationary receivers were downloaded in May and November of 202, with data initially checked to remove false detections, and uploaded to the USGS FishTracks database. The last receiver download occurred in November of 2025, thus early winter carp movements are not included in this report. The 2025 fish detection data were analyzed to identify upstream and downstream passages through lock and dam structures (e.g., Lubejko et al. 2017). Additional acoustic telemetry tags were deployed (n = 161) to replace expiring tags (Figure 1).

RESULTS AND DISCUSSION

In 2025, 161 tags were implanted into bigheaded carp in Alton (Figure 1). These additional tags will maintain sufficient adult surveillance efforts (e.g., early detection of movements past real-time receivers). SIU stationary receivers were retrieved and downloaded from Dresden Island Pool through Alton Pool. All detection data downloaded from stationary receivers were screened to remove false fish detections and submitted for inclusion in the USGS-managed FishTracks telemetry database. Dam passages were most common in the lower river pools (Table 1; Figure 2).

Table 1. *Table summarizing unique bigheaded carp upstream and downstream dam passages in 2024 (a) and 2025 (b). Tag data from SIU, USACE, MDC, Purdue, KDFWR, USGS-UMESC, USFWS Wilmington, and USFWS LaCrosse were used in these summaries.*

2024 (a)	Upstream	Downstream	2025 (b)	Upstream	Downstream
La Grange	2	53	La Grange	51	45
Peoria	29	11	Peoria	27	18
Starved Rock	54	58	Starved Rock	0	0
Marseilles	0	0	Marseilles	0	0
Dresden	0	0	Dresden	0	0

Figure 1: *Histogram summarizing the sex and location breakdown of the 161 carp tagged by SIU in 2025 in the Alton Pool.*

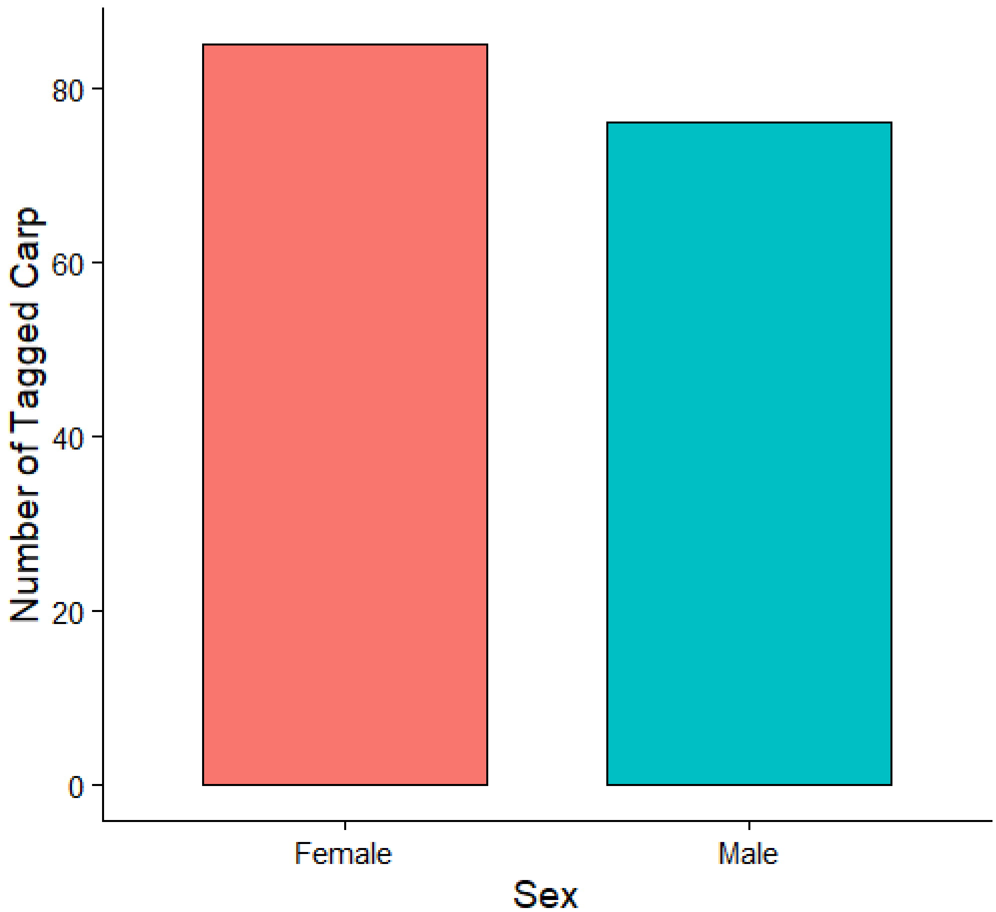
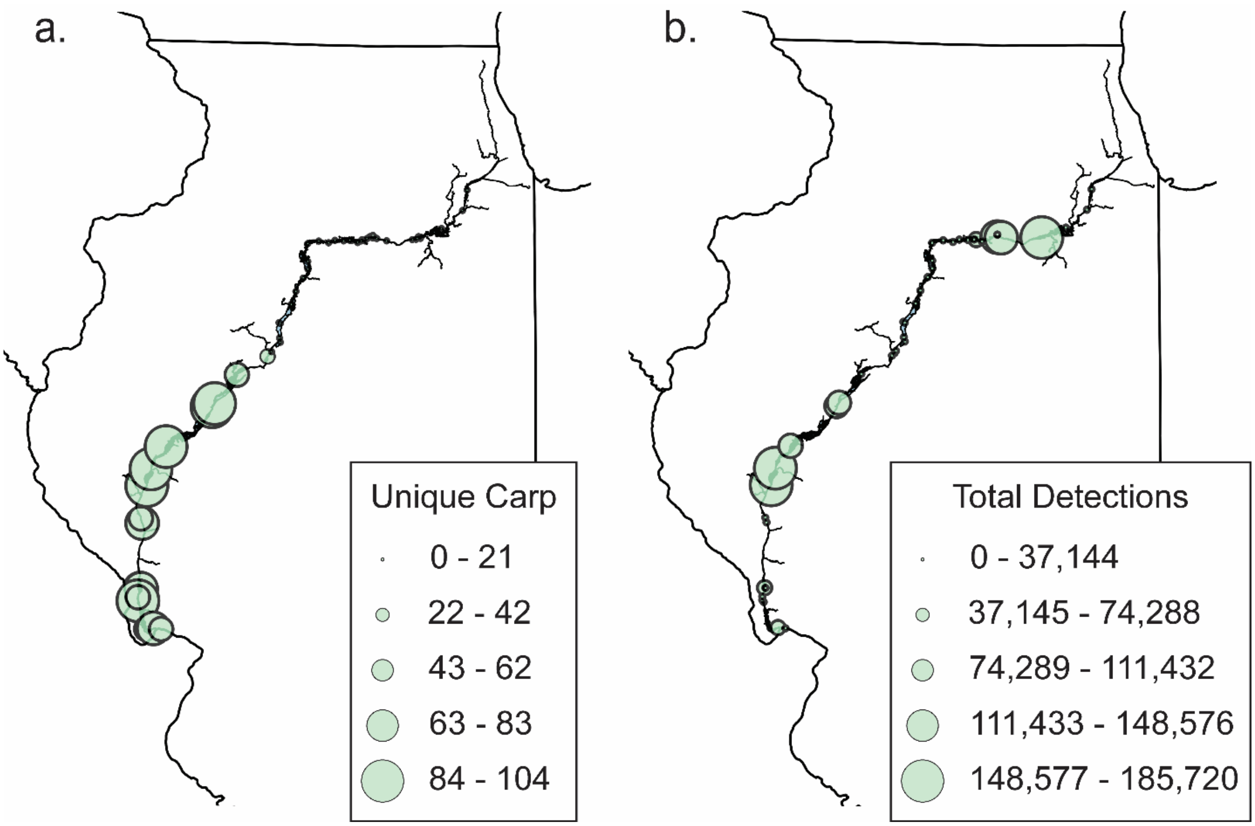


Figure 2. *Map of the passive receiver array (green dots) in the Illinois River (SIU and partner agency receivers). Dot size is scaled by the number of unique individuals tagged Silver Carp (a) and by the total number of detections (b) recorded in 2025. Detections shown include both SIU tagged carp as well as carp tagged by other agencies.*



RECOMMENDATIONS

Continued collection of telemetry movement data will serve to maintain sufficient adult surveillance efforts for detecting movement among pools, including possible movement toward the invasion front. Movement data will also be needed to improve and update movement models used in the SEICarP model and allied spatially explicit modeling of density-dependent patterns of movement among pools toward the Great Lakes. It will also be important to continue to assess annual variation in dam passages and how passage rates vary as densities of bigheaded carp change throughout the Illinois River (e.g., due to removal efforts and reproduction in lower river pools).

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ACOUSTIC TELEMETRY MONITORING NEAR THE INVASION FRONT AND EDBS

Participating Agencies: USACE (lead); USFWS, SIU, ILDNR, USGS, and MWRDGC (field and project support); Alexander Catalano, Dayla Dillon, and Nicholas Barkowski (USACE – Chicago District)

MRWG Work Group: Telemetry

Pools Involved: Dresden Island, Brandon Road, Lockport

INTRODUCTION

Acoustic telemetry has been identified within the ICRCC Action Plan as one of the primary tools to assess the efficacy of the EDBS. The following report summarizes methods and results from implementing a network of acoustic receivers to track the movement of Bighead Carp and Silver Carp in the Dresden Island Pool and associated surrogate fish species (locally captured surrogate species: Common Carp) in the area around the EDBS within the CSSC. This network was installed and is maintained through a partnership between the USACE and other participating agencies as part of the MRWG MRP (MRWG 2020).

The purpose of the telemetry program is to assess the effect and efficacy of the EDBS on tagged fish in the CSSC and assess the behavior and movement of fish in the CAWS and upper IWW using acoustic telemetry.

GOALS AND OBJECTIVES

- Goal 1: Determine if the upstream passage of the EDBS by tagged fish has occurred and assess the risk of Bighead Carp and Silver Carp presence (barrier efficacy).
    - Objective: Monitor the movements of tagged fish near the EDBS using receivers placed immediately upstream and downstream of the EDBS.
- Goal 2: Identify lock operations and vessel characteristics that may contribute to the passage of Bighead Carp, Silver Carp, and surrogate species through navigation locks in the upper IWW.
    - Objective 1: Monitor the movements of tagged fish at Dresden Island, Brandon Road, and Lockport L&Ds using stationary receivers placed above and below each lock (N = 5) and within Lockport Lock (N = 1), Brandon Road Lock (N = 1), and Dresden Island Lock (N = 1).
    - Objective 2: Review and compare standard operating protocols and vessel lockage statistics for Lockport, Brandon Road, and Dresden Island locks for comparison of known fish passage events.
- Goal 3: Evaluate temporal and spatial patterns of habitat use at the leading edge of the Bighead Carp and Silver Carp invasion front.
    - Objective 1: Determine if the leading edge of the Bighead Carp and Silver Carp invasion (currently RM 286.0) has changed in either the upstream or downstream direction.

- Objective 2: Describe habitat use and seasonal movement in the upper IWW and tributaries where Bighead Carp and Silver Carp have been captured and relay information to the population reduction program undertaken by ILDNR and commercial fishermen.

- Additional Objectives:
  - Integrate information between agencies conducting related acoustic telemetry studies.
  - Download, analyze, and post telemetry data for information sharing.
  - Maintain existing acoustic network and rapidly expand into areas of interest in response to new information.
  - Support the modeling efforts by USFWS with supportive data and adjust the network accordingly in consultation with the Telemetry Work Group.

PROJECT HIGHLIGHTS

- To date, USACE has acquired 60.3 million detections from 8,972 tagged fish.
- No known live tagged fish have crossed the EDBS in the upstream direction.
- A high percentage of tagged surrogate fish in the lower Lockport Pool continues to be detected near the EDBS.

METHODS

In 2025, USACE tagged 23 Common Carp, with 6 (538.5 mm ± 44 mm) captured and released in Lockport Pool and 17 (543 mm ± 57 mm) in Brandon Road. As of November 2025, USACE had 50 Common Carp tags active (36 detected on 2+ receivers in 2025) in Lockport Pool, 37 Common Carp tags active (13 detected on 2+ receivers in 2025) in Brandon Road Pool, and 40 tags active (39 detected on 2+ receivers in 2025) in Dresden Island Pool. A total of 23 invasive carp tags and 20 Common Carp tags expired in 2025, and no tags are expected to expire in 2026. All receiver-download files, as well as tagged fish data, were uploaded to the USGS RAFT database.

Tagged surrogate fish have been previously released below the EDBS, but no tagged invasive carp were released above Brandon Road L&D. No invasive carp caught in Lockport or Brandon Road pools would be tagged and returned, as these areas are above the known upstream extent of the invasion front. Displaced fish exhibit site fidelity and attempt to return to their original capture location. As such, to induce more approaches to the EDBS, many of the surrogate fish previously released within lower Lockport Pool were originally captured from upper Lockport Pool.

Stationary receiver deployment and downloads were maintained from previous years' efforts. After deployment, data retrieval occurred bi-monthly throughout the season by downloading stationary receivers. A detailed description of methods can be found in the MRP and ISR (2012). Stationary receivers that were removed from the Kankakee River for winter in November 2023 were redeployed in March 2024. All other receivers within USACE network remained deployed over that same period. The layout of receiver positions within the study remained almost the same as in the previous years, with additional receivers being deployed at newly identified areas of interest (MRWG 2020, 2021). The revised study area was covered by 44 USACE stationary receivers, extending approximately 33.5 RM from the Cal-Sag Channel in Worth, Illinois, to the Dresden Island L&D on the Illinois River in Channahon, Illinois.

Barrier Efficacy – Barrier efficacy was assessed through 12 stationary receivers—four upstream and eight downstream of the EDBS—within Lockport Pool. Receivers were placed in Lockport Lock, at the lock entrance, in areas offering shallow habitat, near the EDBS, and at the confluence of the CSSC and Cal-Sag Channel. Receiver data were analyzed for individual fish detections that would indicate an upstream or downstream passage through the EDBS. Additionally, data were analyzed to assess temporal and spatial distribution patterns within lower Lockport Pool. All detections were recorded and compiled into the detection data set. Detections underwent quality assurance/quality control review to remove false detections and dead fish.

Inter-pool Movement – Four pools are defined within the study area, demarcated by the L&Ds within the system and the EDBS. Lockport Pool is defined as all waters upstream of Lockport L&D, including the CSSC and Cal-Sag Channel. Within this analysis, the pool is further separated into upper Lockport and lower Lockport. Lower Lockport Pool is characterized by the area downstream of the EDBS and upstream of Lockport L&D, while upper Lockport Pool consists of the area upstream of the EDBS to the CSSC and Cal-Sag Channel. The remaining pools include Brandon Road Pool and Dresden Island Pool, which include the Des Plaines and Kankakee rivers. VR2W/VR2Tx receivers were placed above and below each L&D, as well as at any other potential transfer point between pools. Data from the VR2W/VR2Tx receivers were analyzed for probable inter-pool movement. Dates with the nearest time interval and the pathway used for each passage were recorded for each tagged fish found to have moved between pools.

Invasive Carp Movement Analysis – A total of 39 USACE-tagged invasive carp were included for analysis within the Dresden Island Pool in 2025. The movements of individual fish were tracked via stationary receivers strategically placed throughout the Des Plaines and Kankakee rivers.

RESULTS AND DISCUSSION

The results discussed in this section will address the three goals of the study. The Chicago District continues to maintain receivers upstream of the EDBS to monitor any movement of fish from below the barrier. Results to date have shown that zero known live tagged fish have crossed the EDBS in the upstream (northward) direction.

- Goal 1: Determine if the upstream passage of the EDBS by tagged fish has occurred and assess the risk of Bighead Carp and Silver Carp presence (barrier efficacy).

In 2025, 50 tagged surrogate fish with active transmitters were at large between Lockport L&D and the EDBS. Seven stationary receivers detected the movement of 36 tagged surrogate fish throughout the pool on two or more receivers in 2025. Only these 36 fish were used for analysis. A total of 36 unique tagged Common Carp were detected near the EDBS. There was a total of 3,402,653 detections within lower Lockport Pool and zero detections in upper Lockport Pool, indicating no passage of tagged fish through the EDBS.

- Goal 2: Identify lock operations and vessel characteristics that may contribute to the passage of Bighead Carp, Silver Carp, and surrogate species through navigation locks in the upper IWW.

From 2010 to 2025, there were 120 occurrences of tagged fish moving downstream and 55 occurrences of upstream movement between navigation pools (Table 1). There were four occurrences of inter-pool movement by three tagged fish (all Common Carp) in 2025. There were four occurrences of fish passage in 2025, all occurring by Common Carp downstream through Lockport Control Works. All passages occurred in a four-day window from August 15 to 19. The receiver immediately below Dresden L&D was not downloaded in 2025, so passages through Dresden L&D were not evaluated for this document.

Table 1. *Total occurrences of inter-pool movement by tagged fish from 2010 to 2025. * Indicates did not have required data to analyze.*

Location	Up	Down	Total
Lockport Lock	23	28	51
Control Works	4	40	44
Brandon Road	6	17	23
Dresden Island*	22	35	57

- Goal 3: Evaluate temporal and spatial patterns of habitat use at the leading edge of the Bighead Carp and Silver Carp invasion front.

A total of 41 invasive carp in Dresden Island Pool across 25 USACE receivers were included for analysis. The 2024 trend of consistent use of the CENPP discharge canal by invasive carp continued in 2025. USACE has had acoustic receivers within the discharge since the fall of 2023. Invasive carp use the canal during the winter months and well into late spring/early summer. In 2024 and 2025, many of the tagged carp were not detected within the discharge canal in mid-June. It appears that the tagged carp leave the discharge canal and start to congregate outside the canal around the time that the CENPP turns to an open cycle, pumping warm water through the discharge canal and into the Illinois River. This typically occurs around June 15 and remains an open cycle until October 15. Around June 15, more carp were detected on receivers located near the mouth of the discharge canal and across the main channel from the discharge canal. Due to the high flow, tagged carp may be outside the canal, where less energy is used fighting the current but still close enough to the high flow to take advantage of abundant food from the current leaving the discharge canal and cooling lake. Collaboration with USGS and ILDNR to place a real-time receiver within the discharge has led to increased removals within the discharge canal.

Four additional receivers were placed within the Constellation Energy cold water canals in early 2024 to evaluate invasive carp use of the canals. Twelve unique invasive carp were detected within the cold-water canals in 2024, and in 2025, only four invasive carp were detected, with most of these detections occurring from March to early June. Additional analysis on invasive carp movement within the CENPP is in progress.

Extensive use of Rock Run Rookery by Silver Carp continued this year, opposite to what was seen in 2022 through 2023, when no invasive carp were detected in Rock Run Rookery. None of the invasive carp tagged in the lower Dresden Island Pool was detected in Rock Run Rookery during 2024 or 2025. Invasive carp tagged in Rock Run Rookery were detected in other areas, such as the lower Kankakee River or the CENPP discharge canal. Historical data shows similar trends, where a large proportion of detected invasive carp within Rock Run Rookery were tagged in Rock Run Rookery, and very few fish tagged outside of Rock Run Rookery were detected inside the backwater.

RECOMMENDATIONS

USACE recommends continuing the telemetry program and maintaining the target level of surrogate species and invasive carp tags within the system by replacing expired tags throughout all three pools below the EDBS in the spring and fall of 2026. USACE will continue to collaborate with MRWG partners to maximize our understanding of invasive carp movement and biology within Dresden Island Pool. USACE recommends continued collaboration with MRWG partners to perform comparisons of surrogate species to Bighead Carp and Silver Carp. Understanding how well Common Carp and other surrogates represent the behavior of invasive carp is important in determining the usefulness of the data collected from those surrogate species near the EDBS.

USACE recommends maintaining acoustic receivers within the Constellation Energy Nuclear Power Plant cold water canals for an additional year to further identify the timing of when invasive carp are using the canals and are susceptible to commercial removals. Additional tagging of invasive carp in the middle pool (I-55 downstream to the confluence of the Kankakee and Des Plaines rivers) is recommended to determine if middle pool tagged fish are utilizing Rock Run Rookery as well, or if Rock Run Rookery fish may be originating from other locations. USACE will assist with tagging and monitoring around the INHS one-way passage devices used in Dresden Island to determine ways to optimize removals within key habitats (Rock Run Rookery) used by invasive carp.

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TELEMETRY SUPPORT FOR THE SPATIALLY EXPLICIT INVASIVE CARP POPULATION (SEICarP) MODEL

Participating Agencies: USFWS, Carterville FWCO Wilmington Substation (lead), SIU, USACE, USGS

MRWG Work Group: Telemetry

Pools Involved: Peoria and Starved Rock

INTRODUCTION AND NEED

The SEICarP model was developed as a means of assessing the invasive carp population status in the IWW. SEICarP is a movement probability model used to inform researchers how invasive carp populations respond to management strategies (Brey et al. 2022). The model functions as an important tool that can be used by fisheries managers to inform harvest and control of adult invasive carp (primarily Silver Carp and Bighead Carp) in the IWW. Harvesting from source populations downriver to reduce propagule pressure and physical barriers (dams) are believed to reduce movement probabilities upstream (Kallis et al. 2022; Baker 2017). The USFWS telemetry data complements telemetry data being collected throughout the IWW, describing inter-pool transfers of adult invasive carp, and is used to parameterize the movement probability component of the SEICarP model. This research provides an improved understanding of invasive carp movement in the IWW and its effects on population dynamics. Variations in invasive carp movement, distribution, and habitat in the IWW make targeting invasive carp challenging and costly (ICRCC 2024). To assist this effort, a multi-agency telemetry array maintained across the pools in the IWW provides the parameters for the SEICarP model. A large telemetry array can be used to better understand movement patterns to inform harvesting efforts, monitoring, and contingency actions based on invasive carp movement through these joint efforts (ICRCC 2024). USFWS Wilmington FWCO's involvement maintains an acoustic telemetry array that spans the Peoria and Starved Rock pools.

OBJECTIVES

- Collectively tag 150 individual invasive carp within Peoria and Starved Rock pools, primarily Silver Carp. Forty-five of these tags are to be implanted in bigheaded carp in Marseilles Pool to facilitate USGS invasive carp movement studies.
- Tag an additional invasive carp in Peoria Pool and Starved Rock Pool using a recovered tag from 2024 harvesting efforts from each of those two pools.
- Deploy and maintain an array of 20 69-kHz receivers (Innovasea) within Peoria and Starved Rock pools to enhance detections of transient fish and inter-pool movements.
- Provide data from the acoustic receiver array to the Telemetry Work Group for use in the SEICarP model and pool transition data for the Modeling Work Group for the SCAA.

PROJECT HIGHLIGHTS

- In April 2025, 152 V-9 acoustic transmitters (Innovasea) were implanted inside invasive carp; 56 in the Peoria Pool, and 51 in the Starved Rock Pool. Forty-five Silver Carp were tagged in Marseilles Pool to assist USGS with their telemetry work.
- Two additional Silver Carp were tagged in Starved Rock and Peoria pools with viable tags from recaptured fish in 2024.
- Data from the 20 (16 VR2Tx, 4 VR2W) 69-kHz acoustic receivers were collected, processed, and provided to the Telemetry Work Group.

METHODS

The location of each receiver station in the Peoria and Starved Rock pools is shown in Figure 1. In March 2025, 20 69-kHz “Innovasea” acoustic receivers were deployed and downloaded bi-monthly through January 2026. In April 2025, 150 Bighead Carp were tagged with V9 acoustic telemetry tags (Innovasea). Two additional Silver Carp were implanted with tags recovered from 2024 commercial fishing harvest events. The data was uploaded to the USGS RAFT network within 2 weeks of being collected. End-of-month reports were made following receiver downloads, with detections summarized into detection categories. All receivers were tethered to trees to reduce the loss of the receiver. The receivers were removed and downloaded in December 2025 to prevent potential ice flows from breaking receivers from their tethers. There were four remaining receivers in Peoria Pool that were collected and downloaded in January 2026. These could not be retrieved in December due to ice and weather conditions on the river. This was the final year that USFWS supplied telemetry data for the SEICarP program. The receiver array will be redeployed in March 2026 to collect transition movement between Peoria and Starved Rock pools for the SCAA.

RESULTS AND DISCUSSION

A total of 1,452,885 detections from 255 unique tags were recorded across the 20 USFWS-maintained 69-kHz receiver array from March 3, 2025, to January 13, 2026 (Table 1). One hundred fifty-five fish tagged by USFWS between the years 2022 and 2025 were detected in the array. One hundred unique tags came from non-USFWS fish. All data was uploaded to the USGS RAFT by January 2026.

Figure 1. *Locations of USFWS Carterville FWCO acoustic receiver stations across Peoria and Starved Rock pools.*

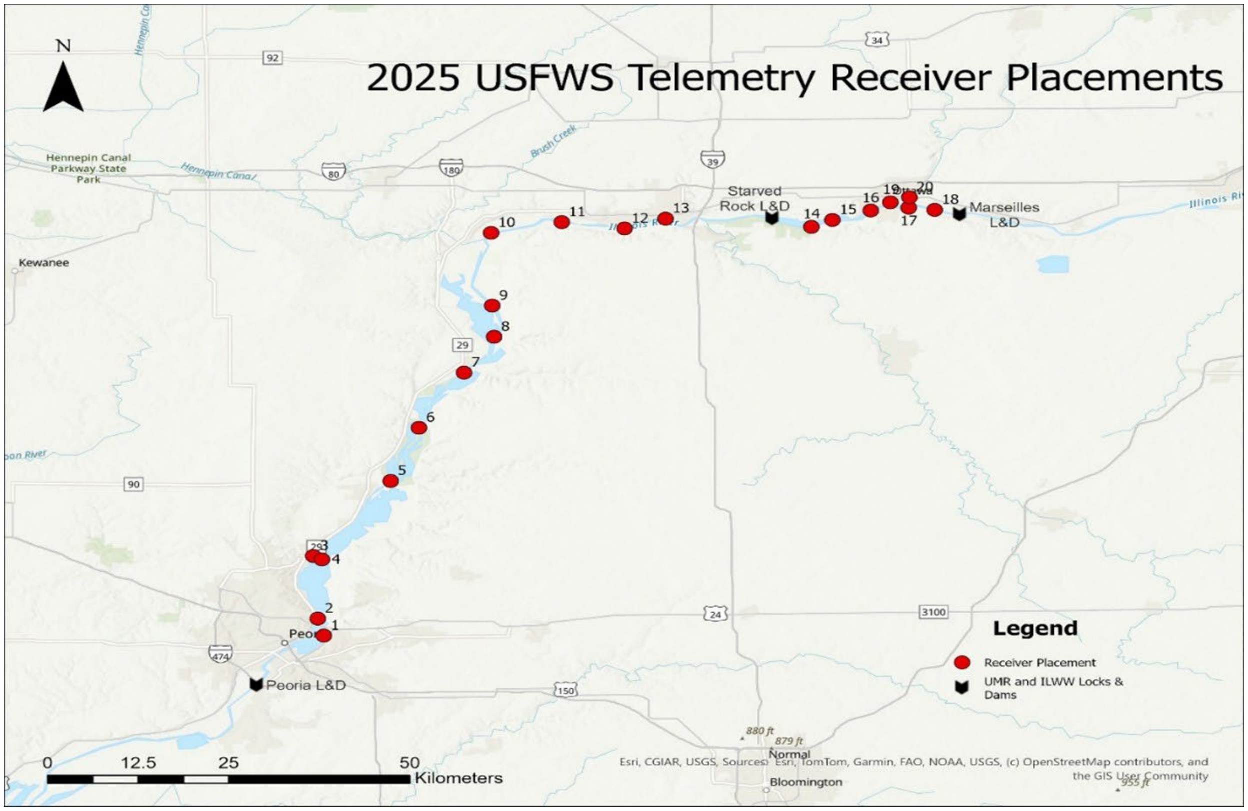


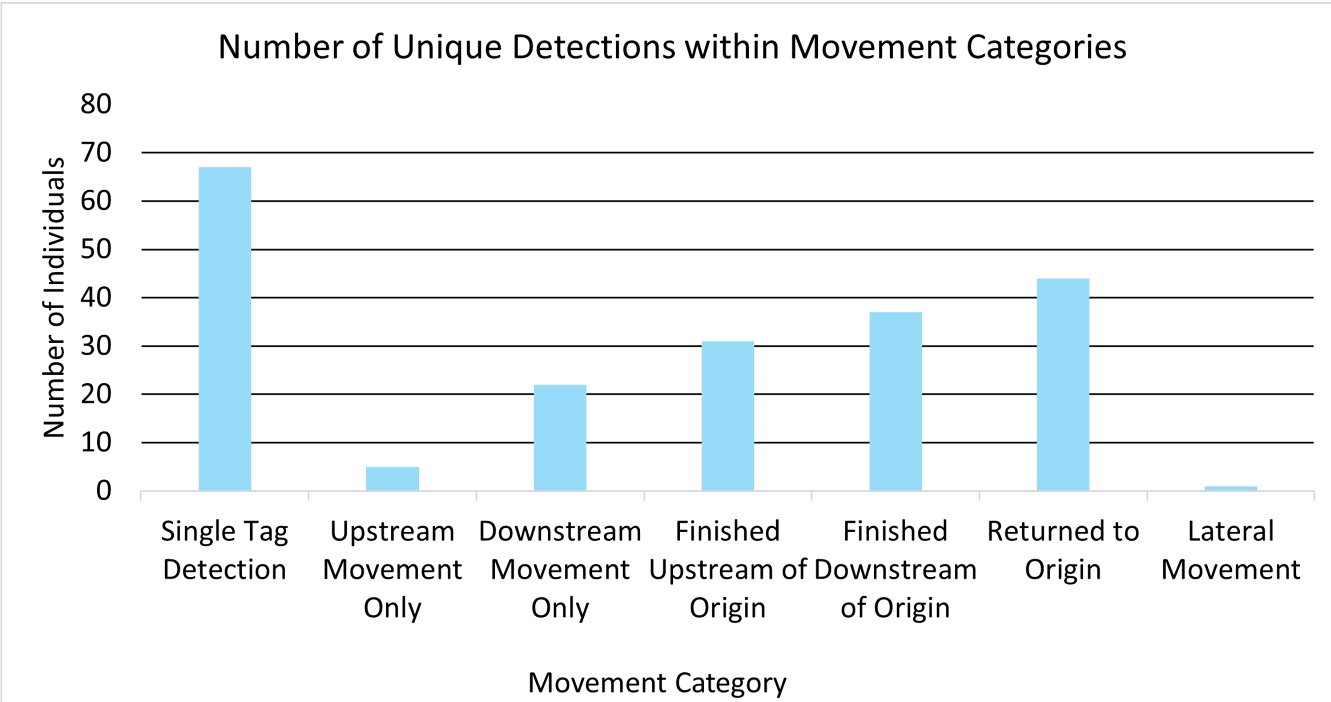
Table 1. *Data downloaded from 69-kHz Innovasea VR2Tx and VR2W receivers from March 5, 2025, to January 13, 2026. Receiver Number and "River Mile" (RM) corresponds to receiver locations shown in Figure 1. Main Channel (MC), upstream (US), and downstream (DS) locations are abbreviated. No RMs are associated with the Fox River receivers, as it is a tributary to the Illinois River. The total number of unique tags at the bottom of the table is the number of individuals contributing to the number of unique tags detected at each receiver.*

Receiver Number	Receiver Station Location	Unique Tags Detected by Receiver	Number of Detections
1	RM164.8 Lower Peoria Lake Point River Left	36	59,797
2	RM166.6 Peoria Lake Narrows	37	1,763
3	RM173 Upper Peoria Lake River Right	25	1,426
4	RM173 Upper Peoria Lake River Left	24	1,088
5	RM182.4 US Chilli Bridge Peninsula	30	1,877
6	RM188.1 DS Lacon MC Sawyer Slough	67	57,305
7	RM194.8 US Upper Henry Island	40	15,261
8	RM199.1 Senachwine Lake Peninsula	36	39,401
9	RM202.7 Lower Twin Sisters Island	34	71,450
10	RM211 MC Near Depue Lake Channel	48	66,276
11	RM216 US of Clark Island	44	14,875
12	RM219.8 US Spring Valley River Left	50	86,163
13	RM223 Peru US Route 251 Bridge	41	32,180
14	RM233.9 Lone Point Delbridge Side Channel	26	161,555
15	RM235.1 MC Sheehan Island	48	142,348
16	RM238.5 Hitt-Mayo Straight	69	151,956
17	RM241 Bulls Island MC Abandoned Harbor	27	120787
18	RM243 US of Heritage Harbor River Left	24	227,456
19	Fox River-US Illinois River Confluence	74	191,866
20	Fox River-US Rt.6 Bridge	18	8,055
-	**TOTALS**	255	1,452,885

Figure 2 summarizes the movement categories from the beginning to the end of the fish's detection period. Detection periods are detections made by tagged individuals between receiver deployments and data retrieval. Results from the number of fish detected within seven movement categories show that most of the fish were detected on a single receiver and displayed little longitudinal movement. The second-highest group was fish that ended their transmission by returning to their original point of origin. Very few individuals continued their movement upstream compared to the other movement categories.

Almost no lateral movement was detected between the two receivers at upper Peoria Lake, River Left and River Right (RM 173).

Figure 2. *Numbers of fish detections within each movement category at the end of their detection period across the 2025 field season.*



RECOMMENDATIONS

In March 2026, USFWS plans to shift its telemetry support to the SCAA model. This will focus on concentrating receiver and tagging efforts around the Starved Rock L&D to detect transitions from the lower to the upper pools. In April 2026, USFWS will tag another 125 adult bigheaded carp between Peoria and Starved Rock pools. The Telemetry and Modeling Work Groups will be consulted prior to tagging and deployment to optimize receive placement within the IWW.

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REMOVAL WORK GROUP PROJECTS

- Contracted Commercial Fishing Below the Electric Dispersal Barrier
- Invasive Carp Enhanced Contract Removal Program

CONTRACTED COMMERCIAL FISHING BELOW THE ELECTRIC DISPERSAL BARRIER

Participating Agencies: ILDNR (lead); INHS; Allie Lenaerts, Andrew Wieland, Madison Meyers (INHS), Eli Lampo, Justin Widloe, Claire Snyder, Brian Schoenung, Kevin Irons, Mindy Barnett (ILDNR)

MRWG Work Group: Removal

Pools Involved: Dresden Island, Marseilles, Starved Rock

INTRODUCTION AND NEED

This project uses contracted commercial fishers to reduce invasive carp abundance and monitor changes in range in the Des Plaines River and upper Illinois River downstream of the EDBS. By decreasing invasive carp abundance, we anticipate reduced migration pressure toward the barrier, lessening the chances of invasive carp gaining access to upstream waters in the CAWS and Lake Michigan. Monitoring for upstream expansion of invasive carp should help identify changes in the leading edge, distribution, and relative abundance of invasive carp in the IWW. The “leading edge” is the furthest upstream location where multiple Bighead Carp or Silver Carp have been captured with conventional sampling gears during a single trip or where individuals of either species have been caught in repeated sampling trips to a specific site. Trends in catch data over time may also contribute to understanding invasive carp population abundance and movement between and among pools of the IWW.

OBJECTIVES

- Monitor the presence of invasive carp in the five pools (Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock) below the EDBS in the IWW.
- Reduce invasive carp densities, lessening migration pressure to the EDBS, thus decreasing chances of invasive carp accessing upstream reaches (e.g., CAWS and Lake Michigan).
- Inform other projects (i.e., hydroacoustic verification and calibration, modeling, small fish monitoring, and telemetry master plan) on invasive carp population distribution, dynamics, and movement in the IWW downstream of the EDBS.

PROJECT HIGHLIGHTS

- Since 2010, commercial fishers’ effort in the upper IWW below the EDBS includes 6,326 miles (10,181 kilometers) of gill/trammel net, 23 miles (37 kilometers) of commercial seine, 239 Great Lakes pound net nights, and 4,369 hoop net nights.
- From 2010 to 2025, 106,955 Bighead Carp, 1,916,468 Silver Carp, and 12,977 Grass Carp were removed by contracted fishers. The total estimated weight of invasive carp removed since 2010 is 8,511 tons (17,022,381 pounds).
- No invasive carp have been collected in Lockport or Brandon Road pools since the inception of this project in 2010.

- The leading edge of the invasive carp population remains near Rock Run Rookery in Dresden Island Pool (approximately RM 281; 452 kilometers from Lake Michigan). No appreciable change has been found in the leading edge over the past 12 years.
- Since 2010, this program has been successful at managing the invasive carp population in the upper Illinois River. Continued implementation of this project will provide the most current data on invasive carp populations at their leading edge and reduce pressure on the EDBS.

METHODS

Contracted commercial netting occurred from February through December in Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock pools of the IWW. The section of the Kankakee River from the Des Plaines Fish and Wildlife Area boat launch downstream to the confluence with the Des Plaines River was included in the Dresden Island Pool (Figure 1). These areas are closed to commercial fishing by Illinois Administrative Rule (*i.e., Part 830: Commercial Fishing and Musseling in Certain Waters of the State, Section 830.10(b): Waters Open to Commercial Harvest of Fish)*; therefore, an agency biologist is required to accompany contracted commercial fishing crews working in this portion of the river. Contracted commercial fishers with assisting agency biologists typically fished 4 days a week during each week of the field season, except for 2 weeks in May and October. Sampling occurred upstream of the EDBS for the SIM project.

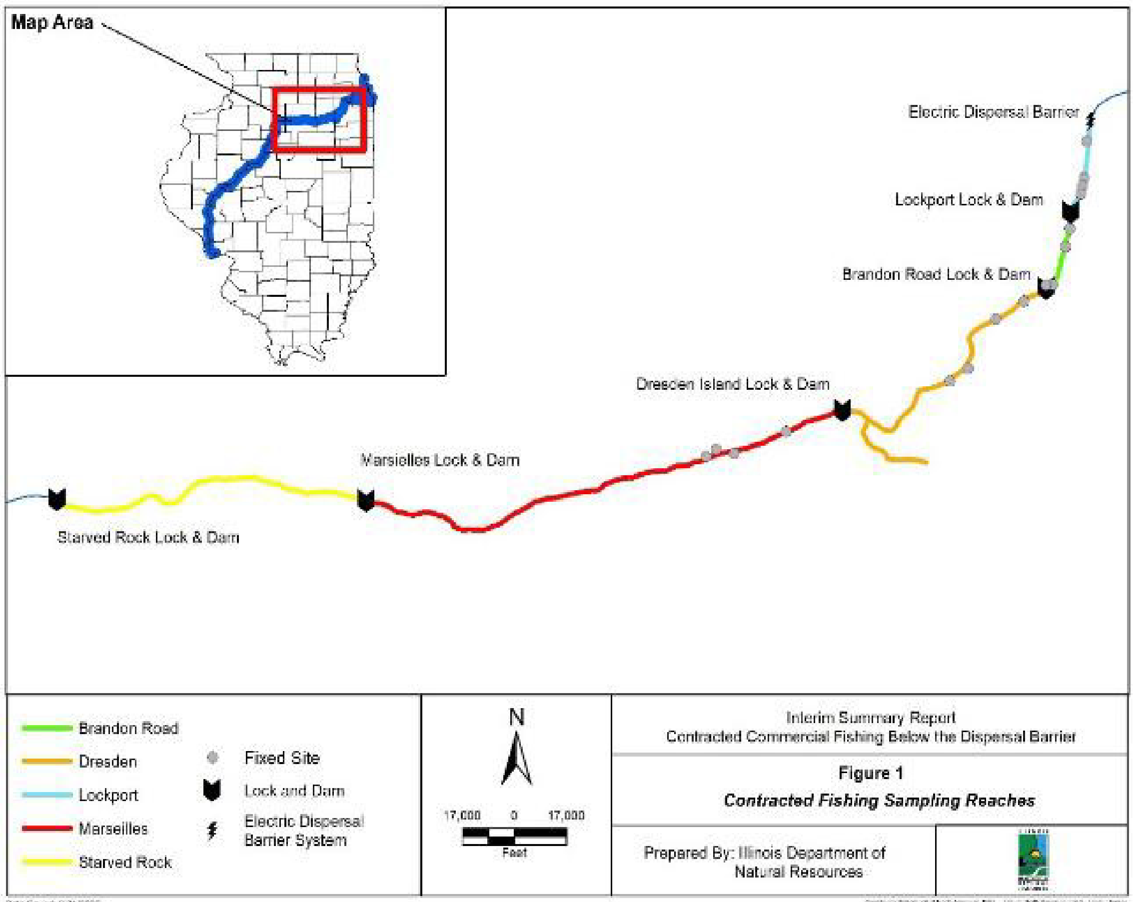
Contract fishing occurred monthly at targeted sites throughout each pool. Four fixed sites, each in Lockport, Brandon Road, Dresden Island, and Marseilles pools, were also sampled monthly (Figure 1). These data were merged to comprehensively understand invasive carp spatial and temporal abundance below the EDBS, especially at their upper-most extent in Dresden Island Pool. However, because invasive carp abundance and fishing locations are spatially heterogeneous within pools, areas of special interest to MRWG (Rock Run Rockery and Dresden Island above I-55) were analyzed individually. This will make pertinent results more easily interpreted, allowing better relative abundance inferences to be drawn in areas of highest concern (e.g., Dresden Main Channel Above I-55).

Large mesh (2.5 to 5.0 inches; 63.5 to 127 mm) gill and trammel nets set in 100- to 1,200-yard segments were used, and fish herding techniques (e.g., pounding on boat hulls, hitting the water surface with plungers, and driving with motors trimmed up) were utilized to drive fish into the net (Butler et al. 2018). Nets were typically set for 20 to 30 minutes. Overnight net sets occasionally occurred in off-channel habitats and non-public backwaters with no boat traffic.

Entangled fish were removed from the net, identified, enumerated, and recorded. All invasive carp and Common Carp were checked for telemetry tags, and all non-tagged invasive carp were harvested and utilized by private industry for purposes other than human consumption (e.g., chum bait, converted to liquid fertilizer, pet treats, food for injured animals, etc.). All tagged invasive carp and all non-invasive carp bycatch were released alive into the water. A representative sample of up to 30 individuals of each invasive carp species (Bighead Carp, Grass Carp, and Silver Carp) from each pool was measured for total length (mm), weighed (grams), and sexed (male or female) one to two times a week to provide estimates of total weight harvested and gather morphometric data on harvested invasive carp over time.

Unified fishing methods were implemented in Dresden Island Pool and the East and West Pits of Hanson Material Services in Marseilles Pool, lasting approximately 1 week each. Gill and trammel nets were set, and fishers used systematic herding techniques in unison to drive fish into nets. Block nets were used to partition the East and West Pits, and the sections were cleared of invasive carp. Great Lakes pound nets were set to block fish from moving out of areas, and commercial seines were pulled to remove mass amounts of invasive carp.

Figure 1. *Contracted commercial fishing sampling area and locations of fixed sites sampling of the contract fishing below the electric dispersal barrier project.*



RESULTS AND DISCUSSION

Since 2010, 6,326 miles (10,181 kilometers) of gill/trammel net, 24 miles (38 kilometers) of commercial seine, 239 Great Lakes pound net nights, and 4,369 hoop net nights have been deployed in the upper IWW. The total estimated weight of invasive carp caught and removed from 2010 to 2025 is 17,022,381 pounds. Silver Carp remains the most abundant invasive carp species in the upper Illinois River, in contrast to 2010, when Bighead Carp comprised approximately 93 percent of total invasive carp catch by weight.

The 2025 gill/trammel net CPUE (number of fish per 1,000 yards of net) in Starved Rock Pool was 298, an increase from 295 in 2024. The gill/trammel net CPUE in Marseilles Pool was 110, an increase from 57.11

in 2024 (Figure 2). The 2025 gill/trammel net CPUE in Dresden Island Pool (leading edge) was 3.1, a decrease from 3.6 in 2025 (Figure 2). For details regarding gill/trammel CPUE of invasive carp for all pools combined from other years, see those years' respective ISRs found online at https://icrcc.fws.gov. We attribute the increase in CPUE in the Marseilles and Starved Rock pools to increased targeted sampling throughout the 2025 season. Contracted commercial fisher and ILDNR biologists deployed two commercial seine hauls in the Starved Rock Pool, removing 45,155 individual invasive carp over the course of 8 days (Figure 3).

Effort and Catch of Invasive Carp within Pools

***Dresden Island Pool**:* Invasive carp abundance is relatively low in Dresden Island Pool compared to downstream pools, and monitoring is essential because the leading edge of the Silver Carp and Bighead Carp population occurs here. In 2025, 1 percent of the total harvested invasive carp came from Dresden Island Pool. Contracted commercial fishing efforts included 53,680 yards (49.1 kilometers) of gill/trammel net. In 2025, 158 Silver Carp and 5 Bighead Carp were harvested from Dresden Island Pool (including Rock Run Rookery, the lower Kankakee River, and the Dresden Nuclear Power Station warm water discharge) (Figure 2).

CPUE estimates for the entire Dresden Island Pool are highly stochastic, likely due to changes in access to fishing hotspots, varying demographics through time (size structure), and environmental and hydrological variation.

***Marseilles Pool**:* In 2025, 7 percent of the total harvested invasive carp came from Marseilles Pool. Contracted commercial fishing efforts included 77,968 yards (71.3 kilometers) of gill/trammel net. In 2025, 8,330 Silver Carp, 232 Bighead Carp, and 1 Grass Carp were harvested from Marseilles Pool, amounting to 46 tons (101,604 pounds) removed. In 2025, Silver Carp dominated the invasive carp catch in Marseilles Pool (98 percent), consistent with the past 8 years. Prior to 2013, Bighead Carp was the dominant invasive carp species caught in the Marseilles Pool.

Starved Rock Pool: In 2025, 92 percent of the total harvested invasive carp came from Starved Rock Pool. Contracted commercial fishing efforts included 418,000 yards (382 kilometers) of gill/trammel net. In 2025, 123,990 Silver Carp, 231 Bighead Carp, and 420 Grass Carp were harvested from Starved Rock Pool from gill/trammel nets, amounting to 370 tons (814,965 pounds) removed. Silver Carp dominated the catch of invasive carp in Starved Rock Pool in 2025 (99 percent), consistent with years past.

Figure 2. *Annual mean CPUE (number of fish per 1,000 yards of gill/trammel net) of invasive carp for Starved Rock, Marseilles, and Dresden Island pools (2010 to 2025).*

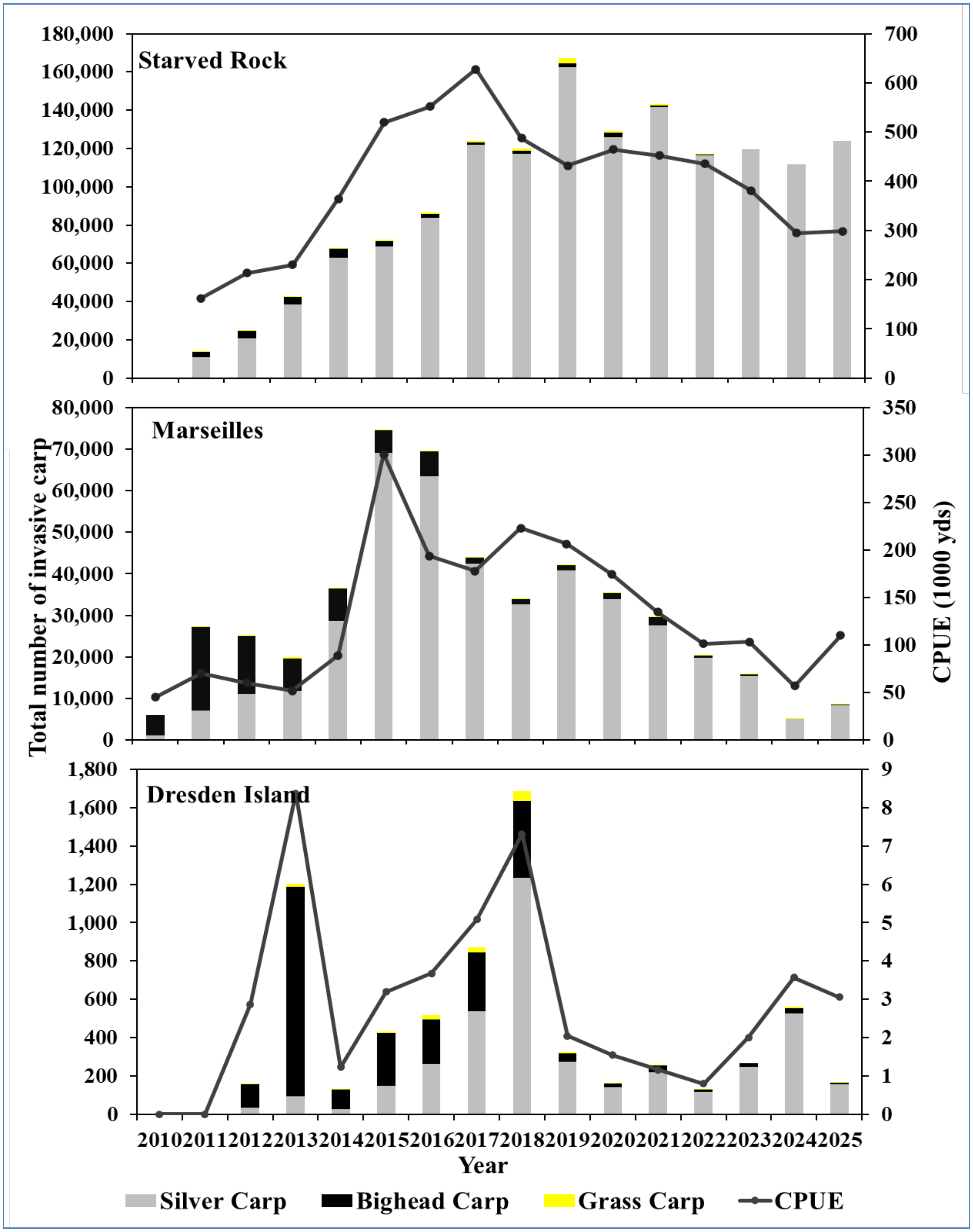
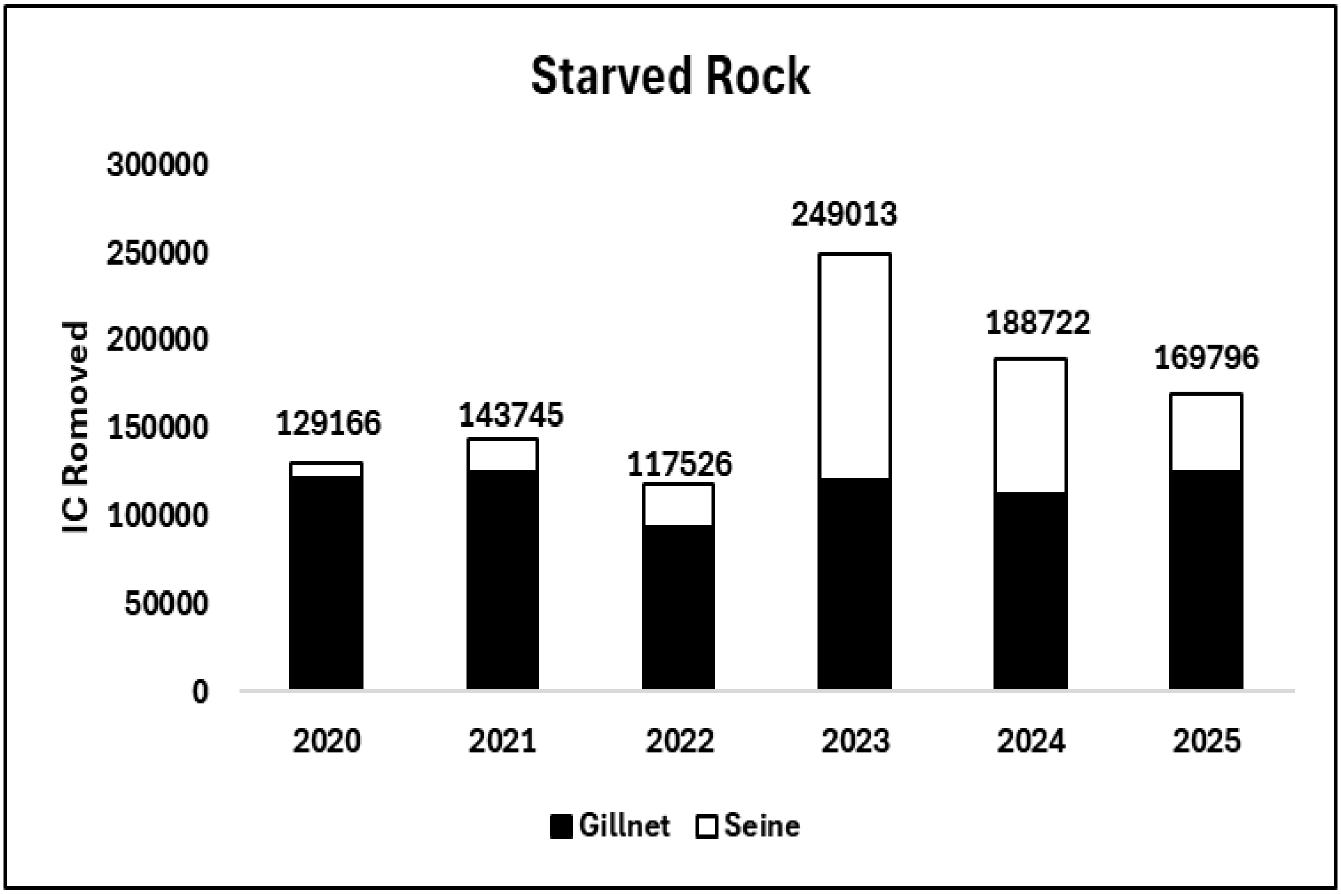


Figure 3. *Number of invasive carp removed using commercial seine and gill net in Starved Rock Pool (2010 to 2025).*



In March 2025, 27 percent (302,245 pounds) of the invasive carp biomass removed in Starved Rock Pool was the result of two commercial seine hauls at Bull's Island and Sheehan Island (Ottawa, Illinois). Out of the 169,796 invasive carp removed from Starved Rock Pool, 45,155 of those individuals were removed via commercial seine (Figure 3). There was minimal bycatch, and Silver Carp comprised 99 percent of the biomass removed. The total weight of this effort and biomass removed via gill and trammel net is 1,117,210 pounds. In 2025, a combined total of 1,221,781 pounds of invasive carp were removed from the Dresden Island, Marseilles, and Starved Rock pools.

RECOMMENDATIONS

Since 2010, this program has been successful at managing the invasive carp population in the upper IWW by significantly decreasing relative biomass near the population front in Dresden Island Pool (Coulter et al. 2018). With these efforts, we hope to further reduce invasive carp abundance at and near the detectable population front and reduce potential propagule pressure on the EDBS. In addition to those core goals, the MRWG Detection and Removal Work Group leads identified several future priorities, including gaining a better understanding of invasive carp abundance and distribution in Dresden Island Pool, assessing how invasive carp species respond to removal at multiple scales, and identifying locations or pools where harvest can have the greatest impact on invasive carp populations. Long-term harvest data provides information necessary to model changes in invasive carp relative abundance and population demographics among pools of the upper IWW in response to management actions. This project will continue to directly inform multiple MRWG work groups (Detection and Removal), and objectives will continue to be adapted by work group leads to better accomplish overall MRWG priorities. Contracted commercial fishing is a critical tool in managing invasive carp populations, and we recommend this program continue in 2026.

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Coulter, D.P., R. MacNamara, D. C. Glover, J. E. Garvey. 2018. Possible unintended effects of management at an invasion front: Reduced prevalence corresponds with high condition of invasive bigheaded carps. Biological Conservation 221:118-1.

INVASIVE CARP ENHANCED CONTRACT REMOVAL PROGRAM

Participating Agencies: ILDNR (lead); USEPA and GLFC (project support)

MRWG Work Group: Removal

Pools Involved: Peoria, La Grange, Alton

INTRODUCTION AND NEED

The ICRCC and MRWG recognize the value of increased harvest of invasive carp in the Illinois River, informed by current fishery stock assessment data. Modeling efforts have provided insights, recommending that removal from downstream reaches can heighten the protection of the Great Lakes by preventing fish population growth upstream.

OBJECTIVES

- Aid in reaching a target removal rate of 20 to 50 million pounds of invasive carp per year from the IWW below Starved Rock L&D.
- Remove 6.8 million pounds of invasive carp under the Enhanced Contract Fishing Program between July 1, 2025, and December 31, 2026, while working toward removing 35 million pounds cumulatively by December 31, 2026.
- Coordinate fishers and processors to increase cooperation with an end goal of increasing the scale of removal operations to satisfy larger orders for harvested invasive carp.
- Leverage other programs, such as the Market Value Program, to continue building increased demand for harvested invasive carp.
- Leverage the new Copi brand launch toward increased removal.

PROJECT HIGHLIGHTS

- Removed more than 5.8 million pounds under this program from the Peoria, La Grange, and Alton pools of the Illinois River in 2025.
- Removed 33.7 million pounds under this program since its inception in 2019.
- Entered into 39 contracts with Illinois-licensed commercial fishers targeting the Peoria, La Grange, and Alton pools.
- Processed over $581,000 in payments to fishers in 2025.
- Continued work to support the Copi brand, with increased domestic and international interest and development of new value-added products using the brand.

MODELING WORK GROUP PROJECTS

- USGS Invasive Carp Database Management and Integration Support
- Support for Invasive Carp Population Modeling in the Illinois River

USGS INVASIVE CARP DATABASE MANAGEMENT AND INTEGRATION SUPPORT

Participating Agencies: USGS (lead); ILDNR; INHS; USFWS; USACE; SIU; Aaron Murphy, Marybeth Brey, Sierra Schuster, Dan Fedorenko (USGS-UMESC)

MRWG Work Group: Modeling

Pools Involved: N/A

INTRODUCTION AND NEED

Invasive carp tracking, monitoring, and contracted removal will continue throughout the Illinois River and upper Mississippi River as part of an adaptive management effort to mitigate, control, and contain invasive carp. To facilitate these actions, a need to compile and analyze invasive carp-related data from all agencies exists. Invasive carp-related data include all data sources that could inform the MRWG objectives or projects. This data, often in disparate formats, must be integrated into a common format that allows all agencies the opportunity to assess invasive carp monitoring, control, and removal efforts. Ensuring the interoperability of these datasets allows for their use in various analyses and modeling efforts. Implementing an interoperable data management framework provides mechanisms for end-users to find and use integrated data. Integrating data for use in modeling and analysis furthers the partnership's collective understanding of invasive carp life history, distribution, and movement and can be used to facilitate adaptive management actions (e.g., directing monitoring, sampling, and removal efforts; assessing invasive carp abundance to support modeling efforts; informing deployment of control actions; etc.). An effective data management strategy will streamline the data update process, providing all agencies with timely data and analyses in support of informed decision-making processes.

OBJECTIVES

- Provide data management, informational products, and decision support tools for scientists and managers to aid and inform the management and removal of invasive carp in the IWW.
- Integrate and transform invasive carp-related datasets into actionable information.
- Develop and maintain the RAFT Network, CarpDAT, and Invasive Carp Open Data Hub applications to facilitate partner (e.g., Modeling Work Group, Telemetry Work Group, etc.) objectives via data compilation, management, and summarization.
- Support modeling efforts to inform management decisions by making data findable, accessible, interoperable, and reusable.

PROJECT HIGHLIGHTS

RAFT Network

- Published the RAFT web application with 30 member projects, over 1,300 receivers, 12,000 transmitters, and 200M detections. Completed extensive bug fixes, optimization, and testing (Home Page - RAFT).

- Finished data upload and download features for acoustic transmitters and receivers. Developed metadata templates for data submission. Implemented process for sharing matched detection extracts with RAFT project PIs.
- Added legacy partner telemetry data to RAFT. Used Python notebooks to QA/QC data from USGS, USACE, USFWS, SIU, and other RAFT members.
- Enhanced the tag lookup tool with species identification and added a new receiver map filter option.
- Developed a data visualization page for each project with summary charts to visualize data on counts and distribution of transmitters, species, and receivers.
- Presented an overview of RAFT to USFWS invasive carp sub-basin partnerships (lower Mississippi, Missouri, Ohio, and Tennessee–Cumberland river subbasins). Hosted webinars to train new and existing RAFT users.
- Continued to collaborate with OTN to share detections with other nodes and improve the QA/QC process.
- Finalized Terms and Conditions to explain data management and sharing (RAFT_TermsAndConditions_20250421_FINAL.pdf).
- Completed cloud migration planning and began coordination with Cloud Hosting Solutions for Amazon Web Services deployment using AI-assisted tools.

CarpDAT (Data, Analysis, Tools)

- Coordinated with USFWS to refine system needs and define data-modeling and demographic requirements.
- Evaluated adapting the Open Data Hub to support CarpDAT's architecture and functional requirements.
- Presented updated CarpDAT plan to USFWS subbasin coordinators and outlined steps for renewed progress.

Invasive Carp Open Data Hub

- Maintained and updated the Hub by adding 220 publications, documents, spatial datasets, images, and maps, including bathymetric, benthic, and hydroacoustic data.
- Planned for future quarterly updates.
- Presented the Hub at the Upper Midwest Invasive Species Conference and USGS Invasive Carp Science Meeting.
- Hub published at: https://geonarrative.usgs.gov/invasivecarpopendatahub/.

METHODS

The RAFT Network is a web-based, centralized location to access, archive, and visualize fish acoustic telemetry data for the Mississippi River Basin. RAFT is an ASP.NET web application linked to a PostgreSQL database. Development of an acoustic telemetry database started at SIU in 2009 using Microsoft Access and eventually grew into a USGS-managed web application called FishTracks. The FishTracks application was redeveloped and renamed RAFT in 2024 to meet updated information technology requirements and support long-term maintenance.

CarpDAT is expected to act as a web-based, centralized location to house data, metadata, and references to facilitate the transfer of knowledge between invasive carp researchers and management agencies. The USGS and USFWS have signed an MOU between agencies to define roles and responsibilities moving forward.

The Invasive Carp Open Data Hub is an ArcGIS-based platform to share datasets, applications, and publications from USGS invasive carp research and inform future research and management.

RESULTS AND DISCUSSION

In 2025, the RAFT web application was published with a provisional USGS data release and currently includes 30 projects and over 200 million records of detection. Prior to publication, the development team completed data upload and download features, created metadata templates, and created a data visualization page for each project. New and legacy data are being added to RAFT as received. The development team has refined the transmitter lookup tool and receiver map based on user feedback. RAFT was presented to multiple Mississippi River subbasin working groups and users, paving the way for broader subbasin data integration and collaboration. The team also developed a detailed plan for migrating RAFT to “the cloud” in coordination with USGS Cloud Hosting Solutions, incorporating AI-enabled development tools.

The CarpDAT system will provide researchers and managers with a centralized location to find invasive carp data and information. During 2025, USGS and USFWS were impacted by staffing losses, and development was slowed. The team reevaluated the project direction to identify priority needs and opportunities to advance development. Coordination meetings were held with the USFWS Mississippi River Invasive Carp Subbasin coordinators to plan data acquisition.

The USGS Invasive Carp Open Data Hub was published in 2024 and is available to the public and invasive carp researchers. In 2025, USGS added 220 publications, documents, datasets, and maps to the Hub.

SUPPORT FOR INVASIVE CARP POPULATION MODELING IN THE ILLINOIS RIVER

Participating Agencies: USFWS Carterville FWCO (lead), USFWS La Crosse FWCO, USGS–UMESC, and ILDNR

MRWG Work Group: Modeling

Pools Involved: Alton, La Grange, Peoria, Starved Rock, Marseilles, Dresden Island, Brandon Road, Lockport; the lower Kankakee and Des Plaines rivers.

INTRODUCTION AND NEED

The goal of this project is to develop objective, data-driven tools in support of the adaptive management process and invasive carp control efforts in the Illinois River. To accomplish this goal, this project focuses on developing novel quantitative tools, such as an SCAA model, to address questions regarding the effects of incentivized removal efforts on the status of invasive carp populations. The SCAA can be used to develop new management targets based on the current assessment of the invasive carp population.

To better understand the effectiveness of removal efforts at reducing the Illinois River invasive carp population, the modeling work group plans to develop an SCAA model following the recommendations of Bence and Brendan (ICRCC 2022). SCAA models are a flexible stock assessment method that can use information from fisheries-dependent, catch-at-age data, as well as other data sources (e.g., fisheries-independent indices of abundance) to estimate the abundance, biomass, and fishery characteristics of age-structured populations through time. Currently, age data for invasive carp harvested through incentivized harvest methods are insufficient to support an SCAA model, and although this type of model can be used to generate estimates for biomass and fishing mortality rates, which will allow us to estimate the proportion of invasive carp biomass removed by contracted fishing every year, interim analyses are necessary while additional data are collected.

A length-based Bayesian biomass analysis is a less robust alternative to an SCAA model that can help the MRWG understand the status of the invasive carp population in the upper Illinois River while data to support the SCAA model are being collected. This model uses length data from incentivized harvest and a series of fisheries equations to estimate the status of a population by comparing the ratio of exploited to unexploited biomass of the population and the ratio of fishing mortality to natural mortality.

In addition to population-level models, such as the SCAA and LBB, this project seeks to develop quantitative tools to help inform efficient sampling protocols for understanding invasive carp presence and distribution in areas where they are assumed to be in low abundance (i.e., the upper Illinois River). Understanding the sampling effort that is necessary to detect rare species of fish (i.e., invasive carps in the upper portions of the IWW) is critical to efficient sampling designs. Species accumulation curve analysis is one method of examining the likelihood that a survey may encounter a species of interest by using fish community data to determine sample completeness and estimate species richness. This method can, therefore, be used to understand if a survey is detecting most species present at a site and if sampling efforts are appropriate, excessive, or insufficient.

OBJECTIVES

- Continue collecting fisheries-dependent demographic data for invasive carp to support the development of an SCAA model for the Illinois River invasive carp population.
- Develop a length-based Bayesian model to better understand the status of the invasive carp population in the Starved Rock, Marseilles, and Dresden Island pools of the upper Illinois River.
- Develop a species accumulation curve analysis to better understand if current early detection efforts for invasive carp in the upper Illinois River are insufficient, sufficient, or excessive.

PROJECT HIGHLIGHTS

SCAA Model

- Implemented an updated sampling plan for fisheries-dependent demographic data collections (including age structures).
- Collected demographic data from 51 to 226 individual Silver Carp captured through incentivized harvest from Peoria, Starved Rock, and Marseilles pools of the Illinois River. These collections represented 75 percent (Peoria pool) to >100 percent (Starved Rock and Marseilles pools) of the target number of individuals for 2025. Demographic data for Silver Carp was not collected from Alton, La Grange, and Dresden Island pools during 2025 due to the federal furlough during October and November.

Length-Based Bayesian Analysis

- A length-based Bayesian analysis was developed to better understand the status of the Silver Carp population in the upper Illinois River (Starved Rock through Dresden Island pools) using length data from incentivized harvest of Silver Carp (2012 to 2025).
  - Starved Rock Pool: The model results indicate that the ratio of the exploited biomass to the unexploited biomass is less than the biomass at maximum sustainable yield, and the ratio of fishing mortality to natural mortality is >1, indicating that this population is likely overfished, with overfishing occurring.
  - Marseilles Pool: The model results indicate that the ratio of the exploited biomass to the unexploited biomass is near the biomass at maximum sustainable yield, and the ratio of fishing mortality to natural mortality is often <1, indicating that this population likely is not overfished, and overfishing likely is not occurring.
  - Dresden Island Pool: The model results indicate that the ratio of the exploited biomass to the unexploited biomass is frequently less than the biomass at maximum sustainable yield, and the ratio of fishing mortality to natural mortality is often >1, indicating that this population may be overfished, with overfishing occurring.

Species Accumulation Curve Analysis

- The analysis was developed to better understand sample completeness and species richness in the upper Illinois River (Dresden Island and Marseilles pools and the Kankakee River).

- Results (from 2022 to 2025 data) suggest that sample completeness ranges from 46 percent to 92 percent when sampling >100 sites, depending on gear type, location, and year.
- The MRWG needs to decide if this method will be used to guide allocation of sampling effort moving forward and, if so, determine the appropriate target for sample completeness.

RECOMMENDATIONS

- Collaborate with the Telemetry Work Group to understand movement to and from the Mississippi River and net movement between the upper and lower portions of the Illinois River to inform the SCAA model.
- QA/QC and harmonization of fisheries-dependent demographic data with harvest data to support the SCAA model.
- Continue collecting fisheries-dependent demographic data in support of the SCAA model.
- Continue discussions within the MRWG to determine the best way to address additional needs of the SCAA model, such as understanding temporal variability in:
    - Natural mortality
    - Stock-recruit relationship
    - Net migration between the upper and lower Illinois River
- Develop a length-based Bayesian analysis for the lower Illinois River as length data from commercial harvest become available.
- Collaborate with the Detection Work Group to revise and update the species accumulation curve analysis while ensuring that its results support the group’s objectives in optimizing early detection monitoring effort.

REFERENCES

ICRCC. 2022. 2022 Invasive carp monitoring and response plan interim summary report. Page 239 pp. Invasive Carp Regional Coordinating Committee.

BLACK CARP WORK GROUP PROJECTS

- Enhanced Detection of Black Carp in the Lower Illinois River
- Data Collection from Commercial Fishers and Recreational Angler Captures of Black Carp in the Lower Illinois River

ENHANCED DETECTION OF BLACK CARP IN THE LOWER ILLINOIS RIVER

Participating Agencies: INHS (lead), ILDNR

MRWG Work Group: Black Carp

Pools Involved: Alton Reach of the Illinois River

ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

INTRODUCTION AND NEED

Exotic Black Carp (*Mylopharyngodon piceus*) 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 individuals, and little is known about the size of the population or potential scope of ecosystem changes that may result from the invasion. The ILDNR has been closely monitoring the range expansion of Black Carp up the Illinois River, despite limited catches reported to date.

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 commercial fishermen catches while targeting other species (e.g., Bighead Carp, Silver Carp, Common Carp, Grass Carp, buffalo spp., catfish spp.). These captures and associated data (e.g., length, weight, age, diet) are valuable, but the limited number of reported individuals makes it difficult to assess their prevalence/establishment in the lower Illinois River. More robust estimates of the current population level are essential to manage and potentially control Black Carp in the Illinois River.

The sampling approach used hoop nets baited and non-baited with experimental baits to assess the population of Black Carp in the lower Illinois River and efficacy of different baits to collect them. In the Alton Reach of the Illinois River, we expanded on standardized hoop netting efforts to compare experimentally baited and non-baited hoop nets to target Black Carp to better detect their presence, abundance, and expansion up the lower Illinois River. This expansion, in conjunction with existing MAM hoop netting efforts, allowed for comparisons between standardized hoop nets baited with soybean and hoop netting using clam-based and cottonseed-based baits and non-baited nets. Additionally, all non-target fish captured were identified, measured, weighed, and enumerated. All Black Carp captured were measured, weighed, and distributed to the proper agency(s) for further study of life history (age, diet, origin, etc.).

OBJECTIVES

- Monitoring for the presence and abundance of Black Carp in the Alton Reach of the Illinois River.
- Improving our catchability while minimizing efforts for acquiring Black Carp.
- Determine the most effective bait to capture Black Carp using baited (cottonseed and clam baits) and non-baited hoop nets.
- Provide other projects and agencies (e.g., USGS-CERC, ILDNR, INHS, etc.) with the necessary Black Carp abundance and distribution to inform management decisions.

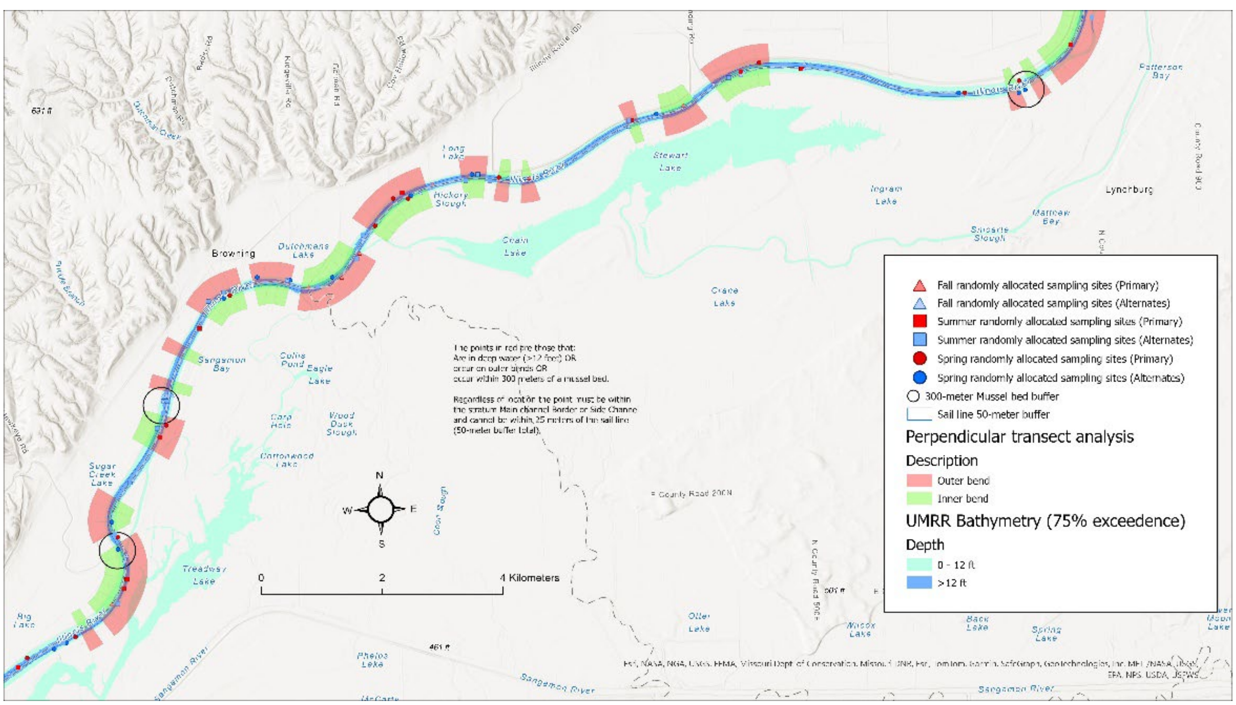
PROJECT HIGHLIGHTS

- In 2025, 65 paired hoop nets were baited with cottonseed-based baits, 65 were baited with clams, and 65 were non-baited paired hoop nets within the Alton Reach of the Illinois River.
- One Black Carp was captured in a non-baited hoop net on August 27, 2025, on the Alton Reach of the Illinois River near RM 27.
- Sampling sites were re-stratified using known Black Carp habitat preferences (e.g., water depth >12 feet, outer bends, within 300 meters of known mussel beds) to increase the likelihood of capture success.

METHODS

Sampling design was created based on standardized protocols outlined by the LTRM Procedures (Ratcliff et al. 2014) using paired large and small baited hoop nets. Hoop nets were baited with Atlantic Surf Clams, cottonseed, and no bait. Sampling sites were reclassified for main channel and side channel habitats following a stratification to create a Black Carp-likely sampling design to increase the probability of capture. Known habitat preference of Black Carp narrowed site selection down to areas with greater than 12 feet of water depth, outer bends within the strata, or within 300 meters of historical mussel beds (Figure 1). Sampling was conducted within the Alton Reach of the Illinois River using this redesigned classification framework following LTRM sampling time periods with bait type per site randomly chosen with an equal number of sites per period of each bait type.

Figure 1. *Snapshot of how sampling sites were determined based on the Black Carp-likely classification system using water depth, historical mussel beds, outer river bend morphology, and side- and main-channel habitats.*



RESULTS AND DISCUSSION

On August 27, 2025, a Black Carp was captured (Figure 2) in a non-baited hoop net in the side-channel of Hurricane Island in the Alton Reach of the Illinois River. The location is near RM 27 between Hardin and Kampsville, Illinois (Figure 3). The fish was returned to Illinois River Biological Station to remove aging structures (dorsal spine) and report the capture information to the Black Carp Work Group. This individual weighed 15.204 kilograms and measured 1,154 mm in total length and was captured in a 4-foot diameter non-baited hoop net.

Figure 2. *Black Carp individual captured on August 27, 2025, near Hardin, Illinois.*

Figure 3. *Capture location of the Black Carp captured on August 27, 2025, near RM 27 in Hurricane Island side-channel.*

The sampling season started on June 15 and set a total of 390 hoop nets throughout 195 locations in the Alton Reach of the Illinois River. A total of 1,542 fish were captured (Table 1) in small and large hoop nets baited with clam and cottonseed and non-baited. Freshwater Drum was the most common catch, followed by Common Carp and Channel Catfish (Table 1). Red-eared Slider turtles (n = 150) were our primary turtle species, followed by Spiny Softshell turtles (n = 83), primarily in nets baited with clams.

Table 1: *Hoop net total fish catch by bait type and by sampling period from Alton Reach of Illinois River June 15-October 31, 2025.*

-	Period 1			Period 2			Period 3			-
Species	**Clam**	**Cotton Seed**	**No Bait**	**Clam**	**Cotton Seed**	**No Bait**	**Clam**	**Cotton Seed**	**No Bait**	**Sum**
Black Carp	-	-	-	-	-	1	-	-	-	1
Bighead Carp	-	-	-	2	1	-	7	5	3	18
Black Buffalo	-	-	-	-	-	-	4	1	-	5
Black Bullhead	-	-	-	-	-	-	-	1	-	1
Black Crappie	1	1	2	1	3	2	1	2	3	16
Blue Catfish	15	3	4	4	5	1	-	-	2	34
Bluegill	-	-	1	-	-	1	2	-	-	4
Bigmouth Buffalo	-	-	-	-	1	-	-	-	-	1
Brown Bullhead	1	1	-	-	-	-	-	-	-	2
Bowfin	-	-	-	1	-	-	-	-	1	2
Carp	5	76	28	9	133	37	13	112	17	430
Channel Catfish	73	34	53	28	14	6	9	19	15	251
Flathead Catfish	15	13	65	12	9	25	4	4	6	153
Freshwater Drum	61	94	95	29	42	41	27	40	21	450
Grass Carp	1	-	1	1	9	-	-	-	-	12
Gizzard Shad	-	1	1	1	-	-	1	-	-	4
Longnose Gar	-	-	-	-	-	-	1	-	-	1
Orangespotted Sunfish	-	-	-	-	-	-	-	-	1	1
River Carpsucker	-	-	-	-	2	-	-	3	2	7
Sauger	-	-	-	-	1	-	-	-	-	1
Shorthead Redhorse	-	-	-	-	2	1	-	-	3	6
Smallmouth Buffalo	8	-	3	1	30	1	4	4	5	56
Shortnose Gar	2	3	6	7	5	2	12	8	4	49
Silver Carp	-	-	1	1	-	1	5	2	3	13
White Bass	-	1	1	-	2	-	2	2	2	10
White Crappie	-	-	2	2	3	-	1	3	2	13
Sum	182	227	263	100	262	119	93	206	90	1542

RECOMMENDATIONS

Continued sampling is recommended to monitor the presence and abundance of Black Carp in the lower Illinois River at their invasion front. This project will continue to directly inform multiple MRWG work groups (Black Carp and Detection) and continue to be adapted to increase catchability and detection of Black Carp in the lower Illinois River to better accomplish management strategies and MRWG priorities.

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USACE. Upper Mississippi River Restoration-Environmental Management Program. June 2014. Program Report LTRMP 2014-P001. 88 pp. including Appendixes A–G.

DATA COLLECTION FROM COMMERCIAL FISHERS AND RECREATIONAL ANGLER CAPTURES OF BLACK CARP IN THE LOWER ILLINOIS RIVER

Participating Agencies: ILDNR (lead), USGS, USFWS, and contributing state resource agencies of the Mississippi River basin

MRWG Work Group: Black Carp

Pools Involved: Greater Mississippi River Basin

INTRODUCTION AND NEED

Since the importation of Black Carp to the U.S., escapes into the wild have been documented, with reports of reproducing populations in the Mississippi River Basin. The greatest concern of Black Carp population establishment is the impact on native mussel and snail fauna, of which many species are already listed as threatened or endangered. Due to their recognized impact to aquatic ecosystems, in 2015, the ILDNR initiated a Black Carp Bounty Program to encourage reporting of Black Carp captures following initial reports from Illinois and adjacent state waters. Over time, this program developed into the primary mechanism for monitoring the rate of incidental Black Carp captures and the species' distribution in the Illinois and Mississippi rivers.

OBJECTIVES

- Coordinate with partners, including Illinois River and Mississippi River commercial fishers, to document the distribution of Black Carp within the Illinois River and other waters that could contribute to the Illinois River to provide up-to-date data on captures to the public and resource managers through the USGS Non-Indigenous Aquatic Species database (Nico et al. 2025).
- Collect demographic data like length, weight, and aging structures to understand species longevity and cohort strength.

PROJECT HIGHLIGHTS

- Expanded the program into the Arkansas-White-Red and lower Mississippi Subbasin.
- Increased public engagement with commercial fishers and state partners through various forms of outreach (webpage designed for ICRCC, https://icrcc.fws.gov/carp/black-carp-bounty-program) since the 2015 initiation of the Illinois Bounty Program.
- Since October 2024, 133 captured Black Carp were reported by five states, and aging structures were pulled and shipped to USFWS for age assessments, resulting in a total of 127 Black Carp dorsal spine structures for assigned ages.

METHODS

The Illinois Black Carp Bounty Program transitioned from research emphasis to population monitoring in 2024. The program relies on commercial fishers reporting incidental captures to a state biologist who completes a simplified catch sampling form that obtains the location of capture, length (mm), weight (kg), sex, aging structure (i.e., dorsal fin ray), and specimen photograph (Kroboth 2025). USFWS validates each species captured and maintains the documented receipt of structures and capture data. Received dorsal fin rays were cleaned, processed, and assigned an age according to procedures in Kroboth et al (2019 AND 2025). All records received throughout the year are documented and publicly accessible through the USGS-NAS database.

RESULTS AND DISCUSSION

During 2025, the Black Carp Bounty Program expanded across the Mississippi River Basin to include states like Arkansas, Louisiana, Mississippi, and Tennessee. Enhanced engagement throughout the MICRA subbasins led to the capture of 133 Black Carp. Many of these specimens were reported by commercial fishers (N = 127), with recreational fishers and state agencies each accounting for three captures (see Tables 1 and 2). Most reported Black Carp captures came from the states of Missouri, Illinois, and Arkansas (Table 1). The upper and lower Mississippi basins accounted for 71 percent and 23 percent of the overall reported captures, respectively, whereas the other subbasins contributed 6 percent of reported captures (Table 2).

Table 1: *The number of Black Carp captured for each state by commercial fishers, recreational fishers, and state agencies from October 2024 to September 2025*.

State	Black Carp (#)
Arkansas	26
Commercial fisher	26
Illinois	49
Commercial fisher	46
Recreational fisher	2
State agency	1
Kentucky	3
Commercial fisher	3
Missouri	52
Commercial fisher	49
Recreational fisher	1
State agency	2
Mississippi	3
Commercial fisher	3
Total	**133**

Table 2: *The number of Black Carp captured for each state by commercial fishers, recreational fishers, and state agencies from October 2024 to September 2025.*

Subbasin and Rivers	Commercial fisher	Recreational fisher	State agency
Arkansas-White-Red	-	-	-
Black River	1	0	0
Lower Mississippi	-	-	-
Arkansas River	7	0	
Desoto Lake (Mississippi River)	3	0	0
Mississippi River	11	0	0
Old River (Mississippi River)	6	0	0
St. Francis River	2	0	0
White River	2	0	0
Missouri	-	-	-
Missouri River	0	0	1
Osage River	0	1	0
Ohio	-	-	-
Ohio River	4	0	0
Upper Mississippi	-	-	-
Horseshoe Lake (Mississippi River)	2	0	0
Illinois River	2	0	1
Kaskaskia River	1	0	0
Mississippi River	86	2	1
Total	**127**	**3**	**3**

Data from the Black Carp Bounty Program provides an important tool for tracking distributional changes and identifying potential range expansion. In the Illinois River, three Black Carp were reported – two from commercial fishers and one from a state biologist from the INHS – with captures occurring in the Alton Pool, upstream of Hardin, Illinois, and in the LaGrange Pool, upstream of Browning, Illinois (Figure 1). These detections fall within the currently documented distribution, and the furthest upstream record remains the April 2023 record downstream of Hennepin, Illinois (Nico et al. 2025). In the Arkansas-White-Red subbasin, one Black Carp was captured by a commercial fisher. Based on USGS-NAS data, this capture represents a range expansion of Black Carp into the Black River downstream of Black Rock, Arkansas (Figure 1).

Individual fish data were used to calculate summary statistics. The average total length and weight of all Black Carp reported for fiscal year 2025 were 1,007 mm and 12.8 kg. Most Black Carp were captured by means of hoop nets and gill nets, regardless of fish size (Figure 2). ILDNR reported one person using hook and line with clam bait in a small drainage ditch off the Mississippi River; this method yielded the two smallest Black Carp captures (i.e., 318 and 358 mm TL) in the 2025 capture records. Finally, a total of 127 dorsal spines were collected and processed for age estimation. Black Carp ages ranged from age one to 12 throughout the greater Mississippi River Basin (Figure 3).

Figure 1: *Locations of Black Carp captures in the MICRA Subbasins. Black circles indicate captures from 1994 to 2025. Red circles indicate captures during fiscal year 2025. All data are from the NAS database.*

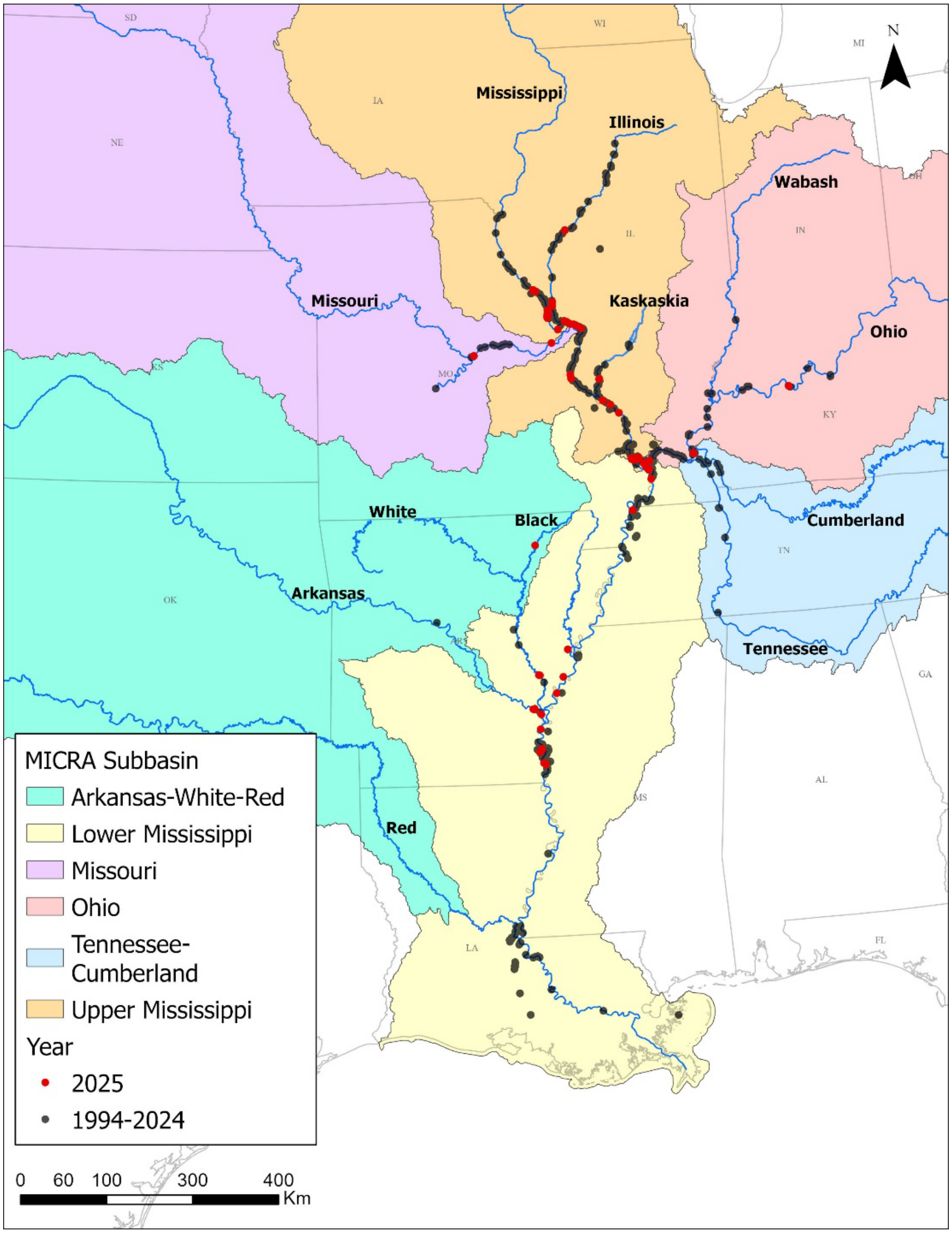


Figure 2: *Length frequency of Black Carp captured by the Black Carp Bounty Program from October 2024 to September 2025. Colors denote capture method.*

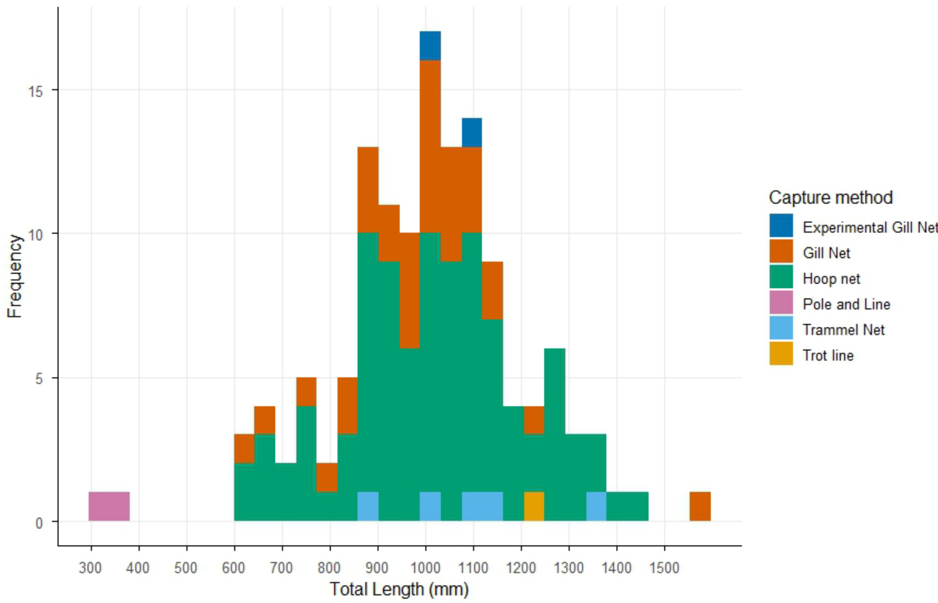
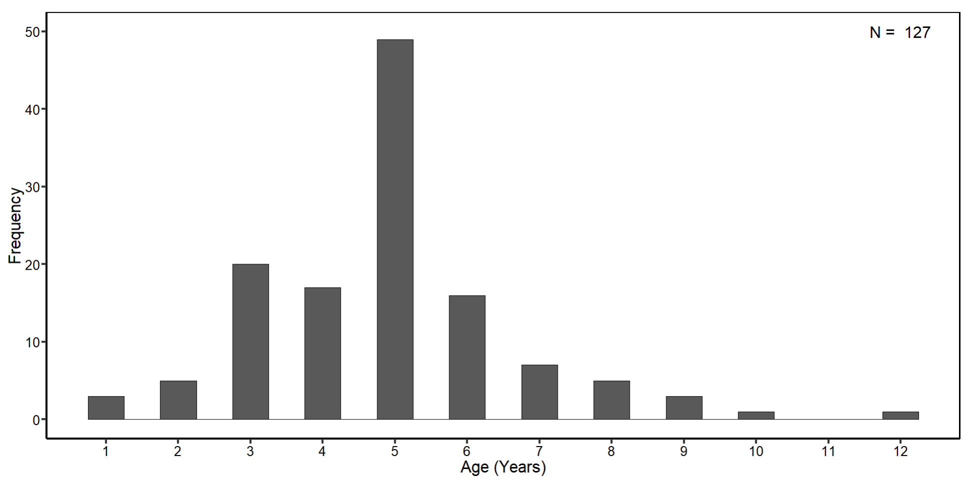


Figure 3: *Age frequency of 127 Black Carp collected during the 2025 fiscal year. Age estimates are based on dorsal spines.*



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APPENDIX A

ZOOPLANKTON AS DYNAMIC ASSESSMENT TARGETS FOR INVASIVE CARP REMOVAL

Participating Agencies: INHS (lead); SIU (field and lab support); Steven E. Butler, Joseph J. Parkos III, Dakota S. Radford, Michael A. Nannini, Anthony P. Porreca, Kristopher A. Maxson, Michael J. Spear, James T. Lamer (INHS), Joseph L. Mruzek, James E. Garvey (SIU)

Pools Involved: Dresden Island, Marseilles, Starved Rock, Peoria, and LaGrange pools

INTRODUCTION AND NEED

Under contexts where an invasive species has become too widely dispersed and abundant for eradication to be a feasible management goal, reducing the size of invasive populations to a level that eliminates their undesirable impacts may be a more viable strategy. However, invasive species suppression programs seldom have specific, measurable, justified targets that can be used to assess whether the removals are producing tangible benefits (Green and Grosholz 2021). Regardless of management context, assessments should be based on metrics with clear links to the managed stressor and should be sensitive to changes in the stressor (Doren et al. 2009). For suppression of a non-native species to the point of functional eradication within an invaded ecosystem, quantification of the relationship between density of the invader and impacts on native taxa can be used to develop assessment metrics to guide invasive species removal targets and promote native species recovery (Green and Gorsholz 2021).

Due to their ability to efficiently filter large volumes of water and capture small particle sizes, Bighead Carp and Silver Carp can deplete zooplankton densities and alter zooplankton community composition (Sass et al. 2014; DeBoer et al. 2018; Hochstrasser and Collins 2024), potentially competing with native fishes for food resources (Schrank et al. 2003; Sampson et al. 2009) and altering flows of organic matter (Collins and Wahl 2017; Kramer et al. 2019). The trophic impact of bigheaded carp planktivory is of great concern because of the importance of zooplankton as grazers, as well as prey for native planktivores and early life stages of all fish (Sampson et al. 2009; Pendleton et al. 2017; Fletcher et al. 2019). Introductions of bigheaded carp outside of North America have been related to declines of native filter-feeding fish and reductions in fish diversity (Spataru and Gophen 1985; De Iongh and Van Zon 1993; Sugunan 1997). In North America, several studies have suggested that bigheaded carp may negatively affect entire fish assemblages, with particularly strong effects on native planktivores (Solomon et al. 2016; Pendleton et al. 2017; Chick et al. 2020).

Due to the risks posed by bigheaded carp to the commercial and recreational fisheries economies of the Great Lakes region, an aggressive invasive carp removal program has been implemented in the upper navigation pools of the IWW to limit further advances of bigheaded carp toward Lake Michigan (Tsehaye et al. 2013; MacNamara et al. 2016; Bouska et al. 2020). In addition to preventing the expansion of bigheaded carp populations toward the Great Lakes, this removal program may also benefit native communities in the IWW by mitigating some of the ecological impacts that bigheaded carp have had on this system. Although the invasion of bigheaded carp in the Illinois River has caused demonstrable changes to fish communities (Solomon et al. 2016; DeBoer et al. 2018), there is little evidence to date that harvest of bigheaded carp has resulted in subsequent responses from native fishes (but see Love et al. 2018). However, zooplankton communities have been found to respond to removal of bigheaded carp from backwater habitats over short time scales (Altenritter et al. 2022), although responses at larger spatial scales have been more muted (Chará-Serna and Casper 2021). Due to their short generation times and high productivity rates, zooplankton taxa have the potential to respond quickly to bigheaded carp removal, providing a rapid assessment of whether enough fish have been removed to allow for ecosystem recovery. However, riverine zooplankton abundance and community structure are also known to vary seasonally, longitudinally, among habitats, and in response to hydrologic factors (Thorp et al. 1994; Wahl et al. 2008; Dickerson et al. 2010; Burdis and Hoxmeier 2011). Separating the influence of changing bigheaded carp abundances from the effects of background environmental factors on zooplankton communities is, therefore, a considerable challenge. Furthermore, zooplankton responses to bigheaded carp harvest have been found to vary among taxa (Altenritter et al. 2022), indicating that the effects of bigheaded carp removals cannot be expected to occur uniformly across the entire zooplankton community.

The native zooplankton community meets some of the criteria for an effective assessment metric for invasive carp removal. There is a conceptual understanding of how bigheaded carp impact zooplankton communities (i.e., negative effect on abundance through predation; Altenritter et al. 2022; Hochstrasser and Collins 2024), as well as empirical evidence for these impacts (Sass et al. 2014; DeBoer et al. 2018; Chará-Serna and Casper 2021). Recovery of pre-invasion zooplankton abundance is also an ecologically and societally relevant goal due to the importance of the zooplankton community as a prey base supporting native fish productivity. However, before zooplankton can be implemented as an assessment metric for bigheaded carp suppression efforts, key information gaps that need to be addressed are identifying specific zooplankton taxa that are sensitive to changes in bigheaded carp density, characterizing the shape and magnitude of bigheaded carp density-prey impact relationships, and separating the influence of other environmental drivers of zooplankton abundance from the impacts of bigheaded carp planktivory (Green and Grosholz 2021; Altenritter et al. 2022). Development of specific zooplankton-based assessment metrics can guide invasive carp management by producing explicit targets for control efforts and a method for objectively evaluating progress in mitigating impacts.

OBJECTIVES

Zooplankton are being sampled throughout the IWW to:

- Quantify variation in zooplankton density, body size distribution, biomass, and community composition in the IWW.
- Assess the sensitivity of a range of zooplankton taxa to bigheaded carp density.
- Use sensitive zooplankton taxa to develop benchmarks for evaluating the impacts of bigheaded carp control and removal efforts.

PROJECT HIGHLIGHTS

- Final analyses used mean monthly densities of a number of zooplankton taxa collected from five navigation pools of the IWW during 2012 to 2023 to assess months in which zooplankton assemblage structure was most variable among navigation pools and between years with higher and lower bigheaded carp abundances, identify which zooplankton taxa contributed most to these differences, and model candidate zooplankton metrics as functions of environmental variables, bigheaded carp density, and native planktivore abundance.
- Mean June *Bosmina* sp. density was identified as the most informative zooplankton metric (largest standardized effect size for a negative effect of bigheaded carp density) and was used to conduct annual assessments of whether bigheaded carp densities in five navigation pools of the IWW have been reduced sufficiently to mitigate their planktivorous impacts.
- A stoplight report card of management progress comparing control intervals (residuals from model predictions under observed conditions) with target variances (residuals from model predictions under target conditions) indicates that bigheaded carp impacts have been reduced in the Dresden Island Pool since 2013, with management targets consistently met since 2017, whereas the Marseilles Pool has demonstrated evidence of reduced impacts since 2019, with management targets met beginning in 2022. However, all other navigation pools continued to show consistent, severe impacts of bigheaded carp planktivory.

METHODS

Field sampling for assessing zooplankton trends was completed in 2023. From 2012 to 2023, zooplankton collections occurred bi-weekly from May to September at established sites to maintain consistency and data comparability. Zooplankton were collected by obtaining vertically integrated water samples using a diaphragmatic pump. At each site, 90 liters of water was filtered through a 55-micrometer mesh to obtain crustacean zooplankton (macrozooplankton), and 10 liters of water was filtered through a 20-micrometer mesh to obtain microzooplankton (rotifers and copepod nauplii). Organisms were transferred to sample jars and preserved in either Lugols solution (4 percent for macrozooplankton) or buffered formalin (10 percent for rotifers). Data on environmental factors known to influence zooplankton communities in large rivers (water temperature, dissolved oxygen concentration, Secchi depth, chlorophyll α concentration) were also collected on each sampling site visit. In the laboratory, individual organisms were identified to the lowest possible taxonomic unit, counted, and measured using a microscope-mounted camera and measurement software. Zooplankton densities were calculated as the number of individuals per liter of water sampled.

Whereas many previous analyses of bigheaded carp impacts on zooplankton assemblages used peak annual densities of select zooplankton taxa as response variables, these metrics would be costly and labor-intensive to implement as assessment tools because the timing of peak zooplankton densities may vary considerably among taxa and across years, so measuring peak densities would require repeated sampling over an extended time period. Much less effort is required to quantify monthly densities of various zooplankton taxa, but identifying time periods when the effects of bigheaded carp planktivory are most apparent or are the most ecologically relevant presents a considerable challenge, given the large diversity of zooplankton taxa and the multiple months during which they are present. To narrow down the possible zooplankton metrics that may be informative indicators of bigheaded carp planktivory, variation in monthly zooplankton assemblage structure among navigation pools and years that differed in bigheaded carp abundance were assessed, and then zooplankton taxa most responsible for these differences were identified. Assemblage structures were compared using permutational multivariate analysis of variance (PERMANOVA) on the Bray-Curtis similarity matrix constructed from square-root transformed density data, using 999 permutations of residuals under a reduced model (Anderson 2008). Rotifer and copepod nauplii assemblages were analyzed using data from the 20-micrometer collections, whereas macrozooplankton assemblages were analyzed using 55-micrometer collection data. For each month's assemblage group, one set of analyses focused on spatial differences between navigation pools, whereas the other set of analyses focused on temporal differences between the years 2012 and 2016 (years with higher bigheaded carp abundances) and the years 2019 and 2023 (years with lower bigheaded carp abundances). When a significant effect was identified ($p < 0.05$), a similarity percentage analysis (Clarke 1993) was conducted to identify which taxa were contributing the most dissimilarity between sites or between time periods (contribution to percentage dissimilarity ≥ 10%). Taxa within months that exhibited the most variation between pools and time periods were considered candidates for further evaluation as assessment metrics.

Once the candidate taxa and months were identified, subsequent analyses focused on distinguishing among environmental factors and planktivore abundances that could potentially influence observed monthly mean densities of each zooplankton taxa. Estimates of bigheaded carp density in each navigation pool were obtained from annual hydroacoustic surveys conducted each autumn (late September to early November) from 2012 to 2023 by SIUC, with each fall density estimate assumed to represent adult invasive carp density within a navigation pool during the previous several months. Reliable invasive carp density estimates were not available for the Peoria and La Grange pools in 2018, so these pool-year combinations were not used in the analyses. Abundance of native planktivores was estimated from LTRMP (Gutreuter et al. 1995), LTEF (McClelland et al. 2012; Fritts et al. 2017), and Illinois River MAM (Ratcliff et al. 2014; MRWG 2025) pulsed-DC electrofishing sampling of unstructured main-channel border habitats conducted in each navigation pool from 2012 to 2023. Mean CPUE of Bigmouth Buffalo (*Ictiobus cyprinellus*), Emerald Shiner (*Notropis atherinoides*), Gizzard Shad (*Dorosoma cepedianum*), Threadfin Shad (*Dorosoma petenense*), and Skipjack Herring (*Alosa chrysochloris*) across the three LTRM and LTEF sampling periods (Period 1 = June 15 to July 31, Period 2 = August 1 to September 14, and Period 3 = September 15 to October 31) were summed to produce a combined estimate of native planktivore CPUE in each navigation pool in each year.

Zooplankton populations may respond to several environmental factors; therefore, discharge, temperature, chlorophyll a concentration, Secchi depth, and dissolved oxygen concentrations were investigated as potential variables influencing zooplankton densities. Discharge data for sites in the upper IWW were obtained from USACE gages located at Brandon Road, Dresden Island, and Marseilles L&Ds. Discharge measured at the USGS gage at Henry (USGS 5558300) was applied to Peoria Pool observations, and data from the gage at Kingston Mines (USGS 5568500) were used for La Grange Pool flow rates. Discharge values were standardized across sites using Z-transformed values for each site. To represent environmental conditions potentially affecting zooplankton densities during particular time periods, mean values of discharge, water temperature, dissolved oxygen, Secchi depth, chlorophyll a concentration, and the coefficient of variation of discharge and water temperature were calculated across all available dates of measurement from 5 days prior to the first date of observation until the last date of observation of zooplankton densities in each month. Mean zooplankton densities, temperature, dissolved oxygen, Secchi depth, and chlorophyll a values were natural log-transformed prior to analysis to normalize variances, with 0.01 added to all zooplankton means to account for zeroes in the dataset.

Due to several correlated environmental variables, an initial analysis was necessary to reduce these variables into smaller sets of unrelated variables. However, several variables contained missing values for certain time periods, rendering principal component analysis on the raw data infeasible unless an unacceptable number of observations were excluded from analysis. Therefore, multiple imputations by fully conditional specification (Rubin 1987; van Buuren 2007; Berglund and Heeringa 2014) were used to create 25 datasets representing plausible realizations of the complete data, given the observed values and estimated joint distributions. PCA was then performed separately on the standardized environmental variables within each imputed dataset, preserving the within-imputation covariance structure, as well as retaining imputation uncertainty through to the derived principal components (Josse et al. 2011; van Ginkel 2023). Because PCA loadings and directions can differ slightly among imputed datasets, we performed a separate PCA on the averaged covariance matrix across imputations to provide a stable reference eigenvector structure. For each imputation, we calculated each loading vector's correlation with its reference counterpart and reversed its sign when the correlation was negative to align the direction with that of the reference PCA, ensuring that PC scores were consistent in orientation across imputations and permitting pooling of subsequent model results. A similar approach is sometimes used in bootstrapping applications, where axes may be reversed among PCAs performed on bootstrapped samples (Jackson 1995; Yu et al. 1998; Peres-Neto et al. 2003, 2005).

For each imputed dataset, repeated-measures models with sampling site as the repeatedly sampled unit were used to model potential zooplankton metrics as a function of environmental variables and pool-scale estimates of bigheaded carp density or native planktivore relative abundance. Candidate models included all linear combinations of bigheaded carp density, native planktivore CPUE, and principal components of environmental variables. A null model (i.e., intercept only) was also included for comparison to assess whether there was meaningful support for any of the models in the set. Bigheaded carp density and native planktivore CPUE were found to be positively correlated ($r = 0.52$), so these variables were not included together in any candidate models. To facilitate model comparison, site-level k-fold cross-validation was used to estimate marginal predictive deviance for each observation under a Gaussian likelihood (Stone 1977; Arlot and Celisse 2010; Yates et al. 2023). By performing cross-validation at the site level, we preserve the hierarchical data structure and avoid leakage of random effects information across training and test folds (Roberts et al. 2017). For each candidate model, mean predictive deviances across folds were averaged within each imputation, then pooled across imputations using Rubin's rules (Rubin 1987). Models were ranked by their pooled bias-corrected mean predictive deviance (lower = better). Model selection was performed by selecting the most parsimonious model (i.e., fewest parameters) that fell within 1 correlation-adjusted standard error of the best-scoring model (Yates et al. 2021; Yates et al. 2023). After selecting the best model from the candidate set, fixed effect parameter estimates and variance components were pooled across imputations using Rubin's rules

(Rubin 1987). Pooled variance components were used to calculate marginal coefficients of determination (Nakagawa and Schielzeth 2013) as a measure of the amount of variance accounted for by the fixed effects in the selected model. Cohen’s f2 (Cohen 1988; Selya et al. 2012) was also calculated to assess the standardized effect sizes of invasive carp or native planktivores on mean monthly densities of each zooplankton taxa. A monthly zooplankton metric was considered potentially informative as a performance indicator for invasive carp removal if the most-supported model of mean zooplankton density included the effect of bigheaded carp density as a significant explanatory factor with at least a medium effect size (f2 ≥ 0.15). The relationship between a putative assessment metric and bigheaded carp density was visualized by fitting the independent variables from the most-supported model to each imputation, calculating predicted zooplankter densities and residuals for each observation, averaging predictions and residuals across imputations, then plotting the relationship between bigheaded carp density and mean metric density. If additional predictors were included in the most supported model, the relationship between bigheaded carp density and the candidate zooplankton metric was visualized with a partial residual plot to separate the effect of bigheaded carp from the other modeled variables.

The most informative metric (i.e., largest Cohen’s f2 for the negative effect of bigheaded carp density) was used to conduct annual assessments of whether bigheaded carp densities in five navigation pools were sufficiently low to meet management targets (i.e., unimpacted zooplankton density). Assessment of impact was based on comparisons between residuals from model-based predictions under observed (i.e., actual bigheaded carp densities) and target (i.e., very low bigheaded carp densities) conditions. A stoplight report card based on the degree of overlap between control intervals and target variances (Trexler and Goss 2009) was produced as a visual summary of the assessed outcome of management. Control intervals (i.e., residuals ± 1.5, 2.0, and 3.0 standard errors calculated from predicted zooplankton densities based on observed environmental and bigheaded carp density values) represent the uncertainty typically associated with predictions based on simple ecological models. If the target variance (i.e., residuals ± 2.0 standard errors calculated from model-based predictions based on target bigheaded carp densities) falls outside the 3.0 standard error control interval, then the predatory impact of bigheaded carp is considered severe, requiring additional management intervention to meet the goal of functional eradication (red light). If target variance falls outside of the 1.5 standard error control interval but falls within the 3.0 standard error interval, then the density of bigheaded carp may be considered reduced enough to have some impact on their planktivorous effects, but not enough to meet the management target (yellow light). If target-based variance overlaps the 1.5 standard error control interval, then bigheaded carp density can be interpreted to be sufficiently reduced to mitigate their ecosystem effects (green light). For this assessment, predicted zooplankton densities from the smallest bigheaded carp density observed during the 2012 to 2023 assessment period (0.003 bigheaded carp/1000 m^3; 2019 estimate from Dresden Island Pool) were used as the management target, as this observed density of bigheaded carp is both desirably low and does not project model predictions beyond the range of bigheaded carp densities used to parameterize the models. Assessments were only conducted for navigation pool-year combinations that contained all the information required by the assessment models.

RESULTS AND DISCUSSION

Bigheaded carp densities during the 2012 to 2023 assessment period varied considerably among navigation pools and years (Figure 1), providing the variation needed to test for responses by various zooplankton taxa. In general, bigheaded carp densities in the IWW have been higher in downstream navigation pools than in upstream pools and demonstrated considerable reductions during recent years (2019 to 2023) in most navigation pools relative to the initial years of this study (2012 to 2016). Native planktivore CPUE also varied among pools and years during the assessed time span but did not exhibit a consistent trend within any navigation pool across years. The lowest abundances of native planktivores were observed in the Dresden Island Pool in most years, but native planktivore CPUE was highly variable among other navigation pools over time (Figure 2).

In the initial analyses, to narrow down the list of monthly zooplankton densities that may be potentially informative assessment metrics, both macro- and microzooplankton assemblage structures were found to differ among navigation pools during all assessed months. Comparisons of macrozooplankton assemblages between early (2012 to 2016) and later (2019 to 2023) time periods identified the months of May, June, and September as varying between these periods of low and high bigheaded carp densities, whereas microzooplankton assemblages differed between these periods during May through August. Taxa that contributed ≥ 10 percent to dissimilarity between all pairs of navigation pools and between time periods during these months and were therefore considered candidates for further analysis included Bosmina sp. in May, June, and September; cyclopoid copepods in May and September; Brachionus, Synchaeta, and Trichocerca sp. in May through August; Keratella sp. in May and June; and Polyarthra sp. in June through August.

Figure 1. *Annual estimates of bigheaded carp density (number/1000 cubic meters ± 1 SE; note log scale) within five navigation pools of the IWW during 2012 to 2023. Estimates are derived from autumn hydroacoustic surveys and represent the combined density of bigheaded carp species (Silver Carp + Bighead Carp). Density estimates for Peoria and LaGrange pools were not available for 2018.*

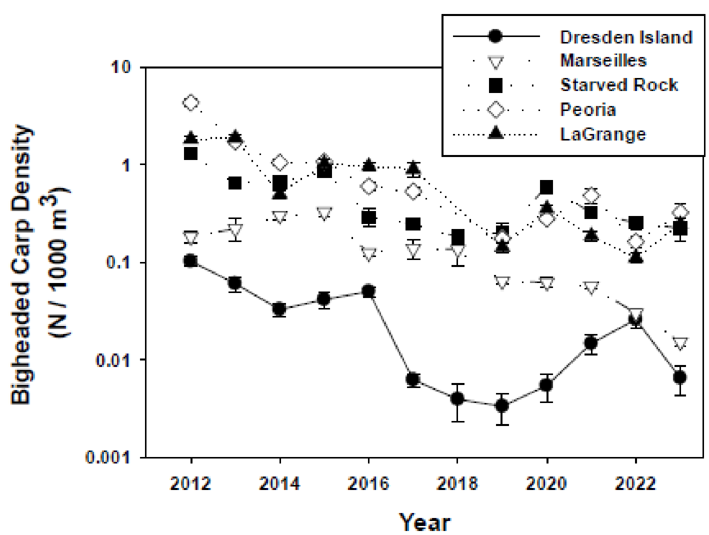
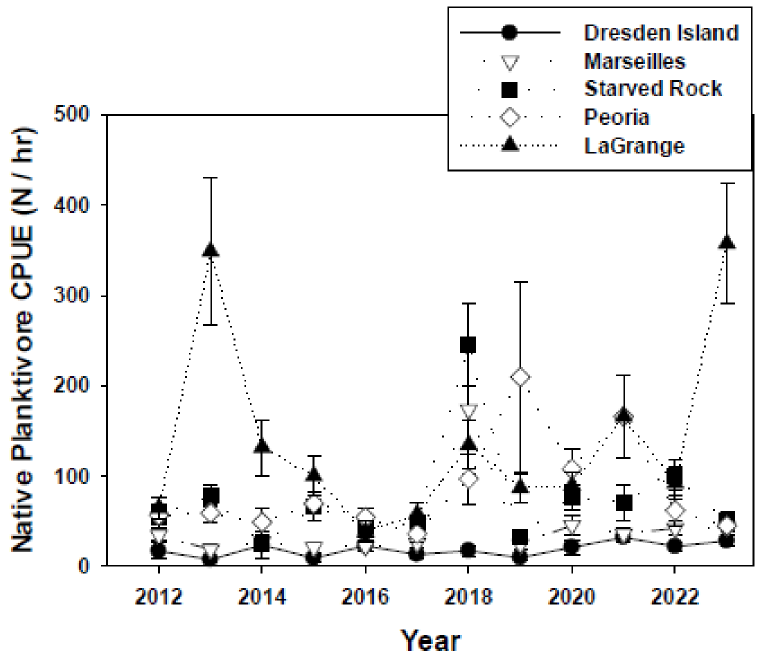


Figure 2. *Annual estimates of native planktivorous fish CPUE (number/hour ± 1 SE) within five navigation pools of the IWW during 2012 to 2023. Estimates are derived from Long Term Resource Monitoring Program, Long-Term Illinois River Fish Population Monitoring, and Illinois River MAM pulsed-DC electrofishing sampling of unstructured main-channel border habitats.*



From the reduced list of 22 candidate zooplankton metrics, only June *Bosmina* sp., September *Bosmina* sp., and May *Trichocerca* sp. densities included bigheaded carp density as an explanatory factor in the most-supported model within each candidate model set, with at least a medium effect size of bigheaded carp density (Table 1). Both June and September mean density of *Bosmina* had a negative relationship with bigheaded carp density, whereas mean May density of *Trichocerca* was positively related to bigheaded carp density. In general, bigheaded carp density was a significant factor in the most-supported model for most macrozooplankton metrics, whereas an assortment of null models (intercept only) and models containing bighead carp density, native planktivore CPUE, and/or principal components of environmental variables were contained in the most-supported models for various rotifer metrics. Coefficient estimates for bigheaded carp density were negative for all macrozooplankton metrics, indicating a generally negative influence of bigheaded carp on populations of macrozooplankton taxa, whereas estimates for native planktivore CPUE were positive in all models for rotifer metrics that contained this variable, indicating a positive association between native planktivores and some rotifer taxa.

The most informative zooplankton metric (i.e., most sensitive to bigheaded carp density), June *Bosmina* sp. density (relationship between bigheaded carp density and mean June *Bosmina* sp. density shown in Figure 3), was used to annually evaluate whether bigheaded carp densities in five navigation pools were sufficiently low to meet management targets for reduced ecosystem impacts of bigheaded carp. Most of the assessed navigation pools still show persistent, severe impacts of bigheaded carp planktivory (red stoplight; Figure 4). Above the Starved Rock Pool, where bigheaded carp densities have been lowest and have also been subject to the most intensive harvest efforts, there is more evidence for diminished impacts of bigheaded carp. In the Marseilles Pool, signs of bigheaded carp impacts being reduced to moderate levels (yellow stoplight) began in 2019 and by 2022 had met management targets for reduced impacts (green stoplight). The Dresden Island Pool fluctuated between moderate and reduced impacts until 2016 and thereafter has consistently met management targets for 7 years (Figure 4).

Table 1. *Pooled coefficients estimates for the selected model for each candidate zooplankton metric (as determined by the most parsimonious model within 1 correlation-adjusted SE of the model with the lowest pooled bias-corrected mean predictive deviance), the marginal coefficient of determination ($R^2_{marginal}$) associated with each model, and the standardized effect size for the effect of bigheaded carp density (f^2_{Carp}) or native planktivore CPUE (f^2_{Plank}) on mean density of each zooplankton taxa in each month. Explanatory variables considered were annual estimates of bigheaded carp density in each navigation pool (CarpDens), mean electrofishing CPUE of native planktivores in each navigation pool (PlankCPUE), and principal components (PC1 – PC3) of hydrologic and physicochemical variables (standardized discharge, water temperature, dissolved oxygen concentration, Secchi depth, chlorophyll a concentration, and the coefficient of variation of discharge and water temperature) measured from 5 days prior to the first observation until the last date of observation of zooplankton densities in each month.*

VARIABLES – MACRO-ZOOPLANKTAN

Taxa	Month	Intercept	CarpDens	PlankCPUE	PC1	PC2	PC3	$R^2_{marginal}$	f^2_{Carp}	f^2_{Plank}
Bosmina	May	-1.4572	-0.3131	-	-	-	-	0.1	0.11	N/A
Bosmina	June	-0.7627	-0.7645	-	-	-	-	0.38	0.61	N/A
Bosmina	September	-2.3472	-0.4534	-	-	-	-	0.23	0.3	N/A
Cyclopoida	May	-1.265	-	-	-	-	-	N/A	N/A	N/A
Cyclopoida	September	-2.2269	-0.2297	-	-	-	-	0.08	0.09	N/A

VARIABLES - ROTIFERS

Taxa	Month	Intercept	CarpDens	PlankCPUE	PC1	PC2	PC3	$R^2_{marginal}$	f^2_{Carp}	f^2_{Plank}
Brachionus	May	2.9661	-	-	-	-	-	N/A	N/A	N/A
Brachionus	June	0.3985	-	0.7263	-	-	-	0.17	N/A	0.21
Brachionus	July	3.7802	-	-	-	-	-	N/A	N/A	N/A
Brachionus	August	3.8586	-	-	0.4084	-	-	0.21	N/A	N/A
Keratella	May	3.787	-0.1606	-	-	-	-	0.09	0.09	N/A
Keratella	June	2.8168	-	-	-	-	-	N/A	N/A	N/A
Polyarthra	June	2.9957	-	-	-	-	-	N/A	N/A	N/A
Polyarthra	July	3.4992	-	-	-	-	-	N/A	N/A	N/A
Polyarthra	August	3.602	-	-	0.3297	-0.3606	-	0.25	N/A	N/A
Synchaeta	May	4.4185	-	-	-	-	-	N/A	N/A	N/A
Synchaeta	June	-2.3382	-	1.4157	-	-	-	0.27	N/A	0.37

Figure 3. *Plot of mean Bosmina sp. density during the month of June in relation to annual bigheaded carp (Silver Carp + Bighead Carp) density in five navigation pools (Dresden Island, Marseilles, Starved Rock, Peoria, and La Grange) of the IWW during 2012 to 2023.*

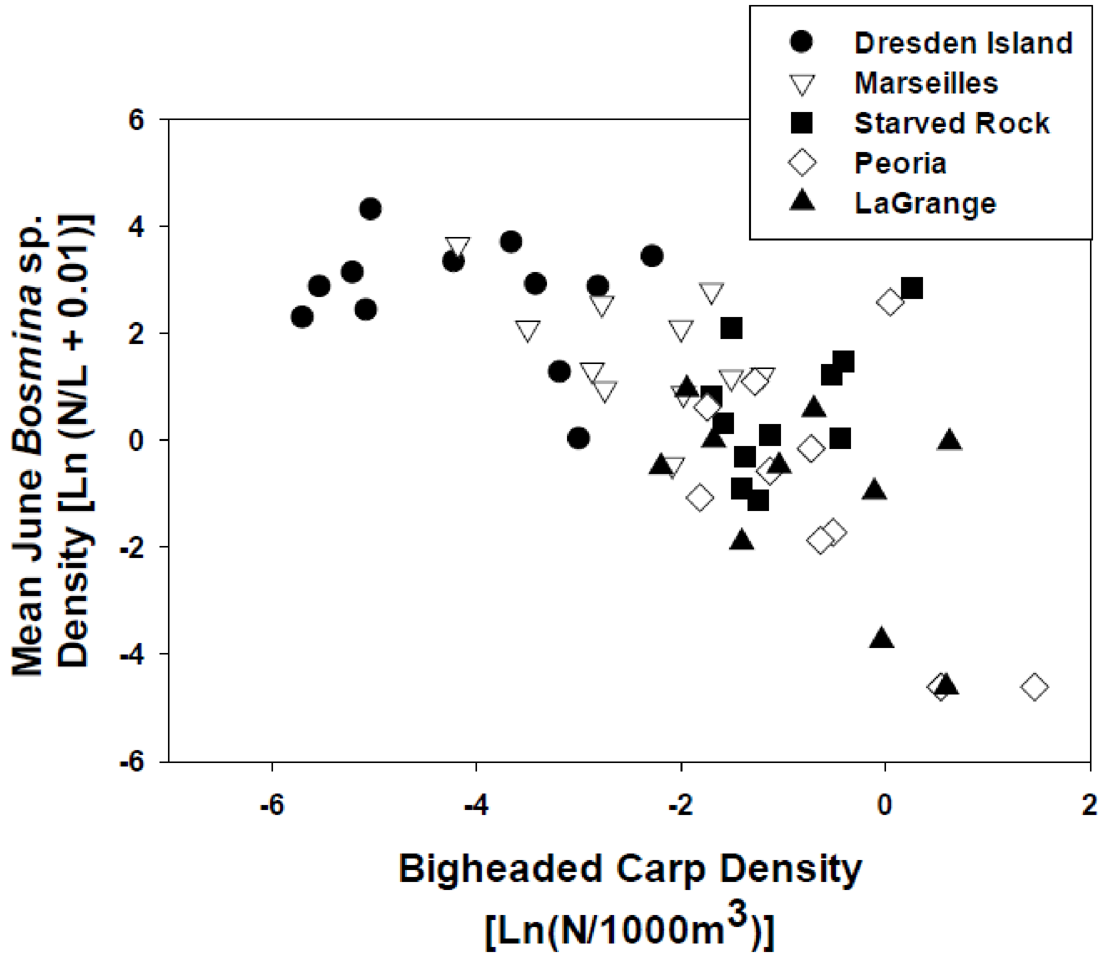
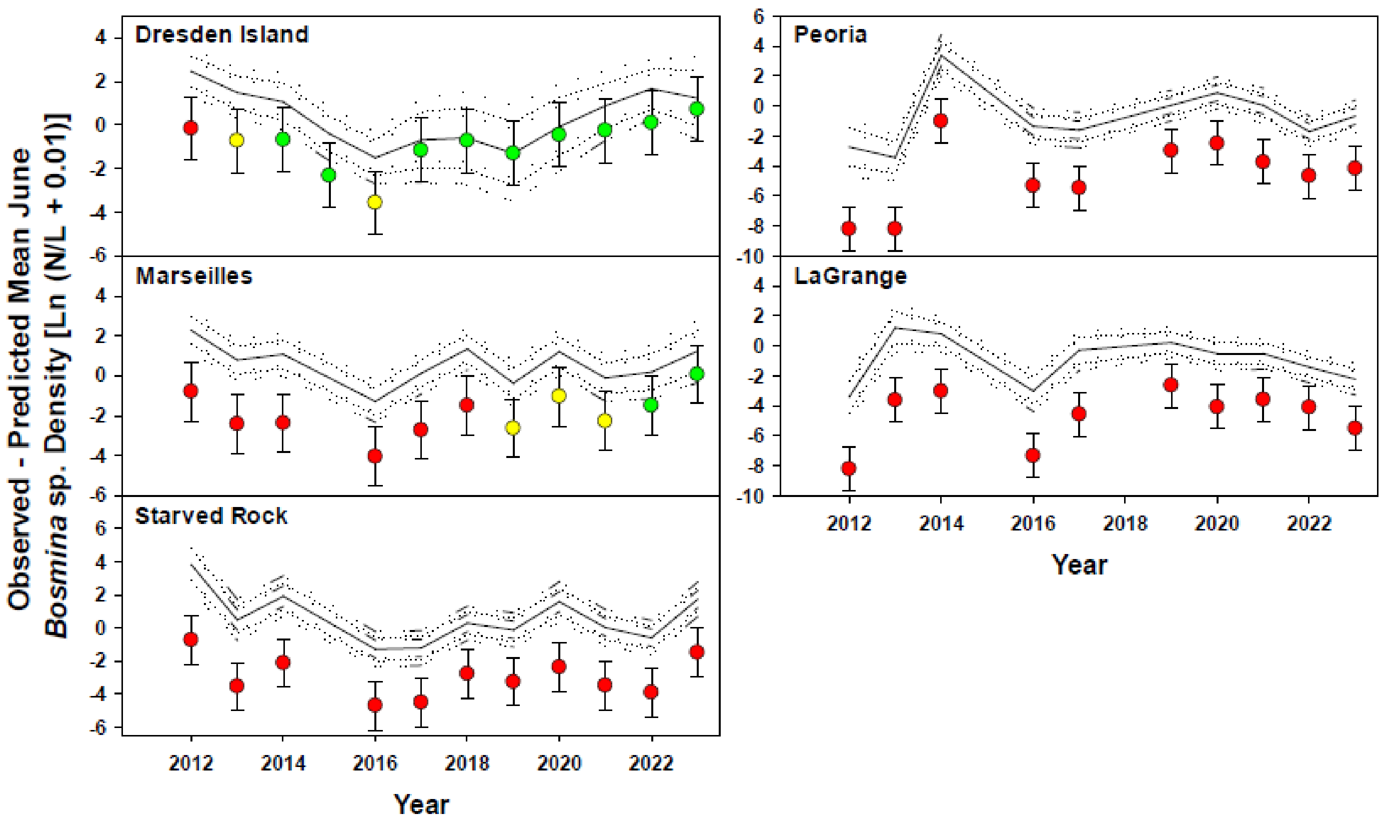


Figure 4. *Assessment plots for June Bosmina sp. in IWW navigation pools during the 2012 to 2023 assessment period. Residuals from model predictions based on observed bigheaded carp densities are the control intervals and are plotted as solid back lines with ± 1.5 (short, dashed lines), ± 2.0 (dotted lines), and ± 3.0 standard errors (long dashed lines). Residuals from model predictions using target bigheaded carp densities are plotted as red, yellow, and green dots with ± 2.0 standard errors. If target variance is outside of control intervals, the assessment point is depicted as red and considered to be a year when the management target of reduced bigheaded carp impacts was not achieved. If target variance falls outside of the 1.5 standard error control interval, but overlaps with the 3.0 standard error interval, the assessment point is depicted as yellow, and the density of bigheaded carp is considered reduced sufficiently to have some impact on their planktivorous effects but still falls short of management goals. If target variance overlaps the 1.5 standard error control interval, the assessment point is depicted as green and the management target of reduced ecosystem impacts of bigheaded carp was considered to have been achieved.*



Previous observations of zooplankton responses to the removal of bigheaded carp have found mixed results (Altenritter et al. 2022). The negative effects of bigheaded carp on zooplankton have been well documented, but only at either a coarse taxonomic scale (i.e., superorder [cladoceran], class [copepod], or phylum [rotifer]) or community-scale responses, such as community structure and taxonomic richness (Sass et al. 2014; DeBoer et al. 2018; Chará-Serna and Casper 2021). The challenge with using these previously quantified impacts as assessment metrics is that these indicators lack specificity in that changes in these indicators could be driven by any of a subset of the different taxa comprising these groups that may vary in their sensitivity to bigheaded carp versus other environmental drivers. A wide diversity of zooplankton taxa was therefore considered for assessing whether enough bigheaded carp have been removed to reduce their ecosystem impacts below a detectable level. Only one metric, June density of *Bosmina* species, fit all criteria for an informative indicator. *Bosmina* are one of the more abundant cladoceran taxa found in large rivers (Pace et al. 1992; Kim and Joo 2000; Wahl et al. 2008; Burdis and Hoxmeier 2011), selectively consumed by some native planktivorous fish (Sampson et al. 2009), and have potential as indicators of other environmental stressors (Adamczuk 2016). Copepods have also frequently been found to be negatively affected by bigheaded carp abundance (Sass et al. 2014; DeBoer et al. 2018; Hochstrasser and Collins 2024), and peak cyclopoid copepod densities were found to be substantially affected by variation in bigheaded carp density in previous assessments by the current study. However, although bigheaded carp density was found to negatively affect September cyclopoid densities, the current analysis found that bigheaded carp density did not have more than a weak effect on any copepod metric. This group may be more strongly affected by abiotic factors, or variation in the responses of the individual species that compose this group may mask the effects of bigheaded carp planktivory.

Responses of rotifers to bigheaded carp planktivory have been found to be highly variable (Sass et al. 2014; Collins et al. 2018; DeBoer et al. 2018; Hochstrasser and Collins 2024). The general dominance of rotifers in large-river zooplankton assemblages (Thorp and Mantovani 2005; Sluss and Jack 2013), their shorter generation times (Lair 2006), the possibility that plankivory by hyperabundant bigheaded carp populations may release rotifers from competition with other zooplankton taxa (Collins et al. 2018) and shift phytoplankton communities toward the smaller taxa favored by rotifer grazers (Miura 1990; Domaizon and Devaux 1999) may explain the neutral or positive effects that bigheaded carp have on rotifer abundances in some studies. Indeed, in the current assessment, rotifer densities were either unrelated or positively related to either native or non-native planktivores in most cases. However, earlier analyses conducted as part of this study found negative relationships between bigheaded carp densities and peak rotifer densities, and rotifers have demonstrated a positive response to bigheaded carp harvest in some backwaters (Altenritter et al. 2022). The complex relationships of rotifers with other trophic levels (Collins et al. 2018; Chara-Serna and Casper 2021) may complicate our understanding of the mechanisms by which bigheaded carp affect this taxonomic group and render these taxa less suitable as potential performance indicators for assessing bigheaded carp impacts.

An important element in functional eradication of an invasive species is the ability to separate the effect of invader density from other environmental drivers (Green and Grosholz 2021). To address this need, we investigated inclusion of environmental conditions and the relative abundance of native planktivorous fish as potential explanatory factors. These factors were only found to account for meaningful levels of variation in monthly densities of some examined rotifer taxa, none of which met our criteria as informative assessment metrics for bigheaded carp density. The lack of inclusion of environmental variables in most top-ranked models should not be inferred to indicate that these zooplankton taxa are entirely unaffected by these factors. Rather, the amount of variation in the candidate metrics that could be attributed to native planktivores or abiotic drivers was not sufficient to warrant their consideration relative to simpler sets of explanatory variables. Nonetheless, it is important to evaluate the potential influence of factors other than densities of the invasive species when assessing their ecological impacts to provide confidence that the invader is among the primary sources of variation driving a potential response metric.

All models are imperfect depictions of reality, and, therefore, there will always be unexplained variation for each observation. For instance, there are likely to be environmental factors other than bigheaded carp density also influencing June *Bosmina* sp. Density, so we would expect predictions from our simple model to deviate to some degree from observed densities. Another source of uncertainty in the assessment was the densities of invasive carp used to parametrize the model and produce predictions. Along with the measurement error associated with invasive carp density estimates (MacNamara et al. 2016), there was also the assumption that densities estimated in the fall provided an accurate index of bigheaded carp relative abundance in the navigation pools during June. To accommodate the unexplained variation in zooplankton density not addressed by the invasive carp predictor, we incorporated this uncertainty into the assessment by basing our evaluations of whether management targets had been achieved on comparisons between the magnitudes of the deviations from model predictions using observed and target invasive carp densities. This method was based on a statistical quality control approach developed for manufacturing and adapted to assess the outcome of restoration actions where models were constrained to only include the predictor variable that was being manipulated by environmental managers (Trexler and Goss 2009).

The assessment system employed here allowed us to evaluate temporal patterns of response by a zooplankton metric to changes in bigheaded carp density. This assessment suggests that the management target of reducing the impact of bigheaded carp planktivory has only been achieved in the Dresden Island and Marseilles pools as of 2023. Despite the declines in invasive carp densities that have occurred in other navigation pools, these have not been sufficient to mitigate the ecological impacts of bigheaded carp planktivory. The fragmentation of the upper IWW by dams that at least partially restrict movements of bigheaded carp between pools and the lack of recruitment within these pools likely helps to facilitate invasive carp suppression efforts upstream of Starved Rock L&D. In addition to maintaining bigheaded carp populations at or below current levels that are shown here to mitigate their planktivorous impacts in the Dresden Island and Marseilles pools, a potential management goal might be to achieve similar results in the Starved Rock Pool. However, this would require continued quantification of June *Bosmina* sp. densities to ascertain if management efforts are truly meeting targets for reducing ecosystem impacts. The ease of movement by invasive carp among lower IWW pools and between the lower IWW and the Mississippi River, and high episodic recruitment in these areas may present substantial challenges for harvesting sufficient numbers of bigheaded carp to meet management targets.

RECOMMENDATIONS

June *Bosmina* sp. density was identified as the most informative metric for evaluating if invasive carp harvest efforts are effectively mitigating the impacts of bigheaded carp planktivory in the IWW. This metric can be readily implemented as an indicator of ecological response to bigheaded carp harvest. *Bosmina* are an easily identified cladoceran, and samples would only need to be collected twice from each navigation pool during the month of June to evaluate if bigheaded carp densities have been sufficiently reduced to elicit a response from the zooplankton community. Other zooplankton metrics might be more useful indicators of ecological responses to bigheaded carp harvest in other waterways, but a similar assessment framework to that used here could be implemented to identify appropriate response metrics in those systems. Other response metrics from other ecological elements of interest to managers (e.g., native fish metrics) should also be investigated to define explicit targets for addressing management goals. Clearly defined and defensible management targets would provide a means of evaluating the progress of invasive carp control efforts within the IWW, in addition to the goal of preventing their establishment in the Great Lakes.

A next step of conducting a synthetic overview of the effects of invasive carp suppression that integrates responses across multiple biological levels is recommended. These responses should be indicator metrics based on relevant ecological elements of interest to managers, such as carp reproduction and recruitment (e.g., Parkos et al. 2023), native fish population metrics (e.g., Irons et al. 2007; DeBoer et al. 2018), or food web impacts (e.g., DeBoer et al. 2018; Kramer et al. 2019). These indicators could be used to develop explicit management targets to address multiple goals, such as inducing recruitment overfishing, reducing upriver movement, and mitigating negative impacts on native fish and their supporting food web. Incorporating clearly defined management targets based on an integrated set of management goals could address multiple potential benefits of invasive carp removal efforts, as well as provide transparent metrics for evaluating progress in suppressing and limiting the expansion of invasive carp populations.

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