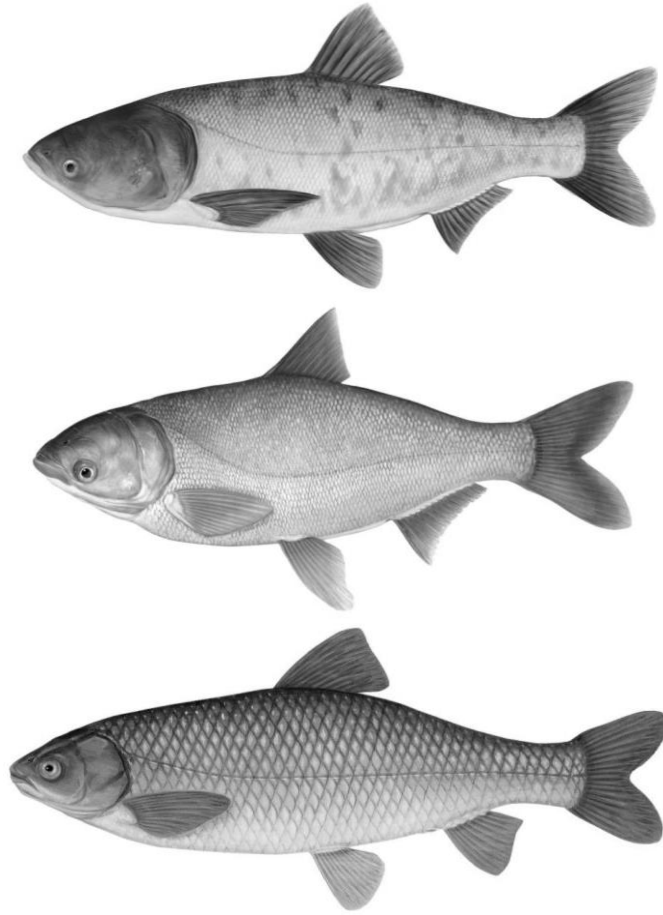


INVASIVE CARP SAMPLING REPORT
JANUARY – DECEMBER 2024
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
SECTION OF FISHERIES



UPPER MISSISSIPPI RIVER, POOLS 1-8
LOWER ST. CROIX RIVER, BELOW ST. CROIX FALLS
MINNESOTA RIVER, BELOW GRANITE FALLS
March 14, 2025

Table of Contents

Introduction	1
Objectives	2
Sampling Sites	3
Sampling Methods	3
Commercial Fishing.....	3
Invasive Carp Acoustic Tagging and Tracking	4
Larval Sampling	6
eDNA	8
Gill and Trammel Netting.....	8
Results and Discussion	8
Sampling Results	8
eDNA results	10
Invasive Carp Acoustic Tagging and Tracking Results	11
Recommendations	13
Acknowledgements.....	15
References	15
Tables	19
Table 1. Invasive carp sampling summary for the Mississippi River Pools 2, 3, 4, 5, 5A, 6, 7 and 8 and the St. Croix and Minnesota rivers for January through December 2024. Number of Invasive Carp Captured represents the number of individuals caught by MN DNR, contracted commercial anglers, or monitored commercial fishing.....	19
Table 2. Invasive Carp caught from January through December 2024 in Minnesota and Wisconsin boundary waters.....	20
Table 3. Larval sampling for the St. Croix and Mississippi Rivers from 2013 to 2024.	21
Table 4. Summary of all fish species identified through MN DNR sampling efforts for Mississippi River Pools 1-9 and the Minnesota and St. Croix rivers from January 2013 through December 2024. ^a	22
Figures.....	26
<i>Figure 1. Locations of all known invasive carp captured in Minnesota waters through 2024. (2024 Silver=100, Bighead=1, Grass=9)</i>	26
<i>Figure 2. Larval fish trawling (dark cross) and larval light trap (dark plus sign) locations on the Mississippi River.</i>	27

Figure 3. All sampling locations for commercial sampling and MDNR sampling on the Mississippi, St. Croix, and Minnesota Rivers during 2024. 28

Introduction

Bighead Carp *Hypophthalmichthys nobilis*, Silver Carp *H. molitrix*, Grass Carp *Ctenopharyngodon idella*, and Black Carp *Mylopharyngodon piceus* (hereafter collectively referred to as invasive carp) are a group of invasive fishes introduced into the United States during the early 1970s as aids in fish aquaculture operations (Henderson 1976). Although not all four fish species fall within the same genus, they are universally grouped together due to their proclivity for invading habitats outside of their shared native range (Kočovský 2018). Large-scale flooding events allowed these species to escape from aquaculture operations into the Lower Mississippi River drainage, where they began reproducing and spreading (Freeze and Henderson 1982). Invasive carp have migrated up the Mississippi River and its adjoining tributaries, quickly establishing populations in these newly invaded areas. In the state of Minnesota, Bighead and Grass carp have been collected in the Minnesota, Mississippi, and St. Croix rivers, while Silver Carp have only been captured in the Mississippi and St. Croix rivers (Figure 1). As of this reporting, there has been no documentation of a Black Carp being collected in either Minnesota or Wisconsin waters. Additionally, invasive carp eggs and larvae have never been detected in Minnesota waters.

Invasive carp can radically alter local ecosystems by outcompeting native planktivores. With high fecundity and the ability to disperse great distances, invasive carp can reach substantial population numbers, sometimes comprising most of the fish biomass in a given system (MICRA 2002). Bighead and Silver carp have a voracious appetite and coupled with their large size (up to 70 pounds), have the ability to consume large amounts of food by filtering zooplankton, phytoplankton, and organic particles out of the water column (Jennings 1988; Smith 1989; Voros 1997). If invasive carp populations establish in Minnesota, native planktivores such as Paddlefish *Polyodon spathula*, Bigmouth Buffalo *Ictiobus cyprinellus*, Gizzard Shad *Dorosoma cepedianum*, and the larval stages of many other native fishes may

experience direct competition for food resources with said invasive carp. Evidence from the Illinois River suggests that competition with invasive carp resulted in reduced condition factors for Bigmouth Buffalo and Gizzard Shad (Irons et al. 2007). Worldwide, introductions of invasive carp have led to declines in fish species diversity and abundance of commercially desirable species (Spatura and Gophen 1985; Petr 2002). Therefore, it is in Minnesota's best interest to keep the abundance of invasive carp low to avoid impacts on native fishes.

With the continuing northward progression of invasive carp up the Mississippi River, Minnesota's waters are threatened with the potential of a reproducing population establishing itself. A better understanding of the current status of invasive carp in Minnesota will allow for more effective actions to prevent spread and impacts. Although standard fish sampling assessments have been ongoing in Minnesota's major rivers and have the potential to catch invasive carp, the gear and methods used in these standard assessments are not the most efficient methods for capturing invasive carp. The purpose of this sampling effort is to use specialized gear and techniques to monitor for all life stages of invasive carp and associated native fishes in Minnesota waters, and to use what is learned from monitoring to inform response including removal and prevention actions.

Objectives

- Detect and monitor all life stages of invasive carp to:
 - Inform management prioritization of prevention and response efforts in Minnesota.
 - Provide current information to Upper Mississippi River (UMR) managers on invasive carp population changes.
 - Establish baseline data relating to habitat use by larval, young-of-year (YOY), and juvenile invasive carp to fill in current knowledge gaps in the scientific literature.
- Monitor native fish species that may be affected by the establishment of invasive carp.

- Implement innovative invasive carp-specific monitoring and capture techniques of invasive carp to increase removal efficiency.

Sampling Sites

In 2024, invasive carp sampling occurred in approximately 200 river miles of the Mississippi River from Pool 2 near Mendota, MN to Lock and Dam 8 in Genoa, WI (Figures 2 and 3). In the St. Croix River, effort focused on its confluence with the Mississippi River near Prescott, WI. In the Minnesota River, effort focused on its confluence with the Mississippi River and a site near Carver, MN.

Sampling Methods

Sampling for invasive carp took place between January 1, 2024, and December 31, 2024. Gear types, methods, and targeted locations were derived from personal communications with biologists who sample invasive carp [V. Santucci, Illinois Department of Natural Resources, personal communication; J. Lamer, Western Illinois University, personal communication, Duane Chapman, U.S. Geological Survey (USGS), personal communication, Jesse Fischer, USGS, personal communication], from those who have been conducting research on what gear is most efficient for capturing invasive carp [M. Diana, Illinois Natural History Survey (INHS), personal communication], from a literature review of sampling techniques and habitat preferences (Lohmeyer and Garvey 2009; Williamson and Garvey 2005; Dettmers et al. 2001; DeGrandchamp et al. 2007; Kolar et al. 2007; DeGrandchamp et al. 2008; Wanner and Klumb 2009; ACRCC 2012), and from the personal experience of commercial partners and Minnesota Department of Natural Resources (MN DNR) employees obtained during prior field seasons.

Commercial Fishing

Commercial anglers were contracted to target invasive carp with gillnets and seines for sampling and response efforts. MN DNR personnel accompanied contracted commercial anglers to direct

sampling locations and monitor sampling efforts. The number of native fish caught per species was either counted or estimated, and total weight harvested was requested from the contracted commercial anglers for both gillnetting and seining operations. Invasive carp captured were measured (mm TL), weighed (g), sexed, otoliths taken for aging, and any tags or spawning patches noted.

Invasive Carp Acoustic Tagging and Tracking

In Minnesota, Statute 84D.05, Subdivision 1 states, “A person may not possess, import, purchase, sell, propagate, transport, or introduce a prohibited invasive species.” In 2017, the legislature passed and Governor Mark Dayton signed an amendment to this statute which reads as follows: “*Subd. 1a. **Permit for invasive carp.** The commissioner may issue a permit to departmental divisions for tagging bighead, black, grass, or silver carp for research or control. Under the permit, the carp may be released into the water body from which the carp was captured.*” As part of the permitting process, MN DNR Fisheries developed a protocol to characterize and minimize potential risk of tagging and releasing a limited number of captured invasive carp while maximizing the amount of information gained. For further information regarding the tagging and tracking procedures, please see the permit issued by the MN DNR’s Division of Ecological and Water Resources (EWR).

The MN DNR was permitted in 2024 to tag two invasive carp in the St. Croix River, two in the Minnesota River, two per river pool in the Mississippi River, and fifteen in Pools 5A, 6, and 8, with acoustic transmitters. In total, fifteen invasive carp received transmitters with the assistance of the U.S. Fish and Wildlife Service (USFWS) in 2024 (Table 2).

The MN DNR utilized both passive telemetry (a stationary receiver array already in place) and active tracking (using a portable receiver and real-time floating receivers) to monitor tagged invasive carp to determine preferred habitats, longitudinal movement patterns, depth preferences, and locations

of concentrated invasive carp activity at which to focus capture efforts for maximum efficiency. There are 96 stationary receivers placed throughout the state of Minnesota. They are located on the Mississippi River from above the Coon Rapids Dam at Coon Rapids, MN (Mississippi River Mile 866.2) downstream to Lock and Dam 5 at Winona, MN (Mississippi River Mile 738.1), on the St. Croix River from Taylor's Falls, MN to the confluence with the Mississippi River at Prescott, WI (Mississippi River Mile 811.3), and on the Minnesota River from the County Road 6 bridge north of Delhi, MN (Minnesota River Mile 209.4) to the confluence with the Mississippi River at St. Paul, MN (Mississippi River Mile 844.0). Sixty-one receivers are maintained by the East Metro Fisheries Office, eighteen are maintained in the Minnesota River by the Hutchinson Fisheries Office (from river mile 18.7 to river mile 209.0), and ten are maintained by the Lake City Fisheries Office in the Chippewa River and Pools 4 and 5 of the Mississippi River. In addition, the USFWS maintains seven receivers in Minnesota waters and 47 additional receivers that extend downstream of Minnesota to Pool 19 near Keokuk, IA. Additional receivers are maintained outside of Minnesota that include, but are not limited to, 11 receivers maintained by the Missouri Department of Conservation (MDC) from Pool 19 to the confluence with the Ohio River.

Due to the schooling nature of bighead and silver carp, MN DNR is able to use tagged invasive carp as traitor fish to reveal the location of conspecifics. Tracking data are used to locate schools for removal by agency sampling or contracted commercial fishing. The MN DNR will take all reasonable measures to ensure that all tagged fish are tracked and that their locations are known through active tracking efforts and the utilization of an extensive passive tracking network.

The impacts of releasing tagged wild-caught invasive carp have been considered and are believed to be negligible when compared to the utility of the potential information gained from this project. Over 400 invasive carp have been removed from Minnesota waters as a result of tracking

tagged invasive carp. As outlined in this report, MN DNR maintains an extensive monitoring and removal program to ensure populations are adequately sampled and to document if reproduction is occurring in Minnesota waters. These efforts provide important information for Upper Mississippi River managers on carp population changes in the present front. MN DNR is strategic in choosing which individual invasive carp are tagged, choosing priority species and locations to maximize the information we gain through their tracking. Only individuals in good physical condition are tagged, and only during water temperatures that allow the fish to heal from tag implantation. Any invasive carp captured that are unable to be tagged are removed from the river system and euthanized.

Based on the 2024 tagging and tracking results, MN DNR staff have gained a better understanding of movement patterns and habitat preferences, while imposing very little risk to native fish populations. The information gained through telemetry will help to improve the effectiveness of sampling and removal efforts and will allow for the more efficient allocation of resources to aquatic areas facing the greatest threat of invasive carp establishment.

Telemetry results are also key for monitoring invasive carp movement upstream into Minnesota, and for implementing deterrents or other prevention strategies to reduce immigration into Minnesota. In 2024, MN DNR collaborated with USFWS and USGS staff to publish an article based on telemetry data that shows invasive carp moving upstream past dams when the dams are in open river condition (Fritts et al. 2024). This information will be used to inform the Lock and Dam 5 Deterrent Project being led by MN DNR.

Larval Sampling

Larval sampling was completed via two methods in 2024: larval trawling and larval light trap deployment. Larval trawling was conducted on Mississippi River Pool 5A (Figure 3). Lock and Dam 5

serves as a pinch point for upstream fish passage, which could prompt a spawn in Pool 5A. Each day of sampling, ten trawls were pulled for five minutes per trawl at intervals fifteen to twenty minutes apart. The samples were then transferred to plastic containers that had been pre-labelled with site and trawl information, stored on ice, and transported back to the lab at the East Metro Fisheries Office. Fisheries biologists then drained the water from the containers and added 90% ethanol for a period of 24 to 48 hours in order to preserve the contents of the trawl. After at least 24 hours had passed, the ethanol was drained and replaced with fresh 90% ethanol for storage until the contents could be sent for visual identification by a third party laboratory. A total of 72 ichthyoplankton samples were collected in May and June of 2024 (Table 3). Larval trawling occurred when there was a spike in the hydrograph at the immediate upstream lock and dam (Lock & Dam 5 at Whitman, MN) and when water temperatures were above 17°C.

Larval light traps were set in Mississippi River Pool 8, targeting backwaters and eddies off the main channel. Sites were chosen at random based on accessibility by boat and water current conditions in backwaters, and MN DNR staff's knowledge of Pool 8 conditions that could serve as invasive carp nursery habitat (Figure 3.). During the 2024 field season, six sets each consisting of five larval light traps were set in Pool 8 for a total of 30 larval light traps (Table 3). Each larval light trap was equipped with a flashing green light, and traps were attached together at five-foot intervals and anchored on both ends. Each set was left overnight and retrieved the following day. Orientation line, current, depth, time of larval light trap deployment and retrieval, and water temperature were recorded. The larval light trap samples were transferred to plastic containers that had been pre-labelled with site and set information, stored on ice, and transported back to the lab at the East Metro Fisheries Office. Fisheries biologists then drained the water from the containers and added 90% ethanol for a period of 24 to 48 hours in order to preserve the contents collected from the larval light traps. After at least 24 hours had passed,

the ethanol was drained from the plastic containers and replaced with fresh 90% ethanol for storage until the contents could be sent to a third party laboratory for visual identification of the eggs and larvae.

eDNA

MN DNR partners with the USFWS to help direct sampling locations. The USFWS La Crosse Fish and Wildlife Conservation Office collects the samples and the USFWS Whitney Genetics processes the samples to detect bighead and silver carp eDNA. The results are then posted on the USFWS eDNA portal. eDNA sites sampled in 2024 included just downstream of Granite Falls on the Minnesota River, and at the Boom Site and just downstream of Taylors Falls on the St. Croix River. Sampling was also conducted in Pool 8 as part of an experiment to test different sample collection techniques (grab samples vs. filtered samples).

Gill and Trammel Netting

Gillnetting and trammel netting occurred during multiple sampling events on each river system. Large mesh gillnets of depths from 8 to 30 feet and lengths of 150 to 1000 feet with bar mesh sizes of 3.5 to 6 inches were used to target adult invasive carp. Nets were set either short-term or overnight, with short-term sets favored when water temperatures were greater than 60°F. All fish caught were identified to species.

Results and Discussion

Sampling Results

In total, 73 days were spent sampling between January and December 2024 in Mississippi River Pools 2, 3, 4, 5A, 6, 7, and 8, and in the Minnesota and St. Croix rivers with gear appropriate for sampling

invasive carp (Table 1, Figure 2, Figure 3). A greater amount of effort was focused on Pools 5A and 8 in 2024 in response to recent captures, sightings, and telemetry data.

Intensive spring sampling occurred in Pools 5-8 of the Mississippi River including a multi-agency netting event (MANE), co-hosted by MN DNR and USGS. Wisconsin DNR (WDNR), the National Park Service (NPS), and Wild Rivers Conservancy also participated in this event. On the last day of the spring 2024 MANE, two Silver Carp were captured and tagged with USFWS assistance. Sampling during this event included many sites that appeared to be potential over-wintering habitat for invasive carp. At each site, block nets were set to surround the site. Anti-jumping nets were then added to the top of the block net before stimulus was added in the area with electrofishing and underwater speakers. Water quality parameters were also recorded at each site. A very high level of stimulus was needed to entice Silver Carp to jump, higher than what was tested at most sites. This could be related to the cold water temperature during the March sampling event, or to other unknown factors. The MANE is currently paused pending further development of a study design to assess MANE performance and applicability in Minnesota waters.

Contracted commercial anglers were hired to use large mesh gillnets and seines to sample in the Mississippi River in Pools 2, 3, 4, 5, 5A, 6, 7, and 8, and in the St. Croix River near Prescott, WI. Contracted commercial anglers set approximately 71,500 feet of gillnets during 21 days of effort and conducted 25 seine hauls during 19 days of effort between January and December 2024. Short term gillnets (.5-1.5 hours) were prioritized over overnight sets due to the silver carp's ability to escape from the nets. After gillnets were set, fish were chased towards the net with boats and underwater speakers, typically in large backwater areas. Unlike previous years, nets were pulled shortly after fish were driven towards the net. In 2024, four non-contract commercial seine operations were also monitored for the presence of invasive carp.

Random electrofishing sampling was conducted on the Minnesota and St Croix River, as well as Pools 2, 3, 5A, 7, and 8 of the Mississippi River. A total of 324 minutes of “on time” over 23 days was spent electrofishing in 2024. Random electrofishing was used to monitor for invasive carp. No invasive carp were captured via electrofishing in Minnesota in 2024.

Gillnets set by MN DNR personnel were often used to sample behind wing dikes and in smaller side channel and backwater areas where it wasn’t feasible for commercial anglers to target with their larger operations. In 2024, a total of 1,900 feet of gillnet were set over 2 days. The nets were set short term to reduce risk to native bycatch (2-5 hours). In 2024, no invasive carp were captured during routine gillnetting operations in Minnesota.

Although no new or notable species were added to the species list in 2024, numerous unique or rare native fishes were encountered during these sampling events. A complete species list of species caught and observed on Pools 2-9, the Minnesota River and the St. Croix River, from January 2013 through December 2024, has been compiled (Table 4).

Determining invasive carp abundance and the effects of management on abundance continue to be key questions for MN DNR managers. While it is likely there are additional invasive carp present in Minnesota’s monitored rivers based on the previously mentioned captures of larger congregations of fish, the degree to which invasive carp populations have changed is unclear. Captures are too limited to allow for an estimate of invasive carp abundance in Minnesota waters. The recent increase in captures could be attributed to a successful year class migrating upstream during extended periods of high water in 2019, 2023, and 2024, but it remains to be seen what the implications will be for the future abundance of invasive carp in Minnesota waters.

eDNA results

eDNA sampling was conducted by the USFWS during the weeks of May 21st and 29th. In the Mississippi River, sampling occurred in Pool 8 as part of a study to evaluate sampling methods. Results from that study are not yet available. Invasive carp are regularly captured in Pool 8, and the monitoring data from eDNA helps the DNR track relative changes in invasive carp abundance in this pool over time.

In the Minnesota river, eDNA sampling occurred below Granite Falls Dam in May 2024. No invasive carp eDNA was detected in any of the 88 samples taken. Invasive carp have been captured and removed below Granite Falls Dam in past years; this location is monitored because it is the furthest extent that invasive carp can travel upstream in the Minnesota River and because DNR's current capacity does not allow for traditional gear sampling at this location.

Two sites in the St. Croix River were sampled for eDNA in May 2024. Of the 114 eDNA samples taken at the Boom Site just upstream of Stillwater, one tested positive for silver carp DNA. This location had four positive eDNA detections out of 110 samples in 2022, and no detections in 2023. The DNR regularly samples for invasive carp in the St. Croix River and has removed both bighead and silver carp from the river. Invasive carp DNA was not detected in any of the 88 samples taken further upstream, just below Taylor's Falls, the furthest extent that invasive carp can travel in the St. Croix River.

Invasive Carp Acoustic Tagging and Tracking Results

On July 28, 2017, during routine monitoring at the Allen S. King Plant on the St. Croix River, a Bighead Carp was caught by MN DNR staff in a large mesh gillnet. The fish was then tagged, released, and tracked. For information from previous years on the tagged bighead carp, refer to the Minnesota Department of Natural Resources 2021, 2022, and 2023 Sampling Reports (MNDNR 2022, 2023, 2024A). This tag was estimated to expire in February of 2024. River conditions during the fall of 2024 prevented

staff from downloading all of the receivers in the network. A report summarizing movement for the life of the tag will be available once all receivers have been downloaded in the spring of 2025.

A total of 15 invasive carp were tagged in 2024, including 12 silver carp and 3 grass carp. The US Fish and Wildlife Service conducted the surgeries. Tagged fish are actively tracked while river conditions allow. Data from the receiver arrays are still being summarized, but flooding in June 2024 allowed for some upstream movement past open dams. At least 2 invasive carp moved past Lock and Dam 5. One individual carp moved upstream and downstream across Lock and Dam 5 multiple times in 2024. Several tagged invasive carp were located in Pool 2, having moved in from either downstream in the Mississippi River or from the St. Croix River. These tagged carp were used as “traitor fish” to catch and tag or remove 4 silver carp and tag an additional 2 silver carp (Table 2). The newly tagged Pool 2 fish spent the rest of the year in Pig’s Eye Lake (P2), suggesting that it may be a location to target for future removal efforts. The Root River, which empties into Pool 8, was also a hotspot for 2024. Five invasive carp (including the three grass carp) were captured and tagged near the mouth of the Root. Little is known about how invasive carp use tributaries in Minnesota and Wisconsin, but due to reproduction being observed in Iowa tributaries to the Missouri River, monitoring at these locations has become an area of focus.

The tagged carp have been vital in the capture of multiple additional invasive carp since the first tagged carp in 2017. Without tracking information from these tagged carp, MN DNR personnel would not have fished certain locations that led to the capture of additional invasive carp. Because the tagged fish exhibit relatively large movements and have inhabited confined areas that are only suitable for sampling for short periods of time, we have learned that the timing of sampling is critical for effective management and removal. The ability to track tagged individuals will continue to allow biologists to

better understand additional habitat preferences and the duration of residence preferences that will improve the effectiveness of capture efforts.

Tracking methods and field sampling will be adjusted accordingly for 2025. MN DNR staff will continue to track tagged fish while analyzing the data to increase sampling and removal efficiencies.

Recommendations

Continued monitoring and removal of invasive carp from Minnesota waters is recommended. This project was funded in part by the past Minnesota Environment and Natural Resources Trust Fund grant through June 2024. An additional grant was received from the ENRTF extending through June of 2027. We recommend this project continue beyond that grant to ensure invasive carp do not establish spawning populations and to adequately document the effects of invasive carp to native fish populations. Additional funding has been received from USFWS Invasive Carp Grants, and state appropriations for invasive carp prevention and management.

Paddlefish are a native planktivore that may compete for food resources with invasive carp. Currently, Paddlefish are a threatened species in Minnesota and populations across their range have suffered due to commercial navigation projects (that impede movement and alter habitats), pollution, and overexploitation (Jennings and Zigler 2000). If invasive carp become established in Minnesota rivers, local Paddlefish populations could be further stressed (Schrack et al. 2003). Non-lethal means of studying Paddlefish populations are recommended, including continued tagging of encountered Paddlefish using jaw and acoustic tags. Tagging and releasing Paddlefish will inform biologists of their populations and life history, as well as provide a population estimate for management purposes. MN DNR should increase effort to encourage boaters to report any deceased Paddlefish for age and growth analysis. Other MN DNR offices should collect all deceased Paddlefish for analysis.

Multi-agency mass netting events have sometimes resulted in captures and sightings, and other times have not produced results. This leaves questions as to the best timing, locations, and methods to apply this approach. The events are currently paused pending a study design that will answer these questions. It is recommended that this method continue to be developed for use in low-density populations. MN DNR will work with partnering agencies towards a more streamlined method that can be deployed by MN DNR staff for rapid response.

Continued eDNA sampling is important as a monitoring tool. Captures of invasive carp are limited, and eDNA detection data can help supplement the available capture data to inform management. Minnesota DNR partners with USFWS and USGS on eDNA sampling in Minnesota.

The Minnesota Invasive Carp Action Plan was first developed in 2011 and updated in 2014 and 2024 (MNDNR 2024B). New management techniques are now available and are listed in the update. The action plan will help guide future management of invasive carp in Minnesota. The key purpose of this plan is to slow the spread of invasive carp, minimize their impact, and reduce the likelihood of invasive carp reproducing in Minnesota waters. Monitoring and management actions will be taken in accordance with the plan, in support of those goals.

Deterrents and barriers have been useful for keeping invasive carp out of lakes in southwest Minnesota. The deterrents and barriers to movement were installed after a watershed breach analysis identified vulnerable connections. Additional watershed breach studies in Minnesota will be important to identifying locations for monitoring and management and are recommended in future funding to reassess Minnesota's changing waterways.

As invasive carp captures increase in Minnesota, the risk of reproduction also increases. Invasive carp require sufficient length of flowing water for their eggs to hatch and larvae to begin swimming, and

the larvae require nursery habitat to survive. FluEgg is a model that can be used to predict whether a location is suitable for invasive carp to reproduce. FluEgg modeling has been conducted on the Lower St. Croix River; further modeling is underway to evaluate pools 2-8 of the Mississippi River. Identifying locations where recruitment is possible will help focus management efforts to prevent reproduction and monitor for potential spawning events.

Acknowledgements

The monitoring and removal of invasive carp in Minnesota is a collaborative program funded by the MN DNR, appropriations from the state legislature, the USFWS, and the Minnesota Environment and Natural Resources Trust Fund. Technical support from the USGS was crucial in planning and executing multi-agency netting events. Field support for multi-agency netting events was provided by USGS, U.S. Fish and Wildlife Service, Wisconsin DNR, National Park Service, and Wild Rivers Conservancy. Coordination and monitoring of the telemetry network and tagged carp was provided by WIDNR and USFWS.

References

- ACRCC (Asian Carp Regional Coordinating Committee). 2012. Monitoring and rapid response plan for Asian carp in the Upper Illinois River and Chicago Area Waterway System. Monitoring and Rapid Response Workgroup, Asian Carp Regional Coordinating Committee, Council on Environmental Quality. Washington. May 2012. <<http://asiancarp.us/documents/2011Framework.pdf>>
- DeGrandchamp, K. L., J. E. Garvey, and L. A. Csoboth. 2007. Linking adult reproduction and larval density of invasive carp in a large river. *Transactions of the American Fisheries Society* 136:1327-1334.
- DeGrandchamp, K. L., J. E. Garvey, and R. E. Colombo. 2008. Movement and Habitat Selection by Invasive Asian Carps in a Large River. *Transactions of the American Fisheries Society* 137:45-56.

- Dettmers, J. H., D. H. Wahl, D. A. Soluk, and S. Gutreuter. 2001. Life in the fast lane: Fish and foodweb structure in the main channel of large rivers. *Journal of the North American Benthological Society* 20:255-265.
- Freeze, M., and S. Henderson. 1982. Distribution and status of the bighead carp and silver carp in Arkansas. *North American Journal of Fisheries Management* 2:197-200.
- Fritts, M., D. Gibson-Reinemer, D. Appel, K. Lieder, C. Henderson, A. Milde, M. Brey, J. Lamer, D. Turney, Z. Witzel, E. Szott, G. Loppnow, J. Stiras, K. Zankle, D. Oliver, R.J. Hoxmeier, and A. Fritts. 2024. Flooding and dam operations facilitate rapid upstream migrations of native and invasive fish species on a regulated large river. *Scientific reports* 14(1).
- Henderson, S. 1976. Observations on the bighead and silver carp and their possible application in pond fish culture. Arkansas Game and Fish Commission, Little Rock.
- Irons, K. S., G. G. Sass, M. A. McClelland, and J. D. Stafford. 2007. Reduced condition factor of two native fish species coincident with invasion of non-native Asian carps in the Illinois River, U.S.A. Is this evidence for competition and reduced fitness? *Journal of Fish Biology* 71 (Supplement D):258-273.
- Jennings, D. P. 1988. Bighead carp (*Hypophthalmichthys nobilis*): a biological synopsis. U.S. Fish and Wildlife Service, Biology Report 88:1-35.
- Jennings, C. A., and S. J. Zigler. 2000. Ecology and biology of Paddlefish in North America: historical perspectives, management approaches, and research priorities. *Reviews in Fish Biology and Fisheries* 10:167–181.
- Kočovský, P. M., D.C. Chapman, S. Qian. 2018. “Asian Carp” is Societally and Scientifically Problematic. Let’s Replace It. *American Fisheries Society, Fisheries* 43(7):311-316.
- Kolar, C. S., D. C. Chapman, W. R. Courtenay, Jr., C. M. Housel, J. D. Williams, and D. P. Jennings. 2007. Bigheaded carps: a biological synopsis and environmental risk assessment. American Fisheries Society, Special Publication 33, Bethesda, Maryland.
- Lohmeyer A. M. and J. E. Garvey. 2009. Placing the North American invasion of Asian carp in a spatially explicit context. *Biological Invasions* 11:905-916.

- MICRA. 2002. Asian carp threat to the Great Lakes. River Crossings: The Newsletter of the Mississippi Interstate Cooperative Resource Association 11:1-2.
- Minnesota Department of Natural Resources. 2018. 2017 Invasive Carp Sampling Report.
- Minnesota Department of Natural Resources. 2019. 2018 Invasive Carp Sampling Report.
- Minnesota Department of Natural Resources. 2020. 2019 Invasive Carp Sampling Report.
- Minnesota Department of Natural Resources. 2021. 2020 Invasive Carp Sampling Report.
- Minnesota Department of Natural Resources. 2022. 2021 Invasive Carp Sampling Report.
- Minnesota Department of Natural Resources. 2023. 2022 Invasive Carp Sampling Report.
- Minnesota Department of Natural Resources. 2024a. 2023 Invasive Carp Sampling Report.
- Minnesota Department of Natural Resources. 2024b. Minnesota Invasive Carp Action Plan. 43 pp.
- Petr, T. 2002. Cold water fish and fisheries in the countries of the high mountain arc of Asia (Hindu Kush-Pamir-Karakoram-Himalayas): a review. *In* Cold Water Fisheries in the Trans-Himalayan Countries, eds. Petr, T. and Swar, D. B., pp. 1-38. FAO Fisheries Technical Paper 431.
- Schrank, S.J., C.S. Guy, and J.F. Fairchild. 2003. Competitive interactions between age-0 bighead carp and Paddlefish. *Transactions of the American Fisheries Society* 132:1222-1228.
- Smith, D. W. 1989. The feeding selectivity of silver carp, *Hypophthalmichthys molitrix* Val. *Journal of Fish Biology* 34:819-828.
- Spatura, P., and M. Gophen. 1985. Feeding behaviour of silver carp *Hypophthalmichthys molitrix* Val. and its impact on the food web in Lake Kinneret, Israel. *Hydrobiologia* 120:53-61.
- Voros, L. 1997. Size-selective filtration and taxon-specific digestion of plankton and algae by silver carp (*Hypophthalmichthys molitrix* Val.). *Hydrobiologia* 342:223-228.
- Wanner, G. A., and R. A. Klumb. 2009. Asian carp in the Missouri River: Analysis from multiple Missouri River habitat and fisheries programs. National Invasive Species Council materials. Paper 10.

Williamson, C. J., and J. E. Garvey. 2005. Growth, fecundity, and diets of newly established silver carp in the Middle Mississippi River. Transactions of the American Fisheries Society 134:1423-1440.

Tables

Table 1. Invasive carp sampling summary for the Mississippi River Pools 2, 3, 4, 5, 5A, 6, 7 and 8 and the St. Croix and Minnesota rivers for January through December 2024. Number of Invasive Carp Captured represents the number of individuals caught by MN DNR, contracted commercial anglers, or monitored commercial fishing.

Invasive Carp Sampling Summary January – December 2023			Days
Random Sampling Effort			
Gill/Trammel Netting	1,900	feet	2
Electrofishing	324	minutes	23
Beach Seine	0	Hauls	0
Standardized Sampling Effort			
Electrofishing	0	minutes	0
Larval Trawl	40	Pushes	4
Larval Light Traps	30	Traps	4
Targeted Commercial Fishing Effort			
Gillnetting	71,500	feet	21
Seining	25	hauls	19
Monitored Commercial Fishing Effort			
Seining	4	hauls	4
Tracking*			
2-person crew		days	77
Number of Invasive Carp Captured			
	110	fish	
Total Number of Days Sampled			
			73

*Does not include tracking by real-time receivers (MN DNR, USFWS) in the St. Croix River, Pool 5A and Pool 8.

Table 2. Invasive Carp caught from January through December 2024 in Minnesota and Wisconsin boundary waters.

Date of Capture	Species	Quantity Captured	Sex	Captured Pool	Capture Method	Notes
2/13/2024	Silver Carp	81	39-M, 41-F	MSR Pool 5A	Comm. Seine	Removed
2/13/2024	Bighead Carp	1	Unknown	MSR Pool 5A	Comm. Seine	Removed
2/14/2024	Silver Carp	1	1-F	MSR Pool 5A	Comm. Seine	Removed
3/13/2024	Silver Carp	1	1-F	MSR Pool 8	Floating Gillnet	Tagged by USFWS (La Crosse)
3/13/2024	Silver Carp	1	1-F	MSR Pool 8	Block Net	Tagged by USFWS (La Crosse)
4/30/2024	Grass Carp	5	Unknown	MSR Pool 8	Comm. Gillnet	Removed
5/6/2024	Silver Carp	3	3-F	MSR Pool 8	Comm. Gillnet	Tagged by USFWS (La Crosse)
5/7/2024	Grass Carp	3	Unknown	MSR Pool 8	Comm. Gillnet	Tagged by USFWS (La Crosse)
5/8/2024	Silver Carp	1	1-F	MSR Pool 8	Comm. Gillnet	Tagged by USFWS (La Crosse)
5/23/2024	Silver Carp	1	1-F	MSR Pool 8	Comm. Gillnet	Tagged by USFWS (La Crosse)
5/24/2024	Silver Carp	1	1-F	MSR Pool 8	Comm. Gillnet	Tagged by USFWS (La Crosse)
6/3/2024	Silver Carp	1	1-F	MSR Pool 5A	Comm. Gillnet	Removed
7/25/2024	Grass Carp	1	Unknown	MSR Pool 8	Comm. Gillnet	Removed
7/30/2024	Silver Carp	4	4-M	MSR Pool 2	Comm. Gillnet	Removed
7/30/2024	Silver Carp	2	1-M, 1-F	MSR Pool 2	Comm. Gillnet	Tagged by MNDNR
11/7/2024	Silver Carp	1	1-F	MSR Pool 8	Comm. Seine	Tagged by USFWS (La Crosse)
11/7/2024	Silver Carp	1	1-F	MSR Pool 8	Comm. Seine	Tagged by USFWS (La Crosse)
11/25/2024	Silver Carp	1	1-F	MSR Pool 2	Comm. Seine	Removed

Table 3. Larval sampling for the St. Croix and Mississippi Rivers from 2013 to 2024.

<i>Year</i>	Number of Sites		Total number of Samples		Number of Samples with Larval Fish		Number of Larval Invasive carp	
	<i>St. Croix River</i>	<i>Mississippi River</i>	<i>St. Croix River</i>	<i>Mississippi River</i>	<i>St. Croix River</i>	<i>Mississippi River</i>	<i>St. Croix River</i>	<i>Mississippi River</i>
<i>2013</i>	8	8	16	28	6	16	0	0
<i>2014</i>	9	13	28	44	17	28	0	0
<i>2015</i>	8	18	52	253	23	139	0	0
<i>2016</i>	9	16	46	102	25	83	0	0
<i>2017</i>	7	17	20	73	20	73	0	0
<i>2018</i>	8	8	66	68	37	44	0	0
<i>2019</i>	2	4	52	100	37	64	0	0
<i>2020</i>	0	0	0	0	0	0	0	0
<i>2021</i>	0	1	0	108	0	11	0	0
<i>2022</i>	0	6	0	72	0	--	0	0
<i>2023</i>	0	60	0	60	0	24	0	0
<i>2024</i>	0	9	0	72	0	55	0	--

--Pending results

Table 4. Summary of all fish species identified through MN DNR sampling efforts for Mississippi River Pools 1-9 and the Minnesota and St. Croix rivers from January 2013 through December 2024.^a

Common Name	Scientific Name	Pool 1	Pool 2	Pool 3	Pool 4	Pool 5	Pool 5A	Pool 6	Pool 7	Pool 8	Pool 9	Minnesota	St. Croix
American Eel	<i>Anguilla rostrata</i>		X										
Bighead Carp	<i>Hypophthalmichthys nobilis</i>		X	X								X	X
Bigmouth Buffalo	<i>Ictiobus cyprinellus</i>		X	X	X	X	X	X		X		X	X
Bigmouth Shiner	<i>Notropis dorsalis</i>		X										
Black Buffalo	<i>Ictiobus niger</i>		X										
Black Bullhead	<i>Ameiurus melas</i>						X	X					X
Black Crappie	<i>Pomoxis nigromaculatus</i>		X	X						X		X	X
Black Redhorse	<i>Moxostoma duquesnei</i>												X
Blackchin Shiner	<i>Notropis heterodon</i>												X
Blacknose Shiner	<i>Notropis heterolepis</i>		X										X
Blackside Darter	<i>Percina maculata</i>		X										X
Blue Sucker	<i>Cycleptus elongatus</i>		X						X			X	X
Bluegill	<i>Lepomis macrochirus</i>		X		X					X		X	X
Bluntnose Minnow	<i>Pimephales notatus</i>		X										X
Bowfin	<i>Amia calva</i>		X		X			X		X		X	X
Brassy Minnow	<i>Hybognathus hankinsoni</i>												X
Brook Silverside	<i>Labidesthes sicculus</i>		X										X
Brook Stickleback	<i>Culaea inconstans</i>		X										
Brown Trout	<i>Salmo trutta</i>												X
Bullhead Minnow	<i>Pimephales vigilax</i>		X										
Burbot	<i>Lota lota</i>												X
Central Mudminnow	<i>Umbra limi</i>		X										
Central Stoneroller	<i>Campostoma anomalum</i>												X
Channel Catfish	<i>Ictalurus punctatus</i>	X	X		X	X	X			X		X	X
Channel Shiner	<i>Notropis wickliffi</i>		X										
Common Carp	<i>Cyprinus carpio</i>		X	X	X	X	X	X	X	X		X	X

Common Shiner	<i>Luxilus cornutus</i>		X										X
Creek Chub	<i>Semotilus atromaculatus</i>		X										
Crystal Darter	<i>Crystallaria asprella</i>												X
Emerald Shiner	<i>Notropis atherinoides</i>		X	X								X	X
Fathead Minnow	<i>Pimephales promelas</i>		X									X	X
Flathead Catfish	<i>Pylodictis olivaris</i>		X	X	X	X	X	X		X		X	X
Freshwater Drum	<i>Aplodinotus grunniens</i>		X	X	X	X	X	X		X		X	X
Gilt Darter	<i>Percina evides</i>												X
Gizzard Shad	<i>Dorosoma cepedianum</i>		X	X	X		X		X	X		X	X
Golden Redhorse	<i>Moxostoma erythrurum</i>		X				X			X		X	X
Golden Shiner	<i>Notemigonus crysoleucas</i>		X										X
Goldeye	<i>Hiodon alosoides</i>		X	X								X	
Grass Carp	<i>Ctenopharyngodon idella</i>		X					X		X			
Greater Redhorse	<i>Moxostoma valenciennesi</i>		X				X						X
Green Sunfish	<i>Lepomis cyanellus</i>		X									X	X
Highfin Carpsucker	<i>Carpionodes velifer</i>		X				X					X	X
Hornyhead Chub	<i>Nocomis biguttatus</i>		X										X
Hybrid Sunfish	<i>Lepomis microlophus</i> x <i>L. cyanellus</i>		X										X
Iowa Darter	<i>Etheostoma exile</i>												X
Johnny Darter	<i>Etheostoma nigrum</i>		X										X
Lake Sturgeon	<i>Acipenser fulvescens</i>		X	X	X	X	X			X			X
Largemouth Bass	<i>Micropterus salmoides</i>		X		X		X	X		X		X	X
Logperch	<i>Percina caprodes</i>		X										X
Longnose Gar	<i>Lepisosteus osseus</i>		X	X		X	X			X		X	X
Mimic Shiner	<i>Notropis volucellus</i>		X										X
Mooneye	<i>Hiodon tergisus</i>		X							X		X	X
Muskellunge	<i>Esox masquinongy</i>		X										X
Northern Hogsucker	<i>Hypentelium nigricans</i>		X										X

Northern Pike	<i>Esox lucius</i>		X	X	X	X	X			X		X	X
Orangespotted Sunfish	<i>Lepomis humilis</i>		X									X	X
Paddlefish	<i>Polyodon spathula</i>		X	X	X	X	X		X	X		X	X
Pumpkinseed	<i>Lepomis gibbosus</i>		X										X
Quillback Carpsucker	<i>Carpoides cyprinus</i>		X	X	X	X	X	X		X		X	X
Rainbow Darter	<i>Etheostoma caeruleum</i>												X
Redhorse species (sp.)	<i>Moxostoma</i> sp.						X			X			X
River Carpsucker	<i>Carpoides carpio</i>		X	X	X		X	X		X		X	X
River Darter	<i>Percina shumardi</i>		X										X
River Redhorse	<i>Moxostoma carinatum</i>		X			X				X			X
Rock Bass	<i>Ambloplites rupestris</i>		X	X				X					X
Sand Shiner	<i>Notropis stramineus</i>		X									X	X
Sauger	<i>Sander canadensis</i>		X	X								X	X
Shoal Chub	<i>Macrhybopsis hyostoma</i>		X										
Shorthead Redhorse	<i>Moxostoma macrolepidotum</i>		X	X	X		X	X		X		X	X
Shortnose Gar	<i>Lepisosteus platostomus</i>		X	X			X	X		X		X	X
Silver Carp	<i>Hypophthalmichthys molitrix</i>		X		X		X	X		X			X
Silver Chub	<i>Macrhybopsis storeriana</i>		X									X	X
Silver Lamprey	<i>Ichthyomyzon unicuspis</i>		X										X
Silver Redhorse	<i>Moxostoma anisurum</i>		X	X				X		X		X	X
Skipjack Herring	<i>Alosa chrysochloris</i>		X										
Slenderhead Darter	<i>Percina phoxocephala</i>		X										X
Smallmouth Bass	<i>Micropterus dolomieu</i>		X		X		X			X		X	X
Smallmouth Buffalo	<i>Ictiobus bubalus</i>	X	X	X	X	X	X	X		X		X	X
Spotfin Shiner	<i>Cyprinella spiloptera</i>		X									X	X
Spottail Shiner	<i>Notropis hudsonius</i>		X									X	X
Spotted Sucker	<i>Minytrema melanops</i>		X							X			X
Tadpole Madtom	<i>Noturus gyrinus</i>		X										
Trout Perch	<i>Percopsis omiscomaycus</i>		X										X

Walleye	<i>Sander vitreus</i>		X	X	X					X		X	X
Weed Shiner	<i>Notropis texanus</i>		X										
White Bass	<i>Morone chrysops</i>		X	X			X			X		X	X
White Crappie	<i>Pomoxis annularis</i>		X							X		X	X
White Sucker	<i>Catostomus commersonii</i>		X									X	X
Yellow Bullhead	<i>Ameiurus natalis</i>		X										
Yellow Perch	<i>Perca flavescens</i>		X							X			X

^a Fish were collected using a variety of techniques and gears, including cooperative fishing efforts involving commercial fishermen and partner agencies.

Figures

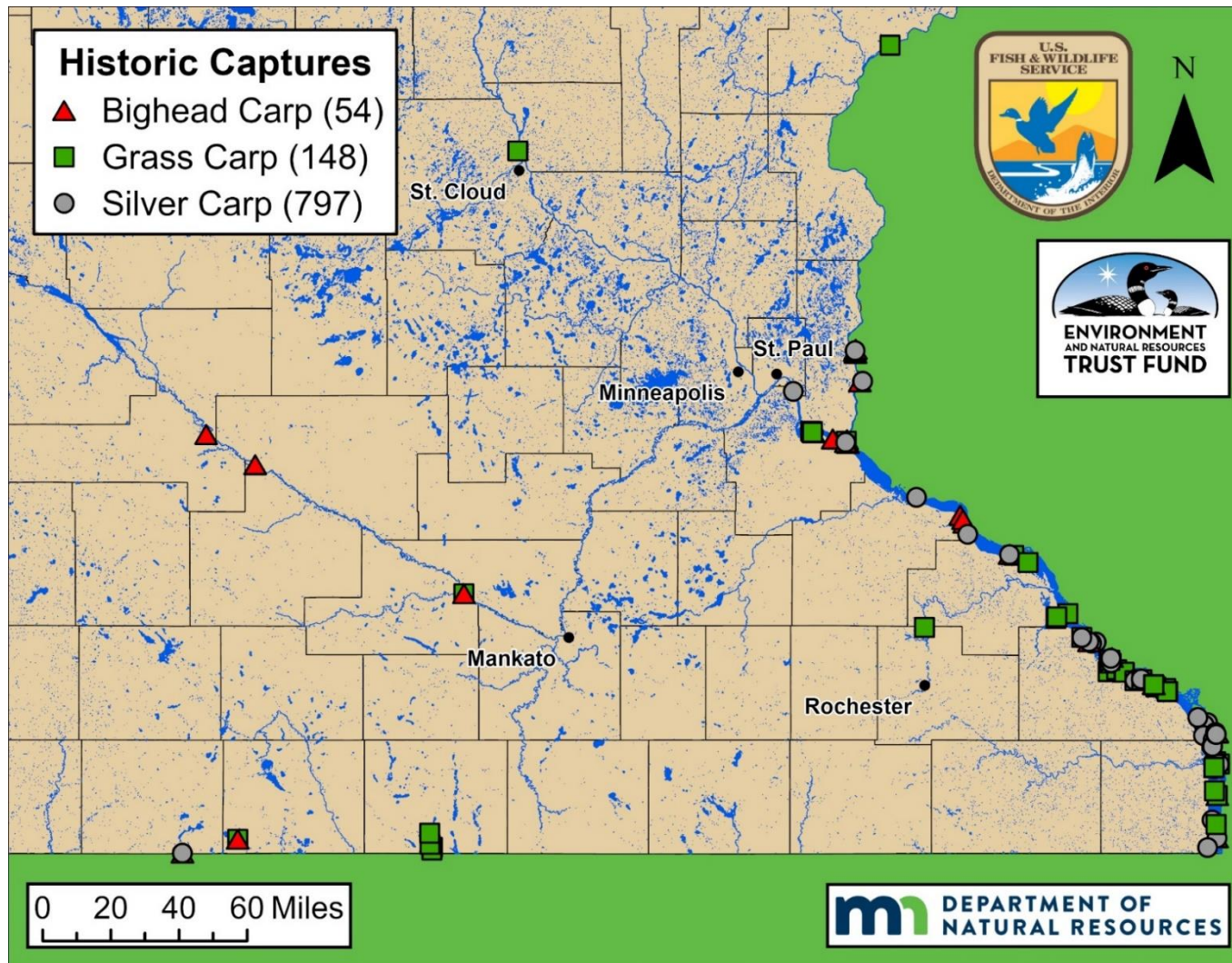


Figure 1. Locations of all known invasive carp captured in Minnesota waters through 2024. (2024 Silver=100, Bighead=1, Grass=9)

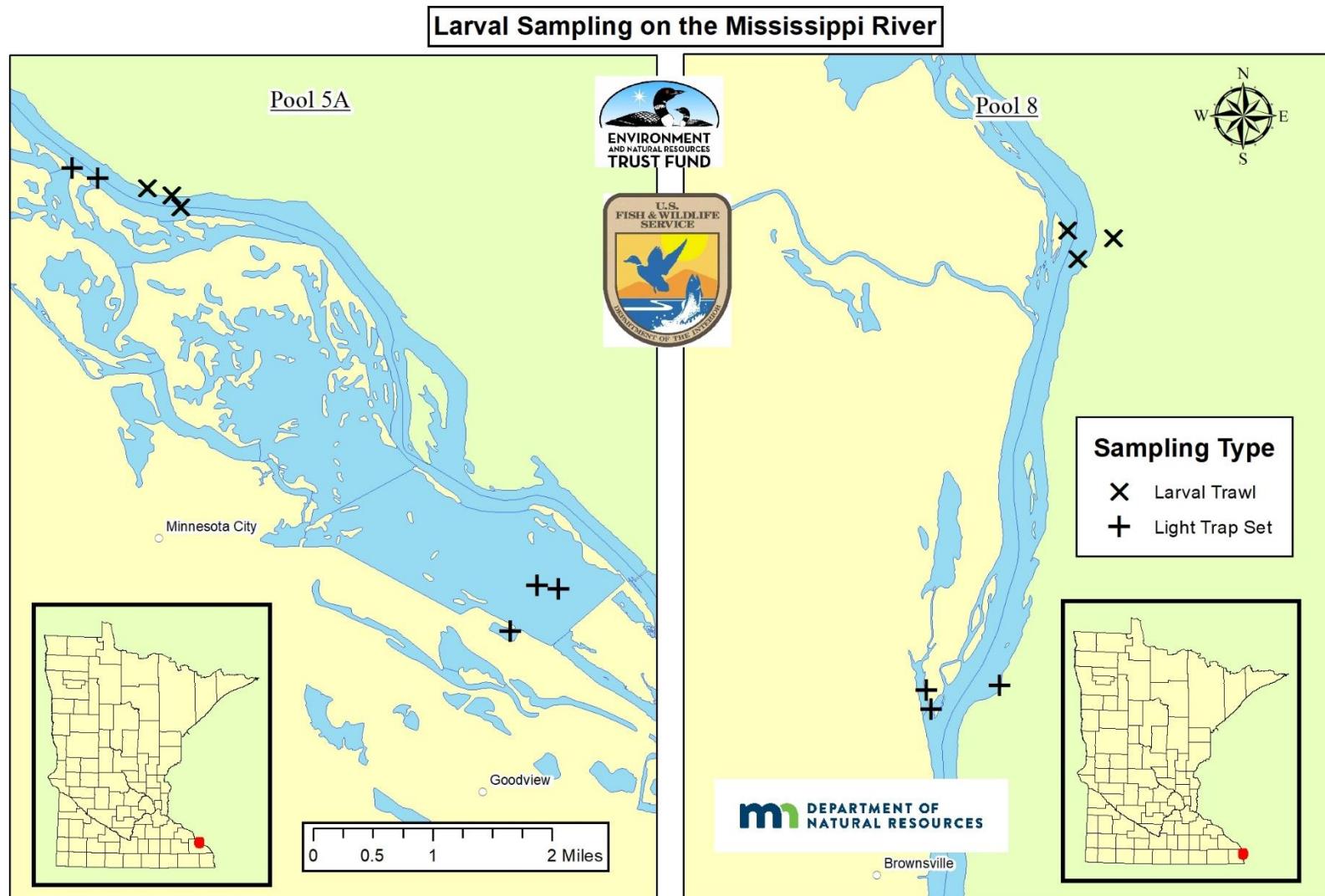


Figure 2. Larval fish trawling (dark cross) and larval light trap (dark plus sign) locations on the Mississippi River.

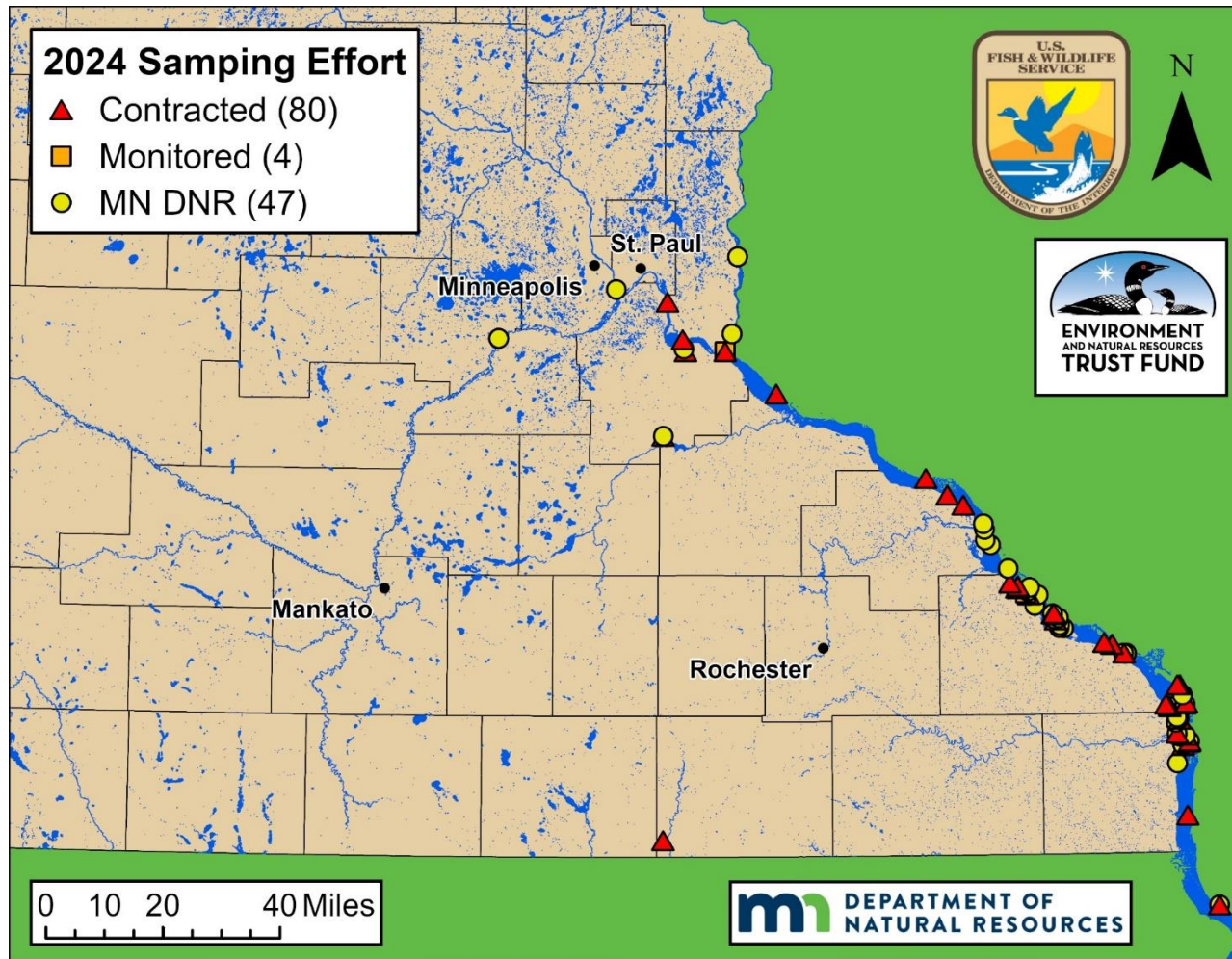


Figure 3. All sampling locations for commercial sampling and MDNR sampling on the Mississippi, St. Croix, and Minnesota Rivers during 2024.

Field work and report by:

Kayla Zankle, Invasive Carp Statewide Field Lead
Grace Loppnow, Invasive Fish Consultant
Brian Glasow, Invasive Carp Fisheries Specialist
Charles Vaughan, Invasive Carp Fisheries Specialist
Coy Blair, Invasive Carp Fisheries Specialist
Courtney Baker, Invasive Carp Fisheries Specialist
Billy Vue, Invasive Carp Fisheries Specialist

Approved by:

Area Fisheries Supervisor:

Regional Fisheries Supervisor:

Date: