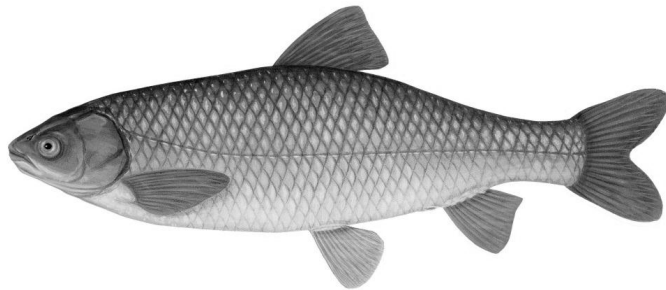
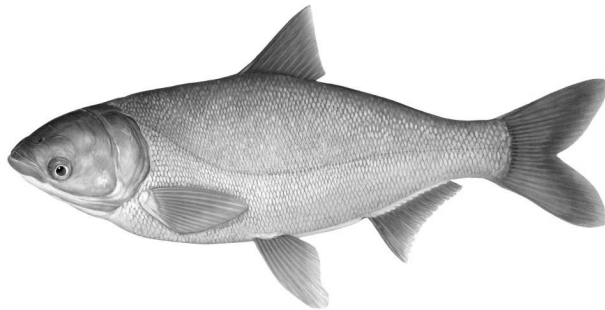
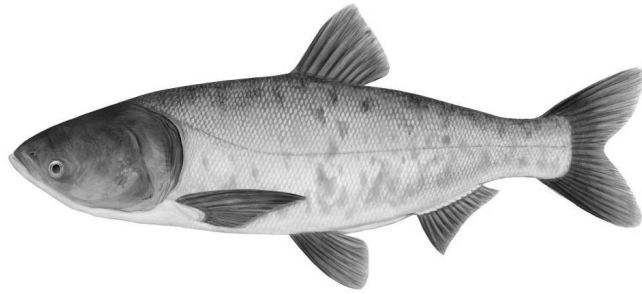


INVASIVE CARP SAMPLING REPORT  
JANUARY – DECEMBER 2022  
MINNESOTA DEPARTMENT OF NATURAL RESOURCES  
DIVISION OF FISH AND WILDLIFE  
SECTION OF FISHERIES



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

March 1, 2023

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## 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 invasive species introduced into the United States during the early 1970's as aids in fish aquaculture operations (Henderson 1976). Large flood events allowed these species to escape into the Mississippi River drainage, where they began reproducing and spreading (Freeze and Henderson 1982). Invasive carp have migrated up the Mississippi River and adjoining tributaries, quickly establishing populations in newly invaded areas. In 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). Black Carp have never been collected in Minnesota or Wisconsin waters. Currently, there is no evidence of invasive carp reproduction in Minnesota waters.

Invasive carp can radically alter local ecosystems by competing with native planktivores and overcrowding other native species. With high fecundity and the ability to disperse great distances, invasive carp can reach substantial populations, sometimes comprising most of the fish biomass in certain systems (MICRA 2002). Bighead and Silver carp have a voracious appetite and coupled with their large size (>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 be in direct competition for food resources with 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).

With the continuing progression of invasive carp up the Mississippi River, Minnesota waters are threatened by a potential invasion. A better understanding of the current status of invasive carp in Minnesota will allow for more effective efforts 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 the standard assessments are not the most efficient methods for capturing invasive carp. The purpose of this sampling effort is to use more carp-specific gear and techniques to monitor all life stages of invasive carp and associated native fishes in Minnesota waters.

## Objectives

- Detect and monitor all life stages of invasive carp to:
  - Inform management prioritization of efforts in Minnesota.
  - Provide current information for Upper Mississippi River managers on carp population changes.
- Monitor native fish species that may be affected by the establishment of invasive carp.
- Implement innovative monitoring and capture techniques of invasive carp to increase removal efficiency.

## Sampling Sites

In the Mississippi River, invasive carp sampling occurred in approximately 200 miles of water from St. Anthony Falls Lock and Dam in Minneapolis, MN to Pool 8 near Brownsville Township, MN. In the St. Croix River, effort focused on a 52-mile stretch from the dam near Taylors Falls, MN to the

confluence with the Mississippi River near Prescott, WI. In the Minnesota River standard effort focused on a 48-mile stretch from Belle Plaine, MN to the confluence with the Mississippi River in St. Paul, MN.

## Sampling Methods

Sampling for invasive carp took place between January 1, 2022 and December 31, 2022. Gear types, methods, and targeted locations were derived from personal communications with biologists who have been sampling invasive carp (V. Santucci, Illinois Department of Natural Resources, personal communication; J. Lamer, Western Illinois University, personal communication, Duane Chapman, USGS, personal communication, Jesse Fischer, USGS, personal communication and conducting research on the most efficient gear to sample invasive carp (M. Diana, Illinois Natural History Survey, personal communication), 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 experience from prior field seasons.

## Commercial Fishing

Commercial anglers were contracted to target invasive carp with gill nets and seines for sampling and response efforts. Minnesota Department of Natural Resources (MNDNR) personnel accompanied contracted commercial anglers to direct sampling locations and monitor efforts. The number of fish caught by species was estimated during gill netting operations and total weight harvested was requested from the commercial anglers for both gill netting and seining operations.

## 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 the governor signed an amendment to this statute: *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, MNDNR fisheries developed a protocol to characterize and minimize potential risk while maximizing the amount of information gained. For further information regarding the tagging and tracking procedures, please see the permit issued by the Minnesota Department of Natural Resource's Division of Ecological and Water Resources.

The MNDNR was permitted in 2022 to tag two invasive carp per river pool, and ten in Pool 8, with acoustic transmitters. The MNDNR utilized both passive telemetry (a stationary receiver array already in place) and active tracking (using a portable receiver and real-time floating receivers) to determine preferred habitats, longitudinal movement patterns, depth preferences, and specific locations for capture efforts. Minnesota DNR tagged and released one silver carp in Pool 8 on May 18, 2022. This individual was detected moving downstream and was last detected in the tailwaters of Lock and Dam 8 on May 26, 2022.

There are 80 stationary receivers placed throughout the state of Minnesota. They are located on the Mississippi River above the Coon Rapids Dam to Lock and Dam #5, on the St Croix River from the Mississippi River confluence at Prescott, WI to Taylor's Falls, and on the Minnesota River from the Mississippi River confluence to the County Road 6 bridge north of Delhi, MN (river mile 209). Sixty-one receivers are maintained by the East Metro fisheries office, nine are maintained in the Minnesota River by the Hutchinson fisheries office (from river mile 18.7 to river mile 209), and ten are maintained by the Lake City office in the Chippewa River and Pools 4 and 5 of the Mississippi River. In addition, the U.S. Fish and Wildlife Service maintains seven receivers in Minnesota waters and 47 additional receivers that extend downstream 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 from Pool 19 to the confluence with the Ohio River.

By tracking tagged invasive carp, we expect to capture additional invasive carp if they are present. Recapture actions will continue to be taken, including the use of commercial anglers, when tagged fish are in jeopardy of being un-trackable due to tag life nearing completion, leaving the passive array network, or to support removal of other conspecifics. The MNDNR will take all reasonable measures to ensure all tagged fish are tracked and their locations known through active tracking and an extensive passive tracking network.

The impacts of releasing wild-caught invasive carp back into the wild have been considered and are believed to be minimal when compared to the potential information gained from this project. As outlined in this report, MNDNR maintains an extensive monitoring and removal program to ensure populations are adequately sampled and document if reproduction is occurring in Minnesota waters to provide accurate information for Upper Mississippi River managers on carp population changes in the present front. MNDNR is strategic in both the species and locations where tagged invasive carp are released, so as to maximize the information we gain through their tracking. Most captured invasive carp are removed and euthanized.

Based on the tagging results, MNDNR staff have gained a better understanding of movement patterns and habitat preferences, while posing a very low risk to native fish populations or risk of increasing invasive carp populations. Other states have already begun work of this nature in riverine environments and have shown significant results and ability to remove additional fish with this tagging method. This information will help to improve sampling and removal efforts.

## **Larval Sampling**



Larval trawling was conducted during the 2022 field season. Sampling was conducted in Pool 5A and 8 of the Mississippi River. These pools were chosen due to the recent increase in captures in Pool 8 and the movement of a tagged silver carp in spring 2022 to Pool 5A. Trawls were conducted on a weekly basis from May-August. Each day of sampling, 12 trawls would be pulled for 5 minutes per trawl 15-20 minutes apart. The samples were then put into plastic containers and transported back to the lab at the East Metro Fisheries office. Fisheries biologists would then drain the water and put in 90% ethanol for 24-48 hours in order to preserve the contents of the trawl. After 24-48 hours the ethanol was drained and replaced to be preserved until the contents could be sampled for the presence of invasive carp eDNA. A total of 72 larval trawl samples were taken during the 2022 field season. Trawling occurred when there was a spike in the hydrograph at the immediate upstream lock and dam and when water temperatures were above 17°C. Sampling was split evenly between Pools 5A and 8. This sampling has been conducted with the aid and support of the USFWS La Crosse Office and the Whitney Genetics Lab. Samples will be screened by the Whitney Genetics Lab for invasive carp by testing the ethanol for invasive carp eDNA. If a sample is determined to be positive for eDNA, the sample will then be sorted for further identification.

Larval light traps were deployed in conjunction with larval trawling. Traps were set overnight in Pool 8 and Pool 5A backwaters. Sites were chosen at random based on accessibility by boat and water current conditions in backwaters. During the 2022 field season 60 larval light traps were set with 15 traps being set in Pool 8 and the remaining 45 being set in Pool 5A. These traps were set in backwaters at the lower ends of the pools. Each set consisted of 5 floating traps, each equipped with a flashing green light, attached 5 feet apart and anchored on both ends. Orientation line, current, depth, set/pull time, and water temp were recorded. Traps were set out overnight in a line of 5 traps. The samples were then collected the following morning and placed in plastic containers to be transported back to the

East Metro Fisheries office where the water was drained and replaced with 90% ethanol for preservation. After 24-48 hours the ethanol was then drained from the sample and replaced with 90% ethanol. The samples were then stored for the remainder of the field season. The ethanol samples are then sent for eDNA analysis for invasive carp DNA. That data has not been processed yet, but historic data can be found in Table 3. Sampling locations can be found in Figure 4.

## **Electrofishing**

Electrofishing occurred in a variety of habitats including backwaters, side channels, main channel borders, and over wing dikes. Sampling locations consisted of eight standardized sampling locations in Pool 2 (Figure 2), the St. Croix River (Figure 3) and Minnesota River (Figure 2), and all other sampling events occurred at non-standardized locations in the aforementioned habitats at the discretion of the sampler. Standardized electrofishing sampling locations were selected based on habitats invasive carp are likely to occupy. Sites averaged 869 seconds of on-time. At these set sampling locations, all observed fish were collected, identified, measured and weighed. If positive identification was not possible, voucher specimens were kept, labeled, and preserved in 90% ethanol for later identification. At non-standardized sampling sites, fish were identified in the water and only invasive carp were collected. This reduced unnecessary processing time and allowed for greater sampling effort. Sampling site locations, sampling dates, gear description, effort, habitat type (main channel border, backwater, wing dike, etc.), water depth, and crew details were recorded for each electrofishing run.

## **Seining**

A small 35-foot seine was used to sample shallow water habitats for young fish from July through August on the St. Croix River with 3 seine hauls completed over 1 day. The seine measure 35 ft. long and 6 ft. deep with 3 ft. square bag (3 ft. x 3 ft. x 3 ft.) located at the center of the net, consisting of

a knotless "Ace"-type nylon netting 1/8 in. mesh, with a mudline. No invasive carp were captured during 2022 using the shallow seine. In 2022 we partnered with NPS St. Croix National Scenic Riverway and Wild River Conservancy to start expanding beach seine sampling over the next 5 years. This information will be used to continue to expand our base-line knowledge of native species in areas that are difficult to sample by other means. There has been no indication of juvenile invasive carp. Small native species along the St. Croix River have limited sampling from Taylor's Falls to the Arcola High Bridge in previous years of this program.

### **Fish Acoustic Tagging Efforts**

Several species of fish in the Mississippi River Pool 2 and the St. Croix River have been tagged according to study guidelines as part of tagging studies. These species included Flathead Catfish *Pylodictis olivaris*, Channel Catfish *Ictalurus punctatus*, Smallmouth Buffalo *Ictiobus bubalus*, and Bigmouth Buffalo in Pool 2. In the St. Croix River, Lake Sturgeon *Acipenser fulvescens*, Muskellunge *Esox masquinongy*, White Bass *Morone chrysops*, Flathead Catfish, and Channel Catfish have been tagged. In both Pool 2 and the St. Croix River, Paddlefish have also been tagged. Invasive carp tagging during 2022 was a joint effort between MN NDR and USFWS, La Crosse.

### **Gill and Trammel Netting**

Gill netting and trammel netting occurred during multiple sampling events on each system. Large mesh gill nets of depths from 8 to 24 feet and lengths of 150 to 300 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 caught were identified.

## Results and Discussion

### Sampling Results

In total, 85 days were spent sampling between January and December 2022 on the Mississippi River Pools 2, 3, 4, 5, 6, 7, and 8, and the Minnesota and St. Croix rivers with gear appropriate for sampling invasive carp (Table 1; Figure 5). A greater amount of effort was focused on Pools 5A and 8 in 2022 in response to recent captures, sightings, and telemetry data. In early April 2022 we conducted a weeklong multi-agency netting effort in Pool 8 called the Modified Unified Method or MUM. During the Spring MUM 6 Silver Carp were caught. Follow-up sampling was conducted by a contracted commercial angler in Pool 8. Capture data and response actions were shared with multiple agencies including the Wisconsin Department of Natural Resources, USGS, and Western Illinois University.

Intensive fall sampling occurred in Pools 5A-8 of the Mississippi River including an additional MUM. On the first day of the fall MUM 8 invasive carp jumped over a downstream block net while pulling in the seine. In response, anti-jump nets were added to all block nets going forward. These nets are intended to entangle escaping invasive carp. No other carp were seen or captured during the MUM. Capture data and response actions were shared with multiple agencies including the Wisconsin Department of Natural Resources, USGS, and Western Illinois University. A total of 148 invasive carp were caught in Minnesota waters and Minnesota-Wisconsin boundary waters in 2022 (Table 2). Of those captures, 140 were carcasses recovered from a fish kill in the creek below Lake Bella, a reservoir in the Missouri River basin about 100 yards from the Iowa border. Invasive carp are not able to move further upstream from this location due to the design of the reservoir spillway.

Contracted commercial anglers were hired to use large mesh gill nets and seines to sample in the Mississippi River in Pools 2, 4, 5, 5A, 6, 7, and 8, and in the St. Croix River from Andersen Bay in

Bayport to the confluence with the Mississippi River near Prescott, WI. Contracted commercial anglers set approximately 36,300 feet of gill nets during 11 days of effort and conducted 46 seine hauls between January and December 2022. Short term gill nets (.5-1.5 hours) were prioritized over overnight sets due to the silver carp's ability to escape from the nets. After gill nets 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 2022, three regular commercial fishing operations were also monitored for the presence of invasive carp.

Both random and standardized electrofishing sampling were conducted on the Minnesota and St Croix River, as well as Pools 2, 3, and 5 of the Mississippi River. A total of 725 minutes of "on time" over 22 days was spent electrofishing between January and December 2022. In 2022, twenty-two standardized electrofishing sites were sampled once, for a total of 318 minutes. Random electrofishing was used to monitor for invasive carp.

Gill nets set by MNDNR 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 2022, a total of 3,400 feet of gill net were set in Pool 2 over five days, with most net sets being short-term sets (2-5 hours). In 2022, no invasive carp were captured during routine gill netting operations, seining or electrofishing.

Although no new or notable species were added to the list in 2022, numerous unique or rare native fishes were encountered during these sampling events. A complete species list of species caught and observed on Pools 2, 3, and 4, the Minnesota River and the St. Croix River, from January 2013 through December 2022, has been compiled (Table 4).

Determining if invasive carp captured in Minnesota are pioneering individuals or are indicative of established populations is a key question for MNDNR 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 change 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, but it remains to be seen what the implications will be for the future abundance of invasive carp in Minnesota waters.

### **Invasive Carp Acoustic Tagging and Tracking**

On July 28, 2017 during routine monitoring at the Allen S. King Plant on the St. Croix River, a Bighead Carp was caught by MNDNR staff in a large mesh gill net. 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 Sampling Report (MNDNR 2022).

This fish was observed on the St. Croix River to range over an extent of 23.3 river miles from Stillwater, MN to the confluence with Pool 3 of the Mississippi River. The tagged bighead Carp traveled into Pool 3 of the Mississippi River in 2022, but unlike previous downstream runs it did not coincide with open water conditions (Figure 6) at Lock & Dam #3 in Hastings, MN.

According to temperature and depth data, this fish comes to the water's surface often, inhabits a wider range of depths (0 to 68.6 feet) than believed (Figure 8), and tolerates temperatures ranging from 33 to 88 degrees Fahrenheit (Figure 9). (See MNDNR 2018, MNDNR 2019, MNDNR 2020 and MNDNR 2021 for data collected from the previous four field seasons.) In 2022, recapture efforts were limited due to lack of staffing and higher priority sampling efforts in lower pools.

From our tagged invasive carp, we have learned of additional areas where this fish has resided for prolonged periods of time, including an overwintering site in the Lakeland area. Therefore, additional VR2Tx receivers were added in the fall of 2020 to the Lakeland area to investigate how the tagged fish uses the bathymetry in the area for overwintering and feeding, while learning about additional environmental preferences to further inform sampling efforts. This data is still being processed and this temporary seasonal deployment has been repeated in the fall of 2021 and again in 2022. Additionally, in one of the sites the tagged bighead had shown high site fidelity a short-term array was deployed to track the tagged bighead carp's interaction with an algae pellet attractant station during May 2022. This VPS array is a scaled back version of what has been deployed in Lakeland for the 2 winters and will provide critical information on the use of algae-based attractants to lure bighead carp into an area suitable for removal. Based on information from other areas tracking carp and historic sightings in Minnesota, the hypothesis was this fish would inhabit the King Plant discharge periodically with forays to Lake St. Croix and overwinter near a natural point where flow is constricted on the river (most likely Point Douglas, near Prescott, WI). Based on tracking data, the fish was never observed within the King Plant discharge despite continued monitoring within the discharge. Data from the real-time receiver and main channel receivers showed the tagged carp inhabited the mouth of the King Plant discharge as well as an adjacent bay for several weeks during the spring. Over nearly four full field seasons, the fish has exhibited some site fidelity, inhabiting several key locations for prolonged periods of time.

On May 26, 2020, a Silver Carp was captured in Anderson Bay on the St. Croix River in a contracted commercial gill net. Although the tagged Bighead Carp was not in the bay at the time of the capture, this capture event provides additional habitat information from the tagged fish. The reason that sampling took place at that location and time was because of past movement patterns of our

tagged fish. This capture is one of many examples how the tagged Bighead Carp aided in the removal of additional conspecifics.

During the 2022 field season MNDNR staff, alongside contracted commercial fisherman and USFWS, were able to tag an additional Silver Carp. The carp was captured on May 18<sup>th</sup> by commercial gill net in pool 8 of the Mississippi River. Previously tagged invasive carp were continued to be tracked such as the Bighead Carp in the St. Croix River and another Silver Carp in Pool 8. The tagged Bighead Carp in the St. Croix River showed similar movements to years past. Please refer to Figure 6, 7, 8, & 9 for movement data, Hastings Lock & Dam 2 discharge data, depth data and temperature data from the tagged bighead carp.

Capture attempts were limited during 2022 due to low water conditions and priority of downstream pools.

Of the 6 Silver Carp tagged in previous years, only one was found during passive and active tracking in 2022. That fish was located on May 20, in Pool 8 approximately 3 miles downstream from where it was tagged in October 2020. When the silver carp was last located in Pool 8 it was in a commercial seine site but never in a vulnerable location for capture. Movement data is still being collected and processed for that fish. However preliminary data shows the fish making an upstream run to Pool 5A starting at the same time MN DNR had nets in the water in the same bay as the fish, May 20. There is not enough data to conclude that the sampling in the area played a role in the upstream movement. The silver carp traveled approximately 36 river miles in 16 hours. Data from additional receivers is still being processed and MN DNR continues to work with USFWS to track the carp in Pool 5A.



The tagged Bighead Carp was vital in the capture of seven invasive carp since it was tagged in 2017. The tagged Silver Carp in Pool 8 has inhabited new areas that had previously not been sampled throughout the last 2 years. Without tracking information from these tagged carp, MNDNR personnel would not have fished certain locations. Because this tagged fish has shown relatively large movements and has inhabited confined areas suitable for complete sampling for short periods of time, timing of sampling is critical for effective management and removal. The ability to track tagged individuals will continue to allow biologist to better understand additional habitat preferences and the duration of residence preferences.

Tracking methods and field sampling will be adjusted accordingly for 2023. MNDNR 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 is funded in part by the current Minnesota Environment and Natural Resources Trust Fund grant through June 2024. 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.

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. 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. MNDNR should increase effort to encourage boaters to report any deceased Paddlefish for age and growth analysis. Other MNDNR offices should collect all deceased Paddlefish for analysis.

MUM multi-agency mass netting events have continued to result in captures and sightings. As we continue to develop this capture technique for use in low-density populations, the MUM will continue to adapt. MNDNR will work towards a more streamlined method that can be deployed by MNDNR 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 Pool 8, the lower St. Croix River, and the lower Minnesota River.

The invasive carp action plan was first developed in 2011 and updated in 2014. As invasive carp captures have increased and additional management options are now available, the plan is due for an update. Minnesota DNR will be pursuing a transparent, inclusive, comprehensive structured decision-making process to identify the best management options to include in the updated action plan.

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.

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 needed to cover the Mississippi River. Identifying locations where recruitment is possible will help focus management efforts to prevent reproduction.

## Acknowledgements

The monitoring and removal of invasive carp in Minnesota is a collaborative program funded by the Minnesota Department of Natural Resources, USGS, U.S. Fish and Wildlife Service, and the Minnesota Environment and Natural Resources Trust Fund. Technical support from USGS was crucial in planning and executing MUM events. Field support for MUM events was provided by USGS, U.S. Fish and Wildlife Service, Wisconsin DNR, National Park Service, and Wild River Conservancy.

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## Tables

**Table 1. Invasive Carp sampling summary for the Mississippi River Pools 2, 3, 4, 5, 6, 7 and 8 and the St. Croix and Minnesota Rivers for January through December 2022. Number of Invasive Carp Captured represents the number of individuals caught by MNDNR, contracted commercial anglers, or monitored commercial fishing.**

<b>Invasive Carp Sampling Summary January – December 2022</b>			<b>Days</b>
<b>Random Sampling Effort</b>			
<b>Gill/Trammel Netting</b>	3,400	feet	5
<b>Electrofishing</b>	406	minutes	9
<b>Beach Seine</b>	7	Hauls	2
<b>Standardized Sampling Effort</b>			
<b>Electrofishing</b>	318	minutes	13
<b>Larval Trawl</b>	72	Hauls	6
<b>Larval Light Traps</b>			
<b>Targeted Commercial Fishing Effort</b>			
<b>Gill Netting</b>	36,300	feet	11
<b>Seining</b>	46	hauls	31
<b>Monitored Commercial Fishing Effort</b>			
<b>Seining</b>	3	hauls	3
<b>Tracking*</b>			
<b>2-person crew</b>		days	20
<b>Number of Invasive Carp Captured</b>	148	fish	
<b>Total Number of Days Sampled</b>			100

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

**Table 2. Invasive Carp caught from January through December 2022 in Minnesota and Wisconsin boundary waters.**

Date	Species	Water Body	Location	State	Length (mm)	Weight (grams)	Sex	Maturity	Capture Method	Captured By
4/4/2022	Silver Carp	MSR - Pool 8	Airport Beach	WI	820	6104	M	Mature	Commercial Seine	MUM
4/4/2022	Silver Carp	MSR - Pool 8	Airport Beach	WI	789	5196	M	Mature	Commercial Seine	MUM
4/4/2022	Silver Carp	MSR - Pool 8	Airport Beach	WI	872	9364	F	Mature	Commercial Seine	MUM
4/4/2022	Silver Carp	MSR - Pool 8	Airport Beach	WI	852	7606	F	Mature	Commercial Seine	MUM
4/4/2022	Silver Carp	MSR - Pool 8	Airport Beach	WI	854	8970	F	Mature	Commercial Seine	MUM
4/5/2022	Silver Carp	MSR - Pool 8	NSP Power Plant	WI	786	5816	M	Mature	Anti-jump net	MUM
4/6/2022	Grass Carp	N Okamanpedan Lake	Martin County	MN	816	5700	F	Immature	Seine	Commercial Fisherman
5/18/2022	Silver Carp	MSR - Pool 8	Bluff Slough, P8	WI	818	6502	M	Mature	Gill Net	Commercial Fisherman/ MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	535	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	483	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	582	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	600	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	588	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	497	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	529	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	582	No Weight	M	Mature	Fishkill	MN DNR

**Table 2 (continued). Invasive Carp caught from January through December 2022 in Minnesota and Wisconsin boundary waters.**

<b>Date</b>	<b>Species</b>	<b>Water Body</b>	<b>Location</b>	<b>State</b>	<b>Length (mm)</b>	<b>Weight (grams)</b>	<b>Sex</b>	<b>Maturity</b>	<b>Capture Method</b>	<b>Captured By</b>
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	524	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	492	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	495	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	640	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	533	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	535	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	557	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	543	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	561	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	562	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	644	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	595	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	553	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	646	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	693	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	658	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	577	No Weight	M	Mature	Fishkill	MN DNR



**Table 2 (continued). Invasive Carp caught from January through December 2022 in Minnesota and Wisconsin boundary waters.**

<b>Date</b>	<b>Species</b>	<b>Water Body</b>	<b>Location</b>	<b>State</b>	<b>Length (mm)</b>	<b>Weight (grams)</b>	<b>Sex</b>	<b>Maturity</b>	<b>Capture Method</b>	<b>Captured By</b>
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	545	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	582	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	660	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	761	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	560	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	568	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	709	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	594	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	614	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	605	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	698	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	546	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	560	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	570	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	542	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	662	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	526	No Weight	M	Mature	Fishkill	MN DNR

**Table 2 (continued). Invasive Carp caught from January through December 2022 in Minnesota and Wisconsin boundary waters.**

<b>Date</b>	<b>Species</b>	<b>Water Body</b>	<b>Location</b>	<b>State</b>	<b>Length (mm)</b>	<b>Weight (grams)</b>	<b>Sex</b>	<b>Maturity</b>	<b>Capture Method</b>	<b>Captured By</b>
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	544	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	613	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	571	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	590	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	535	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	554	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	578	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Bighead Carp	Lake Bella Outlet	Nobles County	MN	584	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	565	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	590	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	550	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	550	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	580	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	557	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	568	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	520	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	526	No Weight	M	Mature	Fishkill	MN DNR

**Table 2 (continued). Invasive Carp caught from January through December 2022 in Minnesota and Wisconsin boundary waters.**

<b>Date</b>	<b>Species</b>	<b>Water Body</b>	<b>Location</b>	<b>State</b>	<b>Length (mm)</b>	<b>Weight (grams)</b>	<b>Sex</b>	<b>Maturity</b>	<b>Capture Method</b>	<b>Captured By</b>
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	580	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	590	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	735	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	527	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	561	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	530	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	511	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	594	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	533	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	524	No Weight	M	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	509	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	590	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	570	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Bighead Carp	Lake Bella Outlet	Nobles County	MN	546	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	578	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	575	No Weight	F	Mature	Fishkill	MN DNR
8/3/2022	Silver Carp	Lake Bella Outlet	Nobles County	MN	645	No Weight	F	Mature	Fishkill	MN DNR

**Table 3. Larval trawl sampling for the St. Croix and Mississippi Rivers from 2013 to 2022.**

Year	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>
2013	8	8	16	28	6	16	0	0
2014	9	13	28	44	17	28	0	0
2015	8	18	52	253	23	139	0	0
2016	9	16	46	102	25	83	0	0
2017	7	17	20	73	20	73	0	0
2018	8	8	66	68	37	44	0	0
2019	2	4	52	100	37	64	0	0
2020	0	0	0	0	0	0	0	0
2021	0	1	0	108	0	~11	0	--
2022	0	6	0	72	--	--	--	--

--Pending results

**Table 4. Species list for the Minnesota, St. Croix and Mississippi (Pool 2, Pool 3 and Pool 4) Rivers from January 2013 through December 2022, including 89 native and invasive species.**

Common Name	Genus Species	Pool 2	Pool 3	Pool 4	St. Croix River	Minnesota River
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
Bigmouth Shiner	<i>Notropis dorsalis</i>	x				
Black Buffalo	<i>Ictiobus niger</i>	x				
Black Bullhead	<i>Ameiurus melas</i>				x	
Black Crappie	<i>Pomoxis nigromaculatus</i>	x	x		x	x
Black Redhorse	<i>Maoxostoma 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
Bluegill	<i>Lepomis macrochirus</i>	x		x	x	x
Bluntnose Minnow	<i>Pimephales notatus</i>	x			x	
Bowfin	<i>Amia calva</i>	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
Channel Shiner	<i>Notropis wickliffi</i>	x				
Common Carp	<i>Cyprinus carpio</i>	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
Freshwater Drum	<i>Aplodinotus grunniens</i>	x	x	x	x	x
Gilt Darter	<i>Percina evides</i>				x	
Gizzard Shad	<i>Dorosoma cepedianum</i>	x	x	x	x	x
Golden Redhorse	<i>Moxostoma erythrurum</i>	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				
Greater Redhorse	<i>Moxostoma valenciennesi</i>	x			x	
Green Sunfish	<i>Lepomis cyanellus</i>	x			x	x
Highfin Carpsucker	<i>Carpionodes velifer</i>	x			x	x
Hornyhead Chub	<i>Nocomis biguttatus</i>	x			x	
Hybrid Sunfish	<i>Lepomis microlophus x L.</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	
Largemouth Bass	<i>Micropterus salmoides</i>	x		x	x	x
Logperch	<i>Percina caprodes</i>	x			x	
Longnose Gar	<i>Lepisosteus osseus</i>	x	x		x	x
Mimic Shiner	<i>Notropis volucellus</i>	x			x	
Mooneye	<i>Hiodon tergisus</i>	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
Orangespotted Sunfish	<i>Lepomis humilis</i>	x			x	x
Paddlefish	<i>Polyodon spathula</i>	x	x	x	x	x

**Table 4 (continued). Species list for the Minnesota, St. Croix and Mississippi (Pool 2, Pool 3 and Pool 4) Rivers from January 2013 through December 2022, including 89 native and invasive species.**

Common Name	Genus Species	Pool 2	Pool 3	Pool 4	St. Croix River	Minnesota River
Pumpkinseed	<i>Lepomis gibbosus</i>	x			x	
Quillback	<i>Carpiodes cyprinus</i>	x	x	x	x	x
Rainbow Darter	<i>Etheostoma caeruleum</i>				x	
River Carpsucker	<i>Carpiodes carpio</i>	x	x	x	x	x
River Darter	<i>Percina shumardi</i>	x			x	
River Redhorse	<i>Moxostoma carinatum</i>	x			x	
Rock Bass	<i>Ambloplites rupestris</i>	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
Shortnose	<i>Lepisosteus platostomus</i>	x	x		x	x
Silver Carp	<i>Hypophthalmichthys molitrix</i>	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
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
Smallmouth Buffalo	<i>Ictiobus bubalus</i>	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	
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
Weed Shiner	<i>Notropis texanus</i>	x				
White Bass	<i>Morone chrysops</i>	x	x		x	x
White Crappie	<i>Pomoxis annularis</i>	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	

# Figures

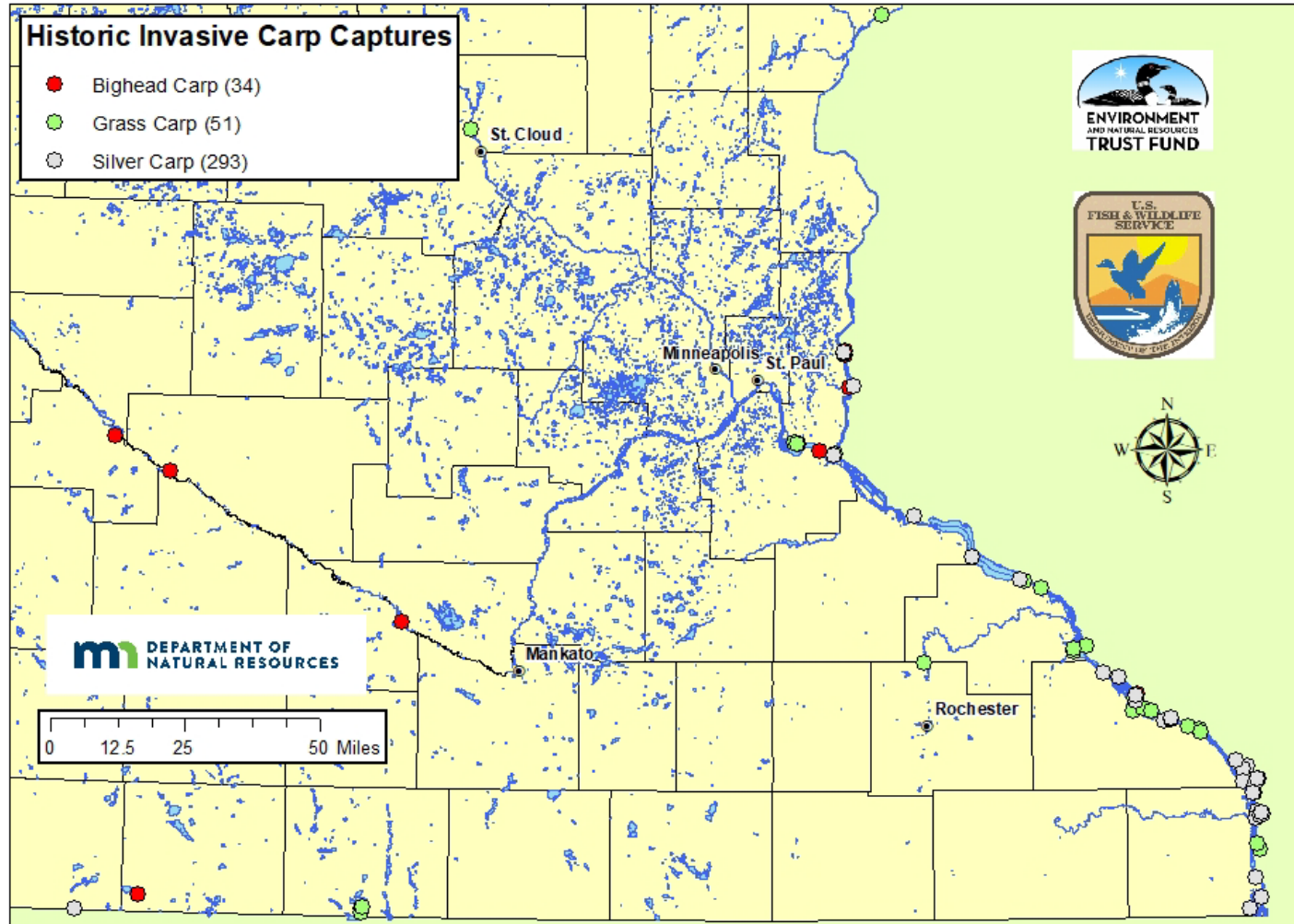


Figure 1. Locations of all known invasive carp captured in Minnesota waters through 2022.

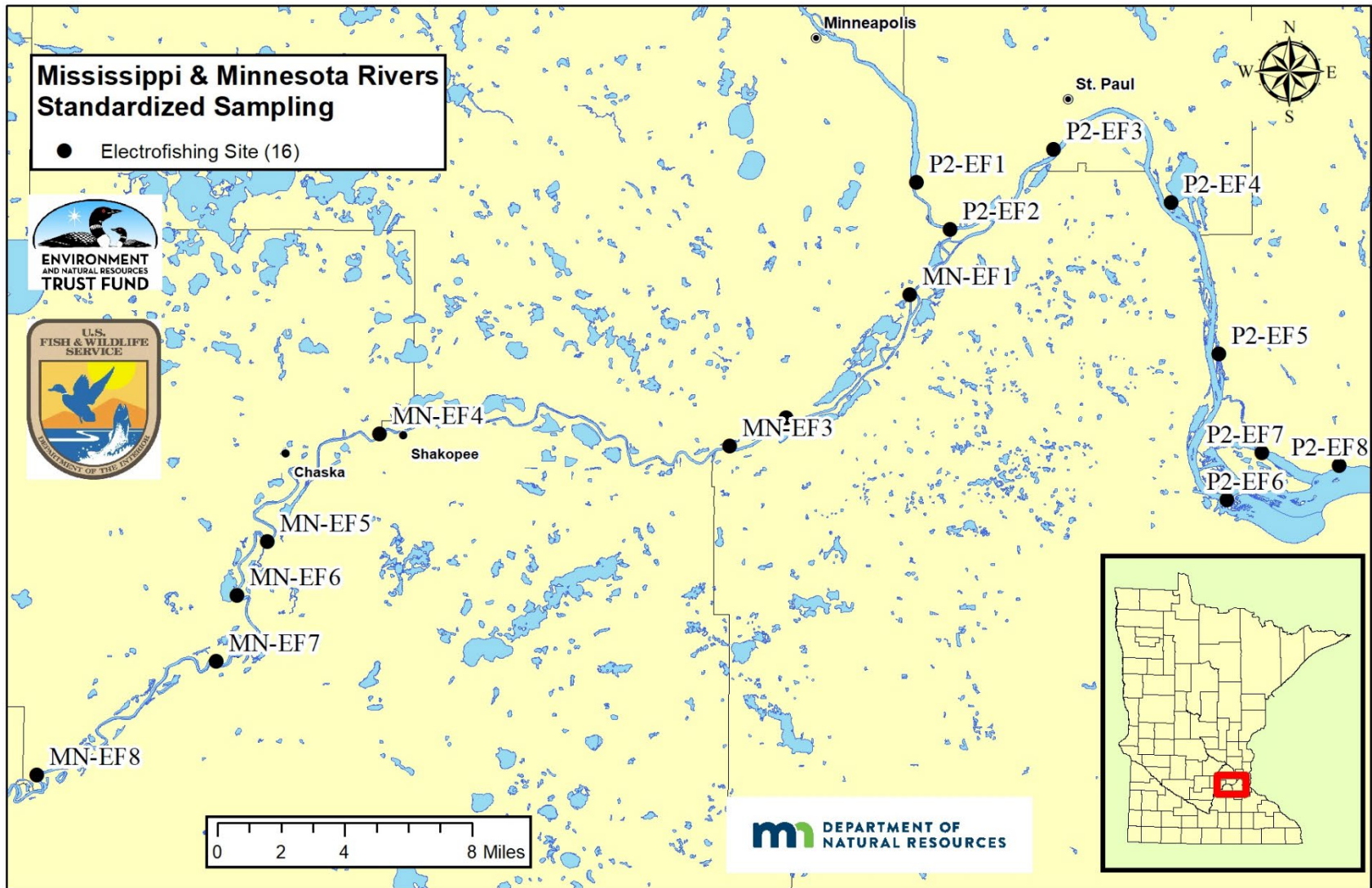


Figure 2. Standardized electrofishing locations on Pool 2 (P2) of the Mississippi River and Minnesota River.



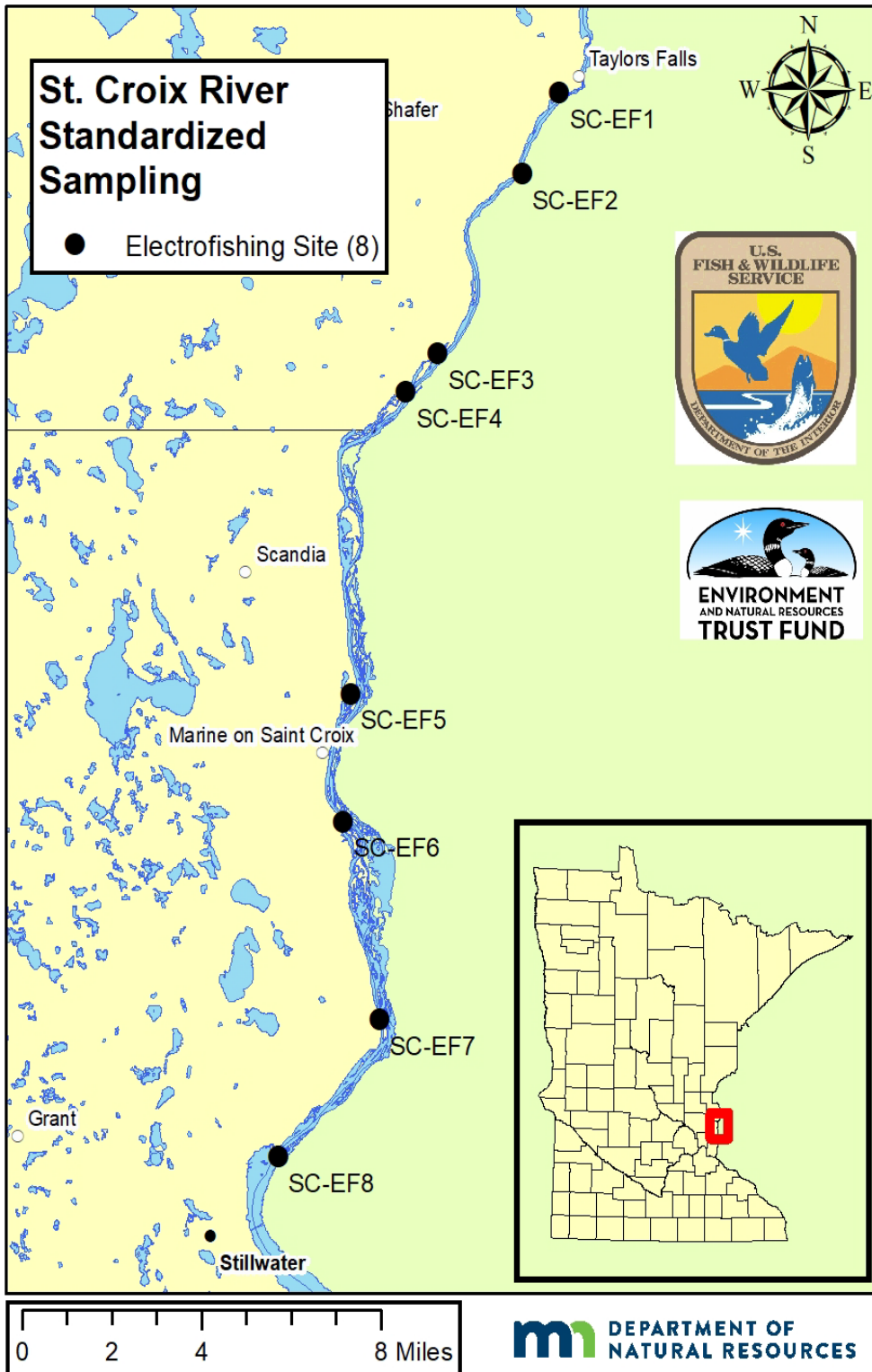
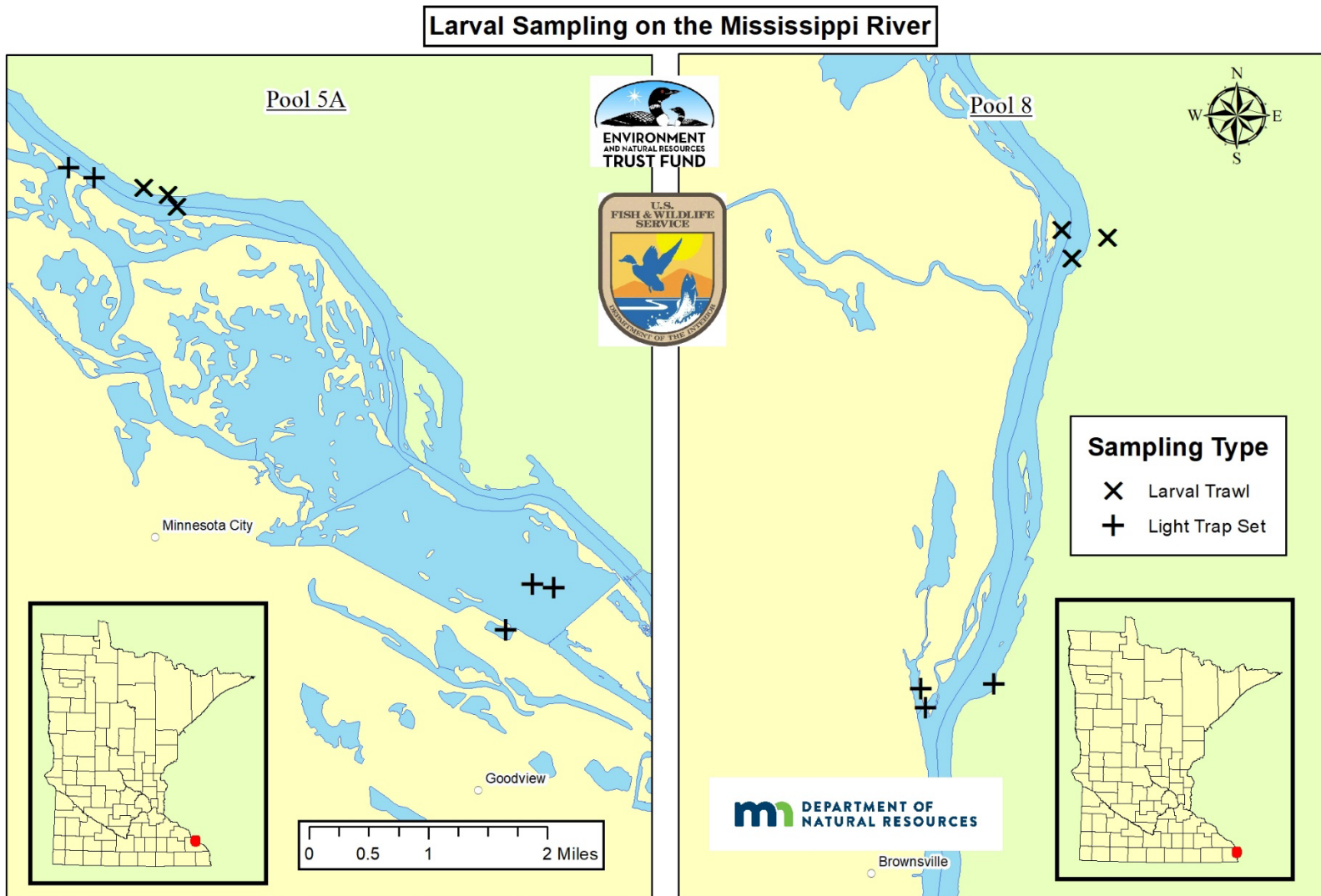


Figure 3. Standardized electrofishing locations on the St. Croix River (SC).



**Figure 4. Standardized larval fish trawling (dark cross) and larval light trap (dark plus sign) locations on the Mississippi River.**

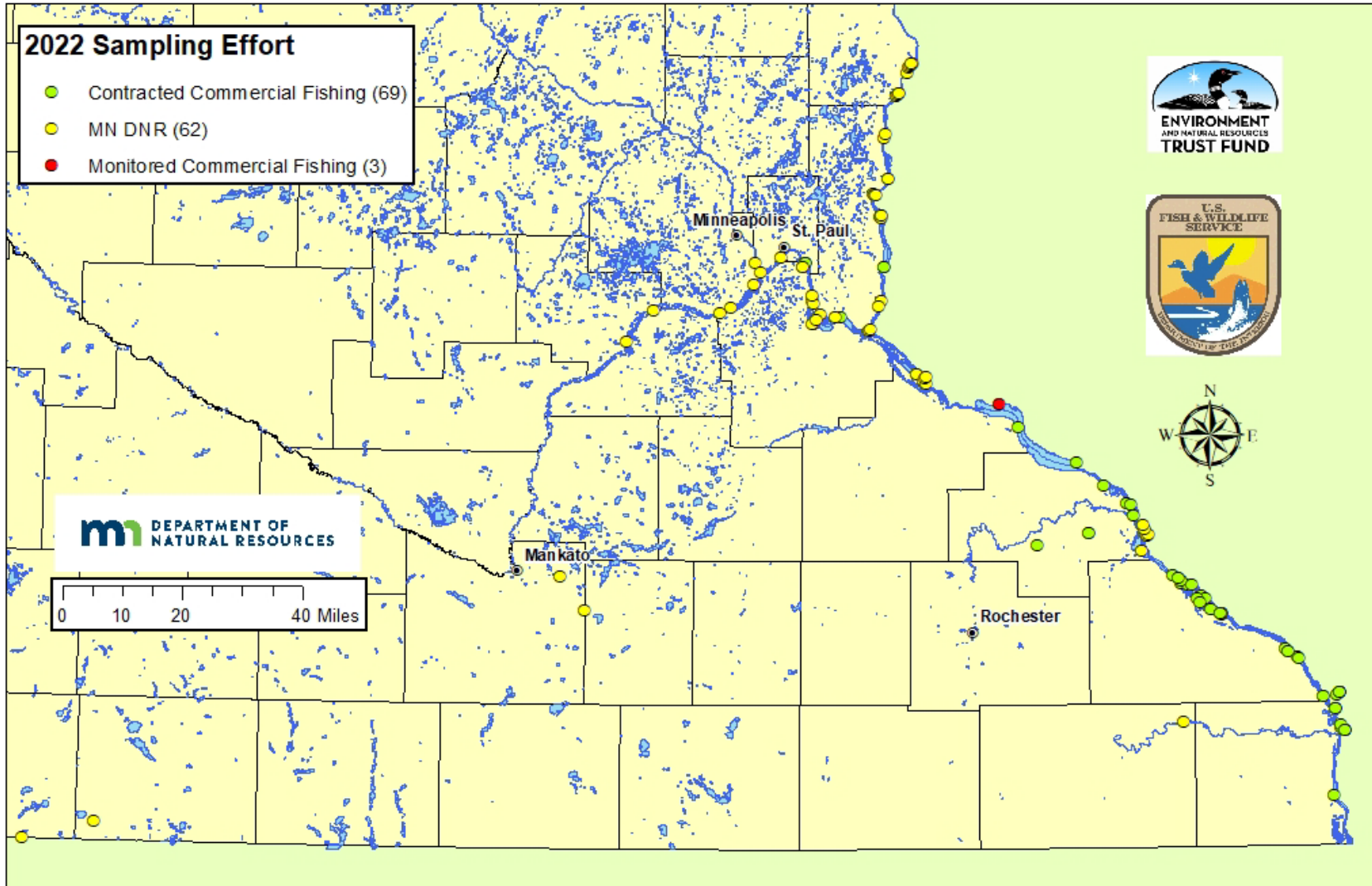
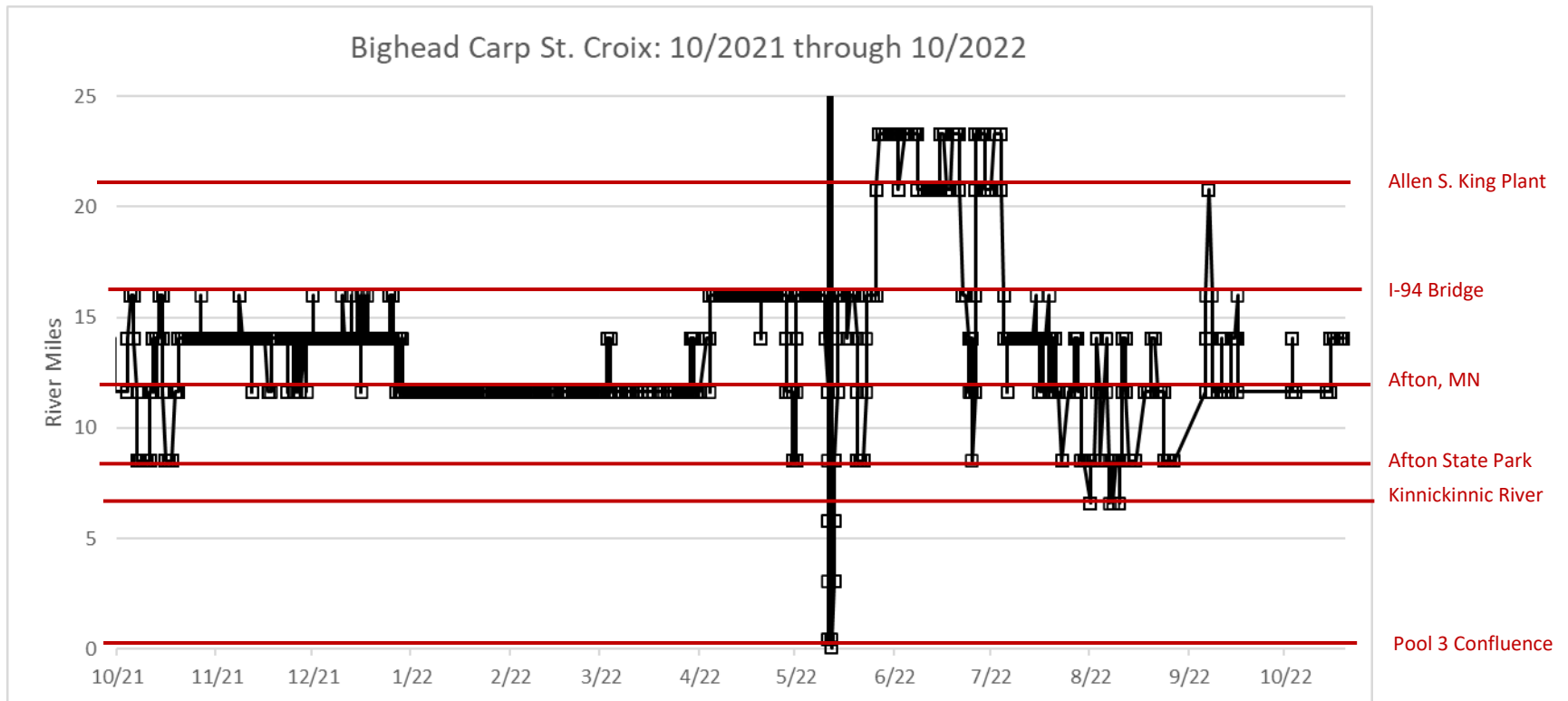
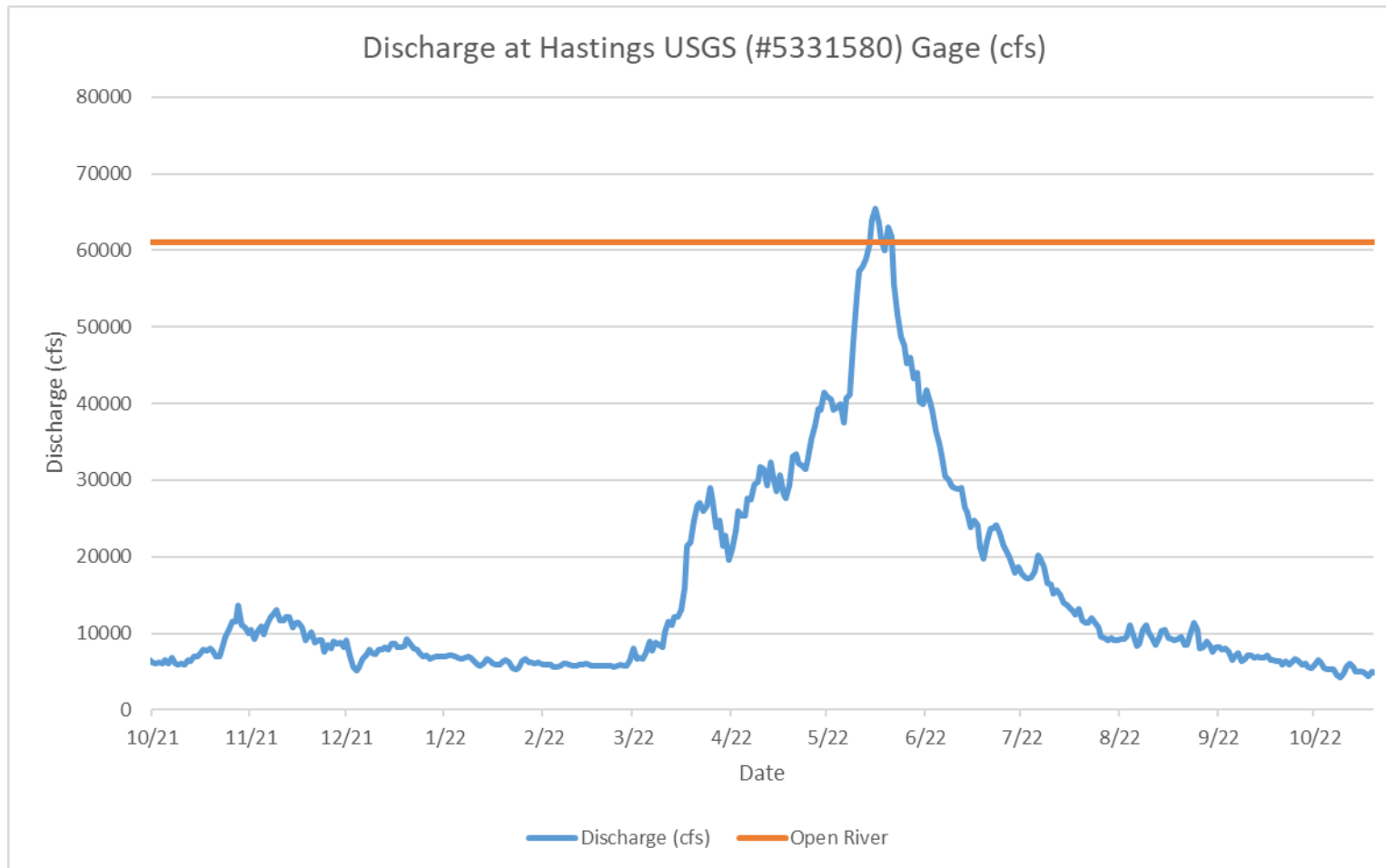


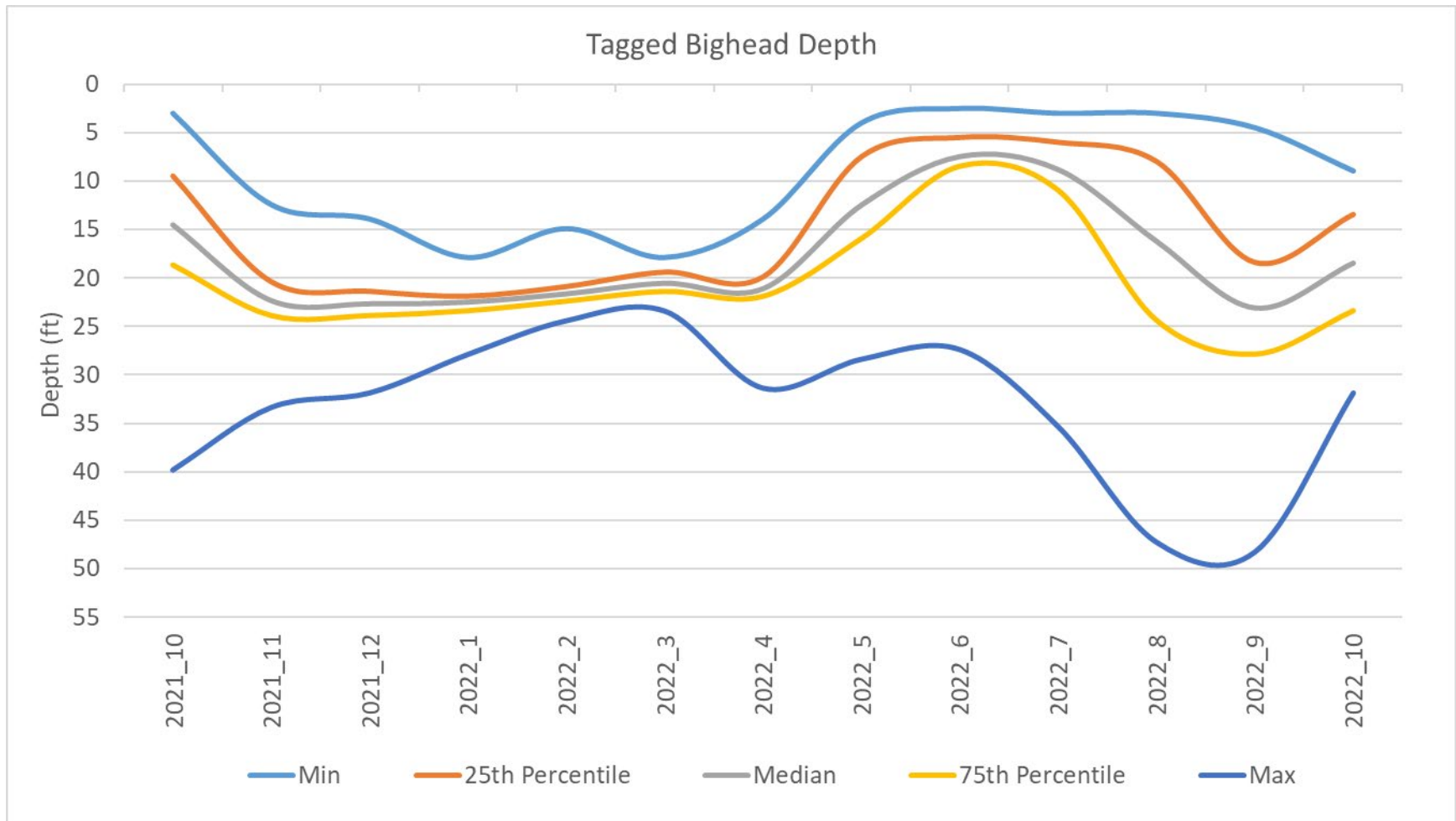
Figure 5. All sampling locations for contracted commercial sampling and MDNR sampling on the Mississippi, St. Croix, and Minnesota Rivers during 2022.



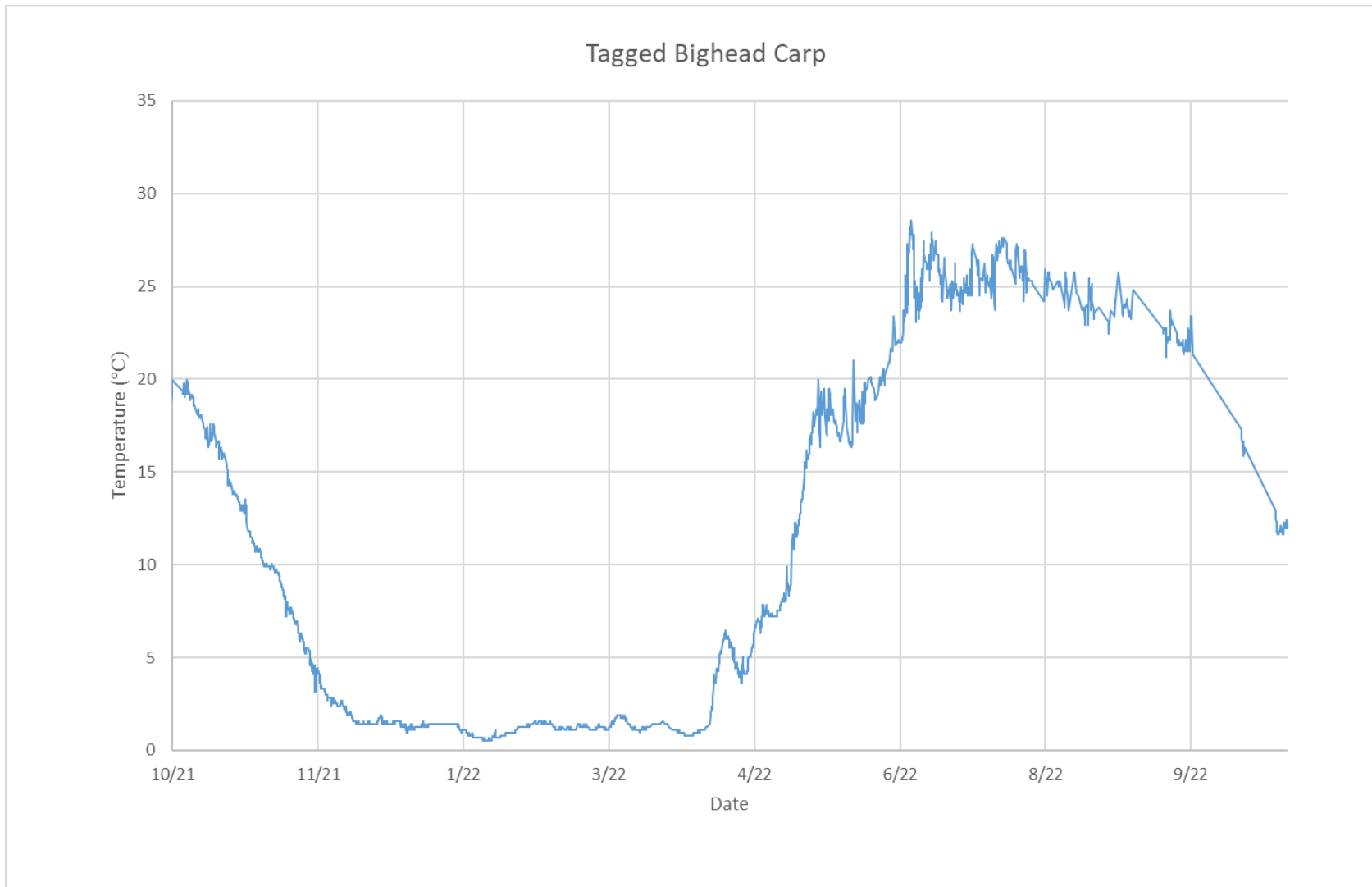
**Figure 7. Movement patterns by River Mile over time of a tagged Bighead Carp from October 6, 2022 through the last receiver download for 2022 on October 24, 2022. The tagged bighead carp moved from the St. Croix River to Pool 3 on the Mississippi River below the Hastings Lock and Dam from May 16, 2022 to May 17, 2022.**



**Figure 7. Discharge patterns of USGS gauge (05331580) at Hastings, MN in Pool 3 of the Mississippi River from October 6, 2021 through October 24, 2022. The tagged Bighead Carp was not detected in the vicinity of the Lock and Dam #2 during this time. The gauge reached open river conditions, or 61,000 cubic feet per second (cfs) from May 20, 2022 – May 23, 2022, and again from May 25, 2022 – May 26, 2022.**



**Figure 8. Depth patterns of tagged Bighead Carp from October 6, 2021 through the last receiver download for 2022 on October 24, 2022. Depths ranged from the surface (0 feet) to a maximum depth of 48.2 feet. Average depth occupied was 15.24 feet below the surface.**



**Figure 9. Temperature patterns of tagged Bighead Carp from October 6, 2021 through the last receiver download for 2022 on October 24, 2022.**

Field work and report by:

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Approved by:

Area Fisheries Supervisor:

Regional Fisheries Supervisor:

Date: