



Minnesota Invasive Carp Action Plan

Minnesota's approach to prevention and management of invasive bighead, black, grass,
and silver carp.

01/18/2024

Minnesota Department of Natural Resources
Division of Ecological and Water Resources
Invasive Species Program
500 Lafayette Road,
St. Paul, MN 55105
mndnr.gov/invasivecarp

Upon request, this material will be made available in an alternative format such as large print, Braille or audio recording. Printed on recycled paper.

Table of Contents

Introduction.....	1
Plan Elements and Actions	5
1. Monitoring to support response actions	5
2. Prevention and Deterrence	10
3. Response Preparation	15
4. Management and Control	16
5. Communication, Outreach, and Coordination.....	19
References cited	23
Appendix A – summary of actions.....	i
Appendix B – Structured decision-making planning process summary	x
Appendix C – Invasive Carp Captured in Minnesota and border waters, 2012-2023	xvi
Appendix D - Map of Locks and Dams on the Mississippi River	xvii

Introduction

This plan describes Minnesota’s approach to prevention and management of invasive carp: bighead (*Hypophthalmichthys nobilis*), black (*Mylopharyngodon piceus*), grass (*Ctenopharyngodon idella*), and silver (*Hypophthalmichthys molitrix*) carp. Invasive carp have the potential to impact native aquatic communities, local economies, and Minnesota’s outdoor heritage. 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.

The DNR and other agencies, governments, organizations, and individuals contribute to the prevention and management of invasive carp in the state and in connected waters. For more information on the Minnesota Department of Natural Resources’ (DNR) past and current work on invasive carp prevention and management, see mndnr.gov/invasivecarp.

2024 plan update

The DNR updated this plan in 2024 to incorporate information we have learned in the last decade through responding to invasive silver, bighead, and grass carp in Minnesota, and to include updated information about approaches to invasive carp prevention and management, such as deterrents, that have changed since the last plan update. A summary of the actions in this plan is included in **Appendix A**.

The original version of this plan was developed a with a working group in 2011. The plan was previously updated in 2014. This plan may be updated and revised as needed.

Structured decision-making planning process

To inform portions of this plan update, the DNR convened technical experts and stakeholders as part of a structured decision-making (SDM) planning process to evaluate potential actions to prevent and manage invasive carp in the Mississippi River. The SDM process was focused on the Mississippi River because that is where key prevention and management strategies are being deployed now in response to increasing invasive carp captures in the river, and where there are opportunities for future action.

SDM involves the following steps: 1) problem framing; 2) objective setting; 3) specifying alternative actions; 4) evaluating consequences; and 5) assessing the recommended course(s) of action with qualitative and quantitative analyses. This planning process allowed participants to evaluate the many prevention and management options in terms of their effectiveness and their ability to meet the objectives that Minnesotans value. The DNR invited participants from state, federal, and tribal agencies; universities; the Minnesota Legislature; nongovernmental organizations; and stakeholder groups.

Participants in the SDM process provided input through eight online workshops, a two-day in-person meeting, and multiple individual assignments to collect expert opinions. Participants considered many different strategies for managing invasive carp, including deterrents at different locations on the Upper Mississippi River (e.g., Locks and Dams 4, 5, 8, 15, and 19); additional commercial fishing for removal of invasive carp; research into control methods; and enhancing native fish populations. The strategies that were ranked most highly through the SDM process were used to inform many of the actions in this plan.

The DNR contracted with the U.S. Geological Survey (USGS) to facilitate this participatory process. The outcomes from the process were used to inform portions of the 2023 update of the action plan. A USGS report on the invasive carp SDM process, including the complete list of strategies evaluated, will be available in early 2024. See **Appendix B** for more information about the structured-decision making process, including a table of the top-ranked strategies.

Background: Invasive carp detections and distribution

Grass carp were first captured in Minnesota in 1977, bighead carp in 1996, and silver carp in 2008. The first captures were of individual fish and captures numbered less than ten individuals a year before 2018. The primary pathway of concern for invasive carp spread in Minnesota is fish swimming into the state through connected waters such as river systems.

Invasive carp captures have increased in recent years, with the largest capture being 410 invasive carp in Pool 6 of the Mississippi River in late 2023. See **Appendix C** for a chart of invasive carp confirmed in Minnesota waters from 2012-2023. As of 2023, the furthest upstream detections of invasive bighead, grass, and silver carp are Pool 2 of the Mississippi River near Hastings, the lower St. Croix River near Stillwater, and below the Granite Falls Dam on the Minnesota River. Information from captures, sightings of jumping silver carp, and tagging data suggest that additional invasive carp moved past open dams up the Mississippi River during 2019 and 2023 spring flooding. Black carp have not been detected in Minnesota; in the Mississippi River, black carp are currently known to be located below Lock and Dam 19 near Keokuk, Iowa.

Taylor Falls on the St. Croix River and the Granite Falls Dam on the Minnesota River effectively act as barriers to fish movement, limiting the potential spread of invasive carp into watersheds above these points in the state. In 2014, Congress authorized closing the lock at Upper St. Anthony Falls and it was closed permanently in June 2015 to prevent the spread of invasive carp upstream past that point in the Mississippi River. See **Appendix D** for a map showing Lock and Dam locations on the Mississippi and Illinois rivers.

Invasive carp have also been captured in the Missouri River basin, just below Lake Bella near Minnesota's southern border. This location is impassible to fish under all but the most extreme floods. A watershed breach study in 2014 identified locations in southwest Minnesota where invasive carp

could enter Minnesota via the Little Sioux River and the Iowa Great Lakes. Electric deterrents and barriers such as culvert screens and berms were installed to prevent invasive carp movement, and invasive carp have not been detected upstream of those locations.

Plan focus and organization

This plan focuses on the actions the DNR and other organizations can take to slow the spread of invasive carp, minimize their impact, and reduce the chance of invasive carp reproducing in Minnesota waters. This plan remains a working document that addresses immediate needs and supports longer-term solutions, and the DNR will continue to update the plan as needed to reflect new technologies, scientific advancements, and the changes to the status of invasive carp in the state.

This plan has a particular emphasis on prevention and management in Pools 2-9 of the Mississippi River where invasive carp are present and captures have been increasing in recent years. A combination of management actions will be needed to slow invasive carp migration into Minnesota and minimize the impact of the invasive carp that are present in Minnesota. Removal of invasive carp is identified as a key management strategy in this plan. A variety of deterrents have been developed since the 2014 update of this plan, but the efficacy of any given deterrent will vary by location, conditions, and deterrent type. In addition to potential deterrents and other actions to prevent spread through connected river systems, this plan includes actions related to outreach and communication and coordination, which can also help address other pathways for introduction of invasive carp such as in contaminated live baitfish. This plan also includes actions related to monitoring to support effective responses to invasive carp in Minnesota and identifies research opportunities for the development of more effective management and control tools.

Plan elements include:

1. monitoring to support response actions;
2. prevention and deterrence;
3. response preparation;
4. management and control; and
5. communication, outreach, and coordination.

Specific actions are identified for each element. Research is a key element in invasive carp prevention and management, and opportunities to take actions or pursue strategies related to research are mentioned in all the other elements.

Partnerships

Partnerships will be a critical aspect to successful implementation to many of the actions in this plan. The DNR is identified as a lead implementation organization for actions where appropriate.

Actions that require partnerships are indicated with icons in the summary of actions, Appendix A.

Funding

Implementation of the actions in this plan will depend on adequate funding and resources to implement them, both to the DNR and to other organizations and agencies whose work contributes to managing invasive carp in Minnesota. Many of the actions in this plan, especially those that are new actions to be implemented, will require additional funding. Even actions that are currently funded will require additional funding to achieve improvements or increases in the application of that action.

The DNR funds a full-time position to coordinate invasive fish, including invasive carp. Most of the invasive carp program's current activities have been funded with competitive grants.

During the last eleven fiscal years (FY), 2013-2023, the DNR has been awarded \$2.27 million in federal grants and \$1.52 million from the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR). The DNR expended about \$1.82 million from Fish and Wildlife Division and Ecological and Water Resources Division funds over FY 2013-2023.

In 2012, the State of Minnesota's Outdoor Heritage Fund provided \$7.5 million to the DNR, which was expended through FY 2019. This funding supported design and construction of deterrents and barriers at locations in southwestern Minnesota that were vulnerable to invasive carp expansion from the Missouri River watershed, as well as scoping feasibility for deterrents at locations on the Mississippi, Minnesota, and St. Croix Rivers.

In FY 2024, the Minnesota Legislature appropriated \$1.72 million to the DNR from the state general fund. That additional funding will not be available after June 30, 2025.

Funding needs to implement the actions in this plan are indicated with icons in the summary of actions, Appendix A.

Timeframe for actions

Actions in this plan will occur over the ten-year period, 2024-2033. Many of the actions in this plan represent continuation of work that the DNR and partners are already doing to prevent and manage invasive carp in Minnesota.

Each action is preceded by an estimated timeframe for taking that action:

- Continuous - action is already being taken, and may continue, improve, and/or increase over the lifetime of the plan (2024-2033)
- Start 2024-2028 - new action is a relatively high priority and it should be initiated in the first five years of the plan, though it may not be completed during that timeframe

- Start 2029-2033 - new proposed action may need additional time, resources, or depend on implementation of other actions before it can be undertaken, and it is therefore more likely to be initiated during the second five years of the plan

These timeframes are estimates based on the DNR's judgement at the time of plan revision, and actual implementation of any given action will depend on the availability of resources and the status of the invasive carp population in Minnesota. Actions may not be completed if they are made obsolete by new technologies or changing conditions.

Plan Elements and Actions

1. Monitoring to support response actions

Due to increased captures of invasive carp in Minnesota since the last plan update, the emphasis on monitoring for purposes of early detection will transition to an emphasis on monitoring that can support response and management actions. Implementation will be prioritized in locations where captures, sightings, and modeling suggest that invasive carp are most abundant.

Knowing where invasive carp populations exist and where they may be reproducing are key components for making informed decisions. To date no evidence of invasive carp reproduction has been detected in Minnesota. At this time, there is little published data on what characteristics of an invasive carp population are needed before the fish can reproduce. The Minnesota DNR monitors for invasive carp eggs and larvae, examines captured fish for evidence of spawning, and uses age data to relate captured invasive carp to known reproductive events downstream in other states. The furthest upstream reproductive events are known from Pool 16, in the Iowa-Illinois section of the Mississippi River. However, invasive carp reproduction has been detected only sporadically in Pools 16 through 18, compared to annual invasive carp recruitment, which includes both spawning and offspring surviving to join the population, which is known to occur below Lock and Dam 19. Tributaries are also proving to be important locations for invasive carp reproduction in Iowa. Continued monitoring for eggs, larvae, and juvenile fish as well as collection of data on reproductive condition and age of captured fish will monitor for any change in this status and inform locations for response.

Monitoring can be used to help direct removal efforts. Tagging and tracking is a key tool that Minnesota DNR has been using since 2017. Tagged fish can be detected on DNR and partner agency receiver networks anchored in the river or by tracking fish manually from a boat. Tracking data helps managers identify seasonal movement patterns, migrations, and locations where invasive carp congregate. Sonar (side-scan or split-beam hydroacoustics) surveys can also be used to identify aggregations of large-bodied fish, including invasive carp, to target. There is also potential for eDNA or

other technologies to identify patterns in aggregation. Data that locates invasive carp is vital to a successful removal program.

Due to limitations on available data, invasive carp abundance has not yet been estimated in Minnesota. However, with improved data and modeling approaches, we may now be able to generate reliable abundance estimates which will inform the implementation of management actions and help to monitor their performance.

The eight actions identified below mostly represent activities that are already underway as part of the DNR and other partners' invasive carp work.

1.1. Tag and track invasive carp in the Mississippi River.

The DNR and other agencies such as the U.S. Fish and Wildlife Service (USFWS) tag and release some captured invasive carp to identify seasonal movement patterns and direct removal efforts. Tagged fish die and sometimes move downstream out of state, so the DNR and partners need to continue tagging new fish just to maintain current levels of data. The DNR maintains an acoustic receiver array for detection of tagged fish in Pools 1-4 of the Mississippi River and in the lower portions of the St. Croix and Minnesota Rivers. The USFWS maintains an array from Pools 5-20.

Continuous

- Maintain a fleet of real-time receivers and use them to monitor locations of tagged fish. Manually track as needed to pinpoint locations to capture invasive carp.
- The DNR will share telemetry data with partners via the FishTracks online database. This database allows staff to see the location of their tagged fish on any partner's receivers.
- The DNR will continue to coordinate field activities with the Wisconsin Department of Natural Resources, USFWS, USGS, and other border water agencies to expand tagging and tracking activities.

Start 2024-2028

- Expand receiver array coverage in Pools 5A-8 to improve detection of tagged fish. Coverage by the current array is incomplete, and these pools are currently the most important locations for removal efforts in Minnesota. More complete coverage would improve our ability to detect tagged fish and provide finer scale data on their location. In 2023, the DNR applied for federal assistance to install and maintain up to 30 additional receivers in Pools 5A-8 with assistance from partner organizations.
- The DNR will consider increasing the number and distribution of tagged invasive carp. Increases to the receiver array and/or to the number of tagged invasive carp will require additional funding for personnel and equipment.

1.2. Apply data from targeted commercial fishing to capture invasive carp.

The DNR contracts with commercial fishers to capture invasive carp for tagging and removal. Commercial anglers on the Minnesota or Wisconsin boundary waters of the Mississippi River have specialized equipment, skills, and knowledge of the locations. The DNR directs where efforts should be targeted, often in coordination with other state agencies on boundary waters.

Continuous

- The DNR will use data from captured invasive carp such as number, length, weight, reproductive condition, and age to inform decisions about where, when, and how to manage invasive carp, and potentially to model invasive carp abundance in the region.
- The DNR and partners will continue to use commercial fishing data from across the Upper Mississippi River basin to identify patterns in catches and gaps in effort. Commercial fishers operating in Minnesota are required to notify the DNR if they capture any invasive carp.

1.3. Conduct invasive carp egg and larval surveys.

These surveys look for indicators of invasive carp spawning.

Continuous

- Light traps, larval tows, or other gears as appropriate will continue to be used by the DNR to monitor for invasive carp spawning. The DNR will conduct sampling multiple times per year during late spring and summer at temperatures that would support reproduction. Locations will be chosen based on the best available information as to where spawning or nursery habitat for larval fish could exist. Currently, Pool 5A and Pool 8 are the most appropriate locations to sample based on capture and telemetry data. This work is currently grant funded.

Start 2024-2028

- Simulate silver carp reproduction using the FluEgg model: the DNR has contracted with the USGS to run FluEgg modeling for Pools 1-9 of the Mississippi River in 2024. The modeling will simulate spawning below each of the upstream dams, and transport and maturation of eggs and larvae. The results will predict locations where invasive carp spawning could result in recruitment of young to the population and identify sites where larval fish would be located after a spawning event. These results can be used to refine site selection for egg and larval monitoring, and to prioritize pools for response if spawning were to occur.
- The DNR will coordinate with Wisconsin, Iowa, and Illinois to support monitoring for reproduction in Pools 9-18 and tributaries, prioritizing areas most likely to support reproduction. Recent captures suggest that invasive carp are migrating from these reaches where intermittent reproduction is occurring. These data will be valuable to understanding the invasive carp population in Minnesota.

1.4. Continue systematic and coordinated annual fisheries monitoring programs.

These surveys provide information on collections of invasive carp and valuable information about native aquatic communities' response to invasive carp.

Continuous

- Continue annual electrofishing, gill netting, seining, trammel netting, and hoop netting completed by the DNR as part of standard fisheries surveys and by partners including the Wisconsin Department of Natural Resources, USFWS, and the Long Term Resource Monitoring Program (a component of the Upper Mississippi River Restoration Program, which is a cooperative program between the U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, and the states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin). Continue to coordinate with other states and federal agencies to maximize limited resources.

1.5. Apply environmental DNA (eDNA) sampling systematically.

The DNR partners with multiple agencies for eDNA surveillance. The USFWS samples for invasive carp eDNA in spring and fall of each year, at locations requested by state agencies. The USFWS processes the samples and provides the resulting detection data. The USGS is also taking eDNA samples, as part of ongoing experiments related to efficacy of fishing techniques and seasonality of invasive carp aggregations. The changes in eDNA detections over time serve as a relative measure of abundance, adding additional lines of evidence for increasing or decreasing abundance and seasonal patterns.

Continuous

- Continue to apply eDNA in systematic, strategic ways that provide data on relative abundance, efficacy of removal, or other useful information. Prioritize sites where eDNA monitoring will contribute to the state's ability to monitor for changes in the population of invasive carp, or where eDNA can inform removal.
- Because eDNA technologies are continually evolving, the DNR will continue to evaluate new applications related to invasive carp; for example, community science programs to monitor for eDNA, metabarcoding to identify all fish species in the sample at once, or population abundance estimation from eDNA samples.

1.6. Use available data to model abundance and spatial distribution.

Due to limitations on available data, invasive carp abundance has not yet been estimated in Minnesota. However, new approaches to modeling invasive carp abundance are now available that are useful where data are limited, and it may now be possible to track relative abundance or spatial distribution over time.

Continuous

- The DNR will continue to explore options for estimating abundance with a goal of gathering more information about the invasive carp population in Minnesota and assessing the efficacy of management actions in reducing invasive carp abundance. The DNR will continue to explore options for modeling distribution of invasive carp with a goal of predicting locations to target for capture. Creating, validating, and applying new modeling approaches will require additional funding.

1.7. Support research on early detection and distribution of invasive carp.

Invasive carp are difficult to capture using existing sampling methods, due to their speed, ability to jump over nets, avoidance of boats, and cryptic nature. Research and development are critical for improved detection methods. The DNR works closely with the Minnesota Aquatic Invasive Species Research Center (MAISRC) at the University of Minnesota, the U.S. Geological Survey, and other research organizations to help identify management-relevant research questions, to inform research prioritization, and to collaborate on specific research projects as appropriate.

The DNR has identified the following areas of research as priorities for informing management of invasive carp in the state. Continuing the current research and initiating the new research described below will both require additional funding.

Continuous

- Continue research to fully develop eDNA and other metagenomic tools for detecting presence and estimating abundance of invasive carp.
- Continuing to support species and pathway risk assessments to aid in prioritizing management efforts.
- The DNR will continue to document details of invasive carp captures (locations, dates, habitat characteristics, river conditions, other species present, etc.) in Minnesota waters to help identify and target high priority locations for future detection efforts.

Start 2024-2028

- Exploring the use of sonar surveys such as recreational sidescan, forward-facing sonar, or split-beam hydroacoustics that can identify aggregations of invasive carp as monitoring tools.
- Exploring algal attractants, pheromone attractants, and Traitor Fish to increase sampling efficiencies. Field trials for application of these techniques are needed.

1.8. Enter invasive carp collections into the USGS Nonindigenous Aquatic Species database.

The USGS maintains a database of invasive carp captures in the United States.

Continuous

- The DNR will ensure that confirmed invasive carp detections are entered into this database.

2. Prevention and Deterrence

Prevention and deterrence strategies include permanent or temporary structures that prevent or slow the upstream movement of invasive carp. Lock and Dam structures 2 through 18 in the Mississippi River contain tainter and/or roller spillway gates in the dam section that regulate the flow of water through the dam to maintain the depth of the upstream pool for navigation, and a lock to pass river traffic. Spillway gates, locks, and high-water bypasses are all potential pathways for invasive carp to migrate into Minnesota. Mississippi River Dams 2 (Hastings, Minnesota) through 18, (Gladstone, Illinois) are constructed and operated such that the spillway gates are removed from the water during high flows, allowing invasive carp to potentially move upstream through the spillway gates (Tripp et al. 2013). Invasive carp may also move upstream through the lock chamber when vessels lock through. Opportunities may exist to modify spillway gate operations and install deterrents into locks to inhibit upstream movement of invasive carp. Lock and Dam 1 does not have spillway gates, and the spillway is high enough to prevent upstream passage of invasive carp; the only way fish can migrate past is through the lock chambers. Upper St. Anthony Falls Lock, just upstream of Lock and Dam 1, was closed permanently in 2015 to prevent upstream passage of invasive carp to the Mississippi River headwaters regions.

Alternative deterrent technologies could restrict or slow upstream movement of invasive carp, and in combination with permanent barriers and other removal techniques could help reduce impacts. New sound-based deterrent technologies are currently undergoing testing, including the underwater acoustic deterrent system (uADS) that has been temporarily installed at Lock and Dam 19, and the Bio-Acoustic Fish Fence (BAFF) that is being tested at Barkley Lock and Dam on the Cumberland River in Kentucky. These are the first two full-scale tests of sound-based deterrents for invasive carp in the United States. The uADS was installed in 2021 and the BAFF in 2019. Preliminary data from these deterrents suggests that they are approximately 50% effective at preventing passage of invasive carp, and that they have little to no effect on the native species that were tested (Brey et al. 2023, Fritts et al. 2023). These and other technologies open the possibility to work towards selective passage of native fish while minimizing invasive carp passage. Other types of deterrents, using carbon dioxide or fast water flows to deter upstream passage of fish, and barriers such as the electric barriers currently being used near Romeoville, Illinois, in the Chicago Sanitary and Ship Canal (CSSC), reduce passage of all fish species. Such deterrents could be part of a comprehensive system to further reduce upstream passage of invasive carp and other invasive fish which may not be affected by sound.

Any deterrent strategy being considered should be weighed against the impact on native species. If the strategy has a greater negative impact than invasive carp on native communities, then it should not be

implemented. Data on the current passage rates of native fish and the potential impacts of deterrents on native communities are limited. All deterrent projects should include monitoring of potential impacts to native communities following construction of the deterrent system.

Opportunities may also exist to reduce or prevent passage of invasive fish species not currently found above Lock and Dam 19 near Keokuk, Iowa, including black carp and the invasive northern snakehead (*Channa argus*). Lock and Dam 19 is constructed and operated such that fish can pass only through the lock, making this a critical location for preventing upstream migration of invasive fish. The uADS deterrent has been temporarily installed at Lock and Dam 19. Actions at that location will require working closely with the states of Iowa and Illinois, the U.S. Army Corps of Engineers, and other partners, through workgroups and committees that coordinate invasive carp management in the Upper Mississippi River.

2.1. Work with state and federal partners to advance scoping, design, and installation of a comprehensive, permanent deterrent at Lock and Dam 19.

The spillway gates at Lock and Dam 19 do not open, so the lock structure is the only pathway for fish to swim upstream. Installing a deterrent system in this lock chamber would cut off one source location of invasive carp. Lock and Dam 19 is a priority location for prevention of invasive carp spread to Minnesota because invasive carp reproduction is occurring annually below Lock and Dam 19 and only sporadically in Pools 16 through 18. The Illinois DNR implements an intensive removal program in Pools 15-19, just above Lock and Dam 19, to reduce the risk of reproduction occurring. Preventing further passage of silver and bighead carp into these pools from downstream would further reduce that risk.

Start 2024-2028

- Although Lock and Dam 19 is not in Minnesota waters, this action could include the DNR advocating for the deterrent system and providing expertise to partners. Scoping and design activities should consider potential efficacy, safety, and native species impacts, and estimate cost of construction and operating costs.
- Black carp and northern snakehead have not been captured above Lock and Dam 19 to date. This action should include evaluating the ability of a comprehensive deterrent system at Lock and Dam 19 to prevent those species from moving upstream, in addition to preventing further passage of silver carp, bighead carp, and grass carp. Sound-based deterrents alone will likely not be able to prevent passage of northern snakehead or other invasive fish.

2.2. Characterize potential watershed breaches - Upper Minnesota River (above Granite Falls), Red River, and Missouri River basin.

Watersheds can periodically become connected under some high-flow conditions. This provides a pathway for fish to move into previously uninhabited watersheds. The DNR led a number of watershed

breach studies and took subsequent actions to prevent invasive carp spread at a number of points in the Missouri River watershed in southwest Minnesota. This action would expand upon that work in the Missouri basin and also include new work in the Upper Minnesota and Red River basins.

Start 2024-2028

- Map, perform field surveys of sites, and prioritize potential breaches between other major watersheds. DNR is pursuing funding for the Upper Minnesota River watershed study through LCCMR. South Dakota State University has proposed a project to identify connections through the Missouri River basin and is pursuing federal funding. Additional funding will be needed to expand these studies to new areas.

2.3. Scope feasibility and design for installing deterrents at Locks and Dams 5 and 4 to improve capabilities to deter invasive carp; secondarily, at Locks and Dams 2 and 8.

Lock and Dam 5 has gates that are opened during high flows, essentially creating run of the river or open river conditions; however, these conditions are relatively less frequent at Lock and Dam 5 compared to Locks and Dams 2-8. Simulations of a model dam where spillway gates open predict that reductions in passage from a deterrent would be modest (Zielinski and Sorensen 2021) but could be somewhat improved by implementing deterrents at two consecutive dams. Lock and Dam 4 is included to leverage this opportunity. Scoping and design activities should consider potential efficacy, safety, and native species impacts, and estimate cost of construction and operating costs. Because scoping and design work can be costly, the actions below will require funding.

Studies of Lock and Dam 8, between Minnesota and Wisconsin near Genoa, Wisconsin, have found relatively high rates of fish passage (Sorensen et al. 2019). Large captures of invasive carp upstream of Lock and Dam 8 (in Pool 8 and Pool 6) support this conclusion. Lock and Dam 2, at Hastings, Minnesota, has spillway gates that do not open frequently; however, this is generally considered a lower priority site for invasive carp deterrents since the closure of Upper St. Anthony Falls Lock just upstream.

Start 2024-2028

- Scope feasibility and design for deterrents in the lock chambers at Locks and Dams 4 and 5. Because the spillway gates open during flooding, deterrents or other measures for reducing invasive carp passage at the spillway gates should be evaluated to maximize the utility of installing deterrents in the lock chambers.
- This action to assess the feasibility of installing deterrents at Locks and Dams 4 and 5 should also evaluate bypasses and include deterrents or barriers to invasive carp passage of those bypasses in the design. For example, the earthen embankment at Lock and Dam 5 contains three culverts that connect the pools above and below the dam.

- Research on selective native fish passage options at Locks and Dams 4 and 5 should be undertaken simultaneous to deterrent design and feasibility studies. The DNR is planning to use funds from the invasive carp appropriation for fiscal years 2024-2025 to further this research.
- The DNR is working with the U.S. Army Corps of Engineers and other partners to consider further development of deterrent designs at Lock and Dam 5 and to better understand permitting and approval requirements.

Start 2029-2033

- The DNR, working with partners, may gather additional information and scope deterrents at Locks and Dams 2 and 8 as potential alternatives if deterrents at Locks and Dams 4 and 5 are not feasible.

2.4. Optimize flows through spillway gates to minimize invasive carp passage when gates are not fully out of the water.

University of Minnesota researchers have found that dam spillway gate flows could be modified to reduce invasive carp passage when gates are not fully open (i.e., outside of high water events) (Zielinski et al. 2018). Lock and Dams 5 and 8 are priority locations for this approach. Computer simulation of flows through Lock and Dam 8 has already been completed by the University of Minnesota. Additional research and implementation will require additional funding.

Start 2024-2028

- Continue to pursue additional research into modifying spillway operations, such as that authorized in the FY 2024-2025 invasive carp appropriation to the DNR.
- The DNR will work with researchers and the U.S. Army Corps of Engineers (USACE) to simulate flows through Lock and Dam 5 to optimize flows and minimize invasive carp passage.
- The DNR will work with the USACE to consider implementation of the optimal flow regime.

2.5. Support research on new technologies and approaches to selectively deter upstream movement of invasive fish.

Several new approaches for deterrents that are specific to invasive fish species, or “selective” for invasive fish, are in testing, including sound-based deterrents, bubble curtains, and fish passage devices that allow for identification and removal of invasive fish. Other deterrent types including carbon dioxide, water velocity deterrents, and electrical deterrents are not selective, but may be more effective at preventing invasive fish passage. Selectivity may be possible by using these deterrents only during certain seasons where invasive carp are more likely to move.

Continuous

- The DNR will continue to support and partner on research to improve effectiveness and determine suitability for these technologies.

Start 2024-2028

- Scope the feasibility of installing fish passage structures or devices that will allow native fish to pass but deter or remove invasive carp. The DNR intends to use funding from the legislative appropriation for fiscal years 2024-2025 for a feasibility study.
- Dam spillways are still vulnerable to invasive carp passage at times when gates must be fully opened (e.g., during high water). Research on preventing invasive carp passage through open spillway gates (e.g., temporary deterrents, diversion to removal areas, or other methods) is needed. The DNR will work with partners to advocate for or obtain funding for this research, and work with research organizations such as MAISRC and USGS to develop spillway gate deterrents.

2.6. Investigate the possibility of a deterrent at Lock and Dam 15.

Lock and Dam 15 is located between Rock Island, Illinois, and Davenport, Iowa, in the “Quad Cities,” just upstream of the invasion front for bighead, grass, and silver carp, where reproduction is occurring intermittently. The spillway gates open relatively infrequently at this location, and it often serves as a barrier to fish movement. Deterrents downstream from Minnesota, such as at Lock and Dam 15, provide a measure of protection for all pools upstream of that location by reducing invasive carp migration upstream. A deterrent at Lock and Dam 15 is a new idea suggested by experts participating in the invasive carp SDM process and requires further study.

Start 2029-2033

- Although Lock and Dam 15 does not border Minnesota, this action could include the DNR providing expertise to partners in the study of a deterrent at this location.

2.7. Investigate native and invasive fish passage overlap at Lock and Dam 14 and 15, and other dams as available.

The timing of native and invasive fish passage could be exploited to minimize invasive fish passage at key locks and dams. Invasive carp primarily move past dams in the Upper Mississippi River in April-July (Vallazza et al. 2021). Deterrents could potentially be operated seasonally to prevent most invasive carp passage and allow for native fish passage, but this concept has not yet been tested. Lock and Dam 15 and Lock and Dam 14, upstream of the Quad Cities near LeClaire, Iowa, were identified as priority locations for researching the timing of passage because they could be useful sites at which to install a

deterrent, and the abundance of invasive carp in this area is sufficient to study the timing of invasive and native fish attempting to pass at that location.

Start 2024-2028

- The DNR will coordinate with partners to advocate for this work, provide professional expertise, and pursue studies as funds are available.
- The DNR will work with partners to increase tagging and tracking of invasive carp and native fish and expand the telemetry array to facilitate this work.

2.8. Increase knowledge of native aquatic communities including abundance, movement, and deterrent impacts.

Increasing knowledge of native aquatic community dynamics will help inform future decisions on actions.

Continuous

- The DNR will continue to collect information on native fish species to better identify impacts of invasive carp and deterrents on the health and abundance of native aquatic populations, prioritizing species with data gaps.
- The DNR will continue to collect telemetry data on native fish movement to evaluate and inform use of deterrents.

3. Response Preparation

The Minnesota DNR has a statewide [Early Detection and Response Plan for Aquatic Invasive Species](#), revised in 2021. Minnesota's [State Management Plan for Invasive Species](#), revised and approved by the federal Aquatic Nuisance Species Task Force in 2022, also includes actions and strategies related to response. These plans would also be used to guide any response activity to a new detection of invasive carp in an area of the state where they had not been previously confirmed.

Response actions for invasive carp may be triggered by the capture of adults, juveniles, young of the year, or eggs in an area of the state where invasive carp had previously not been detected. The objective of responses may vary, but in general actions are employed to gather more information or attempt to remove populations before they become established. Response actions may need to occur immediately or within a couple of months, but typically occur before the next spawning season. Developing appropriate triggers and viable response actions is needed to facilitate promptness, maximize efficiency, and ensure appropriate expenditure of limited funds.

3.1. Support research and partnerships to prepare for responses.

Partnerships and research are critical to laying the foundation for a successful response. Managers in other jurisdictions can provide technical support.

Continuous

- The DNR will continue to work with partners to develop new, and enhance existing, methods for capture and detection in a low-density environment will help us be prepared for all responses.
- The DNR will continue to support research, like work to enhance eDNA technologies, as identified elsewhere in this plan. Additional funding will be needed to support new advances in research.

4. Management and Control

Managing and controlling populations of invasive carp is a critical element of this plan. Removal is a readily available option to reduce abundance of invasive carp, and reduction in abundance is important to reducing the risk of reproduction occurring in Minnesota. Monitoring such as tagging and tracking and eDNA sampling can help to better target removal efforts. Contracted commercial fishing and continued development of more efficient methods for capturing invasive carp are both important components of this strategy.

4.1. Increase contracted commercial fishing to remove invasive carp.

Contracted commercial fishing is currently the most effective way to capture invasive carp for removal or tagging. Commercial anglers on the Minnesota or Wisconsin boundary waters of the Mississippi River have specialized equipment, skills, and knowledge of the location. Invasive carp tend to school during spring and fall, making these important times for capture.

Continuous

- The DNR will increase contracted commercial fishing in Minnesota from 38 days of effort in 2023 to at least 100 days of effort by 2025: multiple contracted commercial fishing crews working simultaneously will be needed to target invasive carp during spring and fall across Pools 2-9.
- Support continued funding for contracted commercial fishing. In 2023, the Minnesota Legislature appropriated \$1.72 million to the DNR to prevent and manage invasive carp and the DNR allocated some of those funds to increasing commercial fishing. Those funds are available through June 30, 2025. Commercial fishing has also been supported by invasive carp grants administered by the U.S. Fish and Wildlife Service, and by grants from the Environment and Natural Resources Trust Fund (ENRTF) as recommended by the Legislative-Citizen Commission

on Minnesota Resources (LCCMR). More stable sources of funding should be identified and pursued to enable this work to continue long-term.

- Support continued funding and staffing for agency and partner monitoring activities, such as tagging and tracking that can help direct contracted commercial fishing.

Start 2024-2028

- The DNR will explore potential application of harvest incentives, such as a bounty on invasive carp, which would be most appropriate at low densities of invasive carp, or a subsidy per pound of invasive carp, which would apply at a high density of invasive carp. This work will evaluate the potential for implementation of incentives, cost, permitting and regulatory requirements, and administrative needs.
- As appropriate, support the commercial fishing industry in Minnesota so that capacity continues to be available. Programs similar to those implemented in other states would require new funding.

4.2. Support DNR-led removal of invasive carp.

Agency-led removal techniques are being developed in Minnesota and in other states. The USGS has been collaborating with DNR since 2021 to develop new technologies and approaches that can enhance capture of invasive carp. The USFWS has developed dozer trawl and paupier net electrofishers that can be used by agencies to capture invasive carp. Grass carp strike teams in Lake Erie and managers at Kansas Department of Wildlife and Parks are developing new approaches to capturing invasive carp as well. These techniques may be particularly important in locations where commercial seining or gillnetting is not possible, such as in smaller tributaries or areas with debris.

Continuous

- The DNR will continue to collaborate with other agencies to identify and utilize effective agency-led removal techniques such as new electrofishing techniques designed to target grass carp, technology advancements in using sound to direct invasive carp towards nets, and methods that combine netting and herding.
- As data allow, use agency-led sampling to estimate abundance and status of invasive carp in Minnesota and border waters.

4.3. Support and accelerate research on long-term control methods.

Research is ongoing regarding invasive carp physiological, genetic, and behavioral controls, such as attractants, toxicants, genetic biocontrol, and deterrents. MAISRC, USGS, and other research organizations are key to advancing this research. Additional funding would be required to support future research initiatives.

Continuous

- The following are priority areas for control-related research that DNR encourages research institutions to pursue:
 - Conduct research to determine whether attractants are species-specific. Conduct trials of attractants for invasive carp removal field applications.
 - Research is also needed to better understand invasive carp population dynamics (recruitment, mortality, predation, immigration/emigration), food webs, and habitat usage, which may lead to the development of management and control tools (e.g., disruption or interception of spawning events, species-specific toxicants, or automated removal systems that exploit movement patterns).
 - Genetic biocontrol holds promise to be an effective long-term solution. Policy, risk assessment, regulatory considerations, and implementation questions should continue to be explored simultaneous to the development of genetic biocontrol methods.
- The DNR will continue to coordinate with researchers to provide feedback, support permitting, and evaluation, as needed to complete studies and implement research projects.

4.4. Explore options for responsible invasive carp disposal.

Invasive carp are edible and can also be used to make products such as fertilizer, pet food, and fish bait. Commercial use of invasive carp has not been permitted in Minnesota to date, but commercial processing plants for invasive carp are operational in other states with higher abundances of invasive carp.

Start 2024-2028

- Research alternatives for disposal appropriate to the current number of invasive carp captured in Minnesota and work with partners to explore the feasibility of those alternatives. This work would require additional funding.

4.5. Protect and enhance native ecosystems.

An important underlying goal of invasive carp management is to protect native ecosystems. The DNR is involved in many fish habitat and community improvement projects, which will continue. While increased resiliency has not been linked to reducing abundance of invasive carp, increasing resiliency is important for the health of native communities facing competition from invasive species.

Continuous

- The DNR will continue existing predator protection and native habitat management programs.
- The DNR will continue to gather data on native fish communities to understand impacts of invasive carp and management actions.

Start 2024-2028

- The DNR will consider fishery management changes aimed at improving the size and age structure of native fishes to increase predation on invasive carp, along with improving the health of commercial fish populations that compete directly with invasive carp for food.
- The DNR will conduct a fish community analysis to determine susceptible aquatic habitats and fisheries management options to increase resiliency.

5. Communication, Outreach, and Coordination

Communication and outreach between agencies and with key audiences will be critical to the success of invasive carp prevention and management in Minnesota. Key audiences include commercial and recreational users of the Mississippi River and connected waters, users of other Minnesota waters at risk of invasive carp, media, legislators, local officials, and the public. An informed public will improve our ability to prevent and manage invasive carp. The interconnected nature of Minnesota's waters and of invasive carp populations in the Mississippi River, Missouri River, and Great Lakes basins makes coordination with other jurisdictions in those regions crucial to effectively preventing and managing invasive carp. Information shared with and received from other organizations and the public will help advance Minnesota's invasive carp program.

5.1. Provide news releases, conduct media events, and provide access to information and experts to effectively communicate advances in prevention and management of invasive carp.

These actions will bring attention to invasive carp issues, highlight activities of participating groups, and communicate outcomes.

Continuous

- The DNR will continue to use news releases, the Gov Delivery email list, and other media to share information about developments and actions related to invasive carp.
- The DNR will continue to provide opportunities for media, legislators, and partners to observe DNR-led capture events.
- The DNR will continue to maintain a list of subject matter experts for media and other public inquiries related to invasive carp.
- The DNR will provide expert testimony and data as requested to legislators to facilitate decision-making.

5.2. Maintain agency websites.

The DNR currently has a [web page focused on invasive carp](#) as well as individual species pages for invasive carp species. These web pages are a good source of stable, current information about the DNR's invasive carp work.

Continuous

- Maintain DNR invasive carp web pages with up-to-date information including current actions, how to identify and report invasive carp, recent news on invasive carp, and publicly available reports on program activities.
- When appropriate, link to partner organization websites to prevent duplication of effort and provide access to the best available information.

5.3. Encourage public reporting of invasive carp captures and sightings.

Public reporting of invasive carp captures and sightings (e.g., jumping silver carp) provides valuable information on the location and status of invasive carp. Reports of jumping invasive carp may indicate an aggregation that could be targeted for removal.

Continuous

- The DNR will continue to promote public awareness and outreach through signage, web pages, social media, and news releases.
- The DNR will track and attempt to verify reported sightings as capacity to respond allows.

5.4. Increase outreach to prevent accidental introductions.

Bighead, black, grass, and silver carp are all classified as prohibited invasive species in Minnesota. Minnesota has also passed several laws to reduce the risk of accidental introductions. Bighead, black, and silver carp are considered injurious wildlife, and importing them into the U.S., its territories or possessions is prohibited by the federal Lacey Act (18 U.S.C. 42) without a permit.

Start 2024-2028

- Increase public awareness and compliance to reduce the risk of spread by the public. Ensure that information reaches key audiences such as anglers, boaters, and bait shop owners. The DNR will partner with other agencies and organizations across the Upper Mississippi River, using consistent messaging to engage the public, and leveraging resources to make campaigns as effective as possible. Provide language translations on signs or other materials, as appropriate.

5.5. Continue DNR participation in regional and national efforts.

Coordination with partners within and outside of Minnesota is critical to accomplishing the actions in this plan.

Continuous

- The DNR will continue active participation in regional and national efforts including: Invasive Carp Regional Coordinating Committee, Upper Mississippi River Conservation Committee, Mississippi River Interstate Cooperative Resource Association, Upper Mississippi River Basin Association, Great Lakes Panel on Aquatic Nuisance Species, Upper Mississippi River Invasive Carp Team, Mississippi River Basin Panel on Aquatic Nuisance Species, Missouri River Basin Invasive Carp Team, National Invasive Carp Framework, eDNA Community of Practice, Black Carp Working Group, Brandon Road States and Provinces Forum, and other conferences, workgroups, and panels.
- In coordination with other states and federal agencies, continue to engage with efforts to harmonize regulations related to invasive species, bait, and possession and transport of invasive carp, to reduce risk from invasive carp and enhance the state's ability to prevent and manage invasive carp.

5.6. Coordinate with researchers to stay up to date on invasive carp projects and to encourage research that is relevant to invasive carp prevention and management in Minnesota.

Sharing scientific research results will improve our understanding of invasive carp populations and control methods and improve our ability to implement the actions in this plan.

Continuous

- The DNR will continue to coordinate with researchers from organizations such as MAISRC, USGS, USFWS, and other universities to identify research needs and considerations for management-ready results.

5.7. Work with partner agencies and other organizations and stakeholders to further the goals of this Action Plan.

Continuous

- The DNR will continue to coordinate and collaborate with other agencies that work on invasive carp in the region. Keep partner agencies informed of developments and activities. Identify opportunities to collaboratively leverage resources for the benefit of the region. Advance basin-wide initiatives that will limit range expansion of invasive carp into Minnesota or reduce abundance of invasive carp in Minnesota. Work to align state and regional priorities for invasive

carp prevention and management. Provide equipment, expertise, data, and staff time as available to support invasive carp efforts in other states that benefit the Upper Mississippi River Basin, Missouri River Basin, or Great Lakes Basin.

- Work with other organizations and stakeholders to communicate DNR steps to implement this plan, to identify opportunities for collaboration and partnership, and to leverage the resources of other groups working on invasive carp in Minnesota.

5.8. Communicate the cost (long-term), risk, and time involved in developing solutions.

Researching and developing solutions for aquatic invasive species is not a simple endeavor. The work is costly and lengthy, with potential failures along the way. The benefits can be immense, as seen with sea lamprey control in the Great Lakes.

Continuous

- The DNR will work with MAISRC and other expert partners to provide accurate assessments of costs, potential risks, and realistic timelines associated with invasive carp related research and solution development to policy makers and the public.

References cited

- Brey, M.K., Woodley, C.M., Stanton, J.C., Fritts, A.K., Sholtis, M., Castro-Santos, T., Vallazza, J.M., and Albers, J.L., 2023, Lock 19 underwater acoustic deterrent system study—Interim project update, through 2022: U.S. Geological Survey Open-File Report 2023–1058, 11 p., <https://doi.org/10.3133/ofr20231058>.
- Fritts, A., Gibson-Reinemer, D., Stanton, J., Mosel, K., Brey, M., Vallazza, J., Appel, D., Faulkner, J., Tompkins, J., Castro-Santos, T., Sholtis, M., Turnpenny, A., Sorensen, P., and Simmonds, R., 2023, Multimodal invasive carp deterrent study at Barkley Lock and Dam—Status update through 2022: U.S. Geological Survey Open-File Report 2023–1051, 7 p., <https://doi.org/10.3133/ofr20231051>.
- Sorensen, P., Finger, J. and Riesgraf, A., 2019. Integrating detection, deterrents, and operations at upper Mississippi River navigation lock and dams. Report Prepared for the Minnesota Department of Natural Resources by the University of Minnesota, Final Report, Minneapolis.
- Tripp, S., Brooks, R., Herzog, D. and Garvey, J. (2013), Patterns of Fish Passage in the Upper Mississippi River. *River Res. Applic.* doi: 10.1002/rra.2696
- Vallazza, J.M., Mosel, K.J., Reineke, D.M., Runstrom, A.L., Larson, J.H. and Knights, B.C., 2021. Timing and hydrological conditions associated with bigheaded carp movement past navigation dams on the upper Mississippi River. *Biological Invasions*, 23, pp.3409-3425.
- Zielinski, D.P, and Sorensen, P.W. 2021. Numeric simulation demonstrates that the upstream movement of invasive bigheaded carp can be blocked at sets of Mississippi River locks-and-dams using a combination of optimized spillway gate operations, lock deterrents, and carp removal. *Fishes* 6.2 (2021): 10.
- Zielinski, D.P., Voller, V.R. and Sorensen, P.W., 2018. A physiologically inspired agent-based approach to model upstream passage of invasive fish at a lock-and-dam. *Ecological Modelling*, 382, pp.18-32.

Appendix A – summary of actions

The actions in the 2024 revision of the Invasive Carp Action Plan are listed below, along with icons describing partnership and funding needs and the estimated timeframe for each action. These actions are characterized based on DNR’s judgement at the time of plan revision. Actual implementation of any given action will depend on the availability of resources and the status of the invasive carp population in Minnesota. Actions may not be completed if they are made obsolete by new technologies or changing conditions. More information about each set of actions can be found in the full text of the Action Plan.

Key to symbols



Action will require partnership



Action will require new, increased, or renewed funding. This icon may appear next to actions where partners would be leading the action and/or funding would be directed to an entity other than the DNR.









Key to Timeframe categories







Continuous - action is already being taken, and may continue, improve, and/or increase over the lifetime of the plan (2024-2033)


Start 2024-2028 - new action is a relatively high priority and it should be initiated in the first five years of the plan, though it may not be completed during that timeframe







Start 2029-2033 - new proposed action may need additional time, resources, or depend on implementation of other actions before it can be undertaken, and it is therefore more likely to be initiated during the second five years of the plan







Action	Requires partners	Requires new funding	Timeframe
1.1. Tag and track invasive carp in the Mississippi River.			
<ul style="list-style-type: none"> • Maintain and use receivers 			Continuous
<ul style="list-style-type: none"> • Share telemetry data with FishTracks 			Continuous
<ul style="list-style-type: none"> • Continue to coordinate with partners 			Continuous



Action	Requires partners	Requires new funding	Timeframe
<ul style="list-style-type: none"> Expand receiver coverage 		\$	Start 2024-2028
<ul style="list-style-type: none"> Consider increasing number of tagged carp 		\$	Start 2024-2028
1.2. Apply data from targeted commercial fishing to capture invasive carp.			
<ul style="list-style-type: none"> Use data from captured carp to inform management 			Continuous
<ul style="list-style-type: none"> Use regional data to inform regional management 			Continuous
1.3. Conduct invasive carp egg and larval surveys.			
<ul style="list-style-type: none"> Monitor for invasive carp spawning indicators 			Continuous
<ul style="list-style-type: none"> Model silver carp reproduction 			Start 2024-2028
<ul style="list-style-type: none"> Coordinate with other states to monitor downstream 		\$	Start 2024-2028
1.4. Continue systematic and coordinated annual fisheries monitoring programs.			
<ul style="list-style-type: none"> Continue annual fisheries surveys with partners 			Continuous
1.5. Apply environmental DNA (eDNA) sampling systematically.			
<ul style="list-style-type: none"> Use eDNA information to inform management 			Continuous
<ul style="list-style-type: none"> Evaluate new eDNA applications 			Continuous





Action	Requires partners	Requires new funding	Timeframe
1.6. Use available data to model abundance and spatial distribution			
<ul style="list-style-type: none"> • Explore options for estimating abundance to inform management 		\$	Continuous
1.7. Support research on early detection and distribution of invasive carp.			
<ul style="list-style-type: none"> • Continued research includes eDNA, risk assessment, and capture characteristics 			Continuous
<ul style="list-style-type: none"> • Explore new research including applying sonar and attractant technologies 		\$	Start 2024-2028
1.8. Enter invasive carp collections into the USGS Nonindigenous Aquatic Species database.			
<ul style="list-style-type: none"> • Ensure invasive carp detections are reported to USGS 			Continuous
2.1. Work with state and federal partners to advance scoping, design, and installation of a comprehensive, permanent deterrent at Lock and Dam 19.			
<ul style="list-style-type: none"> • Advocate and provide expertise for this effort 			Start 2024-2028
<ul style="list-style-type: none"> • Consider other invasive fish in scoping and design 		\$	Start 2024-2028
2.2. Characterize potential watershed breaches - Upper Minnesota River (above Granite Falls), Red River, and Missouri River basin.			
<ul style="list-style-type: none"> • Map, survey, and prioritize potential watershed breaches that have not yet been characterized 		\$	Start 2024-2028


Action	Requires partners	Requires new funding	Timeframe
2.3. Scope feasibility and design for installing deterrents at Locks and Dams (LD) 5 and 4 to improve capabilities to deter invasive carp; secondarily, at LD 2 and 8.			
<ul style="list-style-type: none"> • Scope and design deterrents in lock chambers at LD 4 and 5 		\$	Start 2024-2028
<ul style="list-style-type: none"> • Evaluate deterrents or measures for reducing passage at spillway gates (LD 4 and 5) 		\$	Start 2024-2028
<ul style="list-style-type: none"> • Evaluate bypasses of LD 4 and 5 to include in design 		\$	Start 2024-2028
<ul style="list-style-type: none"> • Research native fish passage at LD 4 and 5 		\$	Start 2024-2028
<ul style="list-style-type: none"> • Continue to learn about permitting and approval requirements 			Continuous
<ul style="list-style-type: none"> • Scope deterrents at LD 2 and 8 as alternatives 		\$	Start 2029-2033 if needed
2.4. Optimize flows through spillway gates to minimize invasive carp passage when gates are not fully out of the water.			
<ul style="list-style-type: none"> • Pursue additional research into modifying spillway operations 		\$	Start 2024-2028
<ul style="list-style-type: none"> • Work with researchers and USACE to simulate LD5 spillway 		\$	Start 2024-2028
<ul style="list-style-type: none"> • Work with USACE to consider feasibility of changing flow regimes 		\$	Start 2024-2028
2.5. Support research on new technologies and approaches to selectively deter upstream movement of invasive fish.			

Action	Requires partners	Requires new funding	Timeframe
<ul style="list-style-type: none"> Support research to improve selective deterrents 			Continuous
<ul style="list-style-type: none"> Scope feasibility of fish passage structures 			2024-2025
<ul style="list-style-type: none"> Work with partners to advance research and develop deterrents 		\$	Start 2024-2028
2.6. Investigate the possibility of a deterrent at Lock and Dam 15.			
<ul style="list-style-type: none"> Advocate and provide expertise for this effort 			Start 2029-2033
2.7. Investigate native and invasive fish passage overlap at Lock and Dam 14 and 15, and other dams as available.			
<ul style="list-style-type: none"> Advocate and provide expertise for this work 			Start 2024-2028
<ul style="list-style-type: none"> Increase fish tagging and tracking to facilitate this work 		\$	Start 2024-2028
2.8. Increase knowledge of native aquatic communities including abundance, movement, and deterrent impacts.			
<ul style="list-style-type: none"> Identify impacts of invasive carp and deterrents on native species 			Continuous
<ul style="list-style-type: none"> Use native fish movement data to evaluate and inform use of deterrents 			Continuous
3.1. Support research and partnerships to prepare for responses.			
<ul style="list-style-type: none"> Develop new, or enhance existing, methods for capture and detection 			Continuous

Action	Requires partners	Requires new funding	Timeframe
<ul style="list-style-type: none"> Support research, for example eDNA enhancements 		\$	Continuous
4.1. Increase contracted commercial fishing to remove invasive carp.			
<ul style="list-style-type: none"> Increase contracted commercial fishing 			2024-2025
<ul style="list-style-type: none"> Support continued funding for contracted commercial fishing 		\$	Continuous
<ul style="list-style-type: none"> Support continued funding for monitoring activities to support commercial fishing 		\$	Continuous
<ul style="list-style-type: none"> Explore harvest incentives 			Start 2024-2028
<ul style="list-style-type: none"> Support commercial fishing industry capacity 		\$	Start 2024-2028
4.2. Support DNR-led removal of invasive carp.			
<ul style="list-style-type: none"> Use effective agency-led removal techniques 			Continuous
<ul style="list-style-type: none"> Use agency sampling to estimate abundance 		\$	Continuous
4.3. Support and accelerate research on long-term control methods.			
<ul style="list-style-type: none"> Research priorities include species-specific attractants, invasive carp population dynamics, and genetic biocontrol 		\$	Continuous
<ul style="list-style-type: none"> Coordinate with researchers to support projects 			Continuous
4.4. Explore options for responsible invasive carp disposal.			

Action	Requires partners	Requires new funding	Timeframe
<ul style="list-style-type: none"> Research alternatives and explore feasibility for disposing of invasive carp 		\$	Start 2024-2028
4.5. Protect and enhance native ecosystems.			
<ul style="list-style-type: none"> Continue predator protection and habitat management 			Continuous
<ul style="list-style-type: none"> Continue to gather data on native fish communities 			Continuous
<ul style="list-style-type: none"> Consider fishery management changes 			Start 2024-2028
<ul style="list-style-type: none"> Conduct fish community analysis 		\$	Start 2024-2028
5.1. Provide news releases, conduct media events, and provide access to information and experts to effectively communicate advances in prevention and management of invasive carp.			
<ul style="list-style-type: none"> Use news releases and other media to share information 			Continuous
<ul style="list-style-type: none"> Provide opportunities for others to observe field activities 			Continuous
<ul style="list-style-type: none"> Maintain a list of subject matter experts 			Continuous
<ul style="list-style-type: none"> Provide expert testimony 			Continuous
5.2. Maintain agency websites.			
<ul style="list-style-type: none"> Maintain DNR invasive carp web pages 			Continuous
<ul style="list-style-type: none"> Link to partner organization website as appropriate 			Continuous

Action	Requires partners	Requires new funding	Timeframe
5.3. Encourage public reporting of invasive carp captures and sightings.			
<ul style="list-style-type: none"> • Promote public awareness and outreach 			Continuous
<ul style="list-style-type: none"> • Track and verify sightings as capacity allows 			Continuous
5.4. Increase outreach to prevent accidental introductions.			
<ul style="list-style-type: none"> • Increase public awareness to reduce risk of people spreading invasive carp 		\$	Start 2024-2028
5.5. Continue DNR participation in regional and national efforts.			
<ul style="list-style-type: none"> • Participate in regional and national groups 			Continuous
<ul style="list-style-type: none"> • Work with partners on regulatory harmonization efforts 			Continuous
5.6. Coordinate with researchers to stay up to date on invasive carp projects and to encourage research that is relevant to invasive carp prevention and management in Minnesota.			
<ul style="list-style-type: none"> • Identify research needs and considerations for management-ready results 			Continuous
5.7. Work with partner agencies and other organizations and stakeholders to further the goals of this Action Plan.			
<ul style="list-style-type: none"> • Coordinate and collaborate with partners on implementation of actions 			Continuous
<ul style="list-style-type: none"> • Keep partners informed of DNR actions 			Continuous
5.8. Communicate the cost (long-term), risk, and time involved in developing solutions.			

Action	Requires partners	Requires new funding	Timeframe
<ul style="list-style-type: none"> • Work with experts to communicate the challenges associated with developing solutions to invasive carp 			Continuous

Appendix B – Structured decision-making planning process summary

The 2024 Invasive Carp Action Plan update was informed by a Structured Decision-Making (SDM) process to examine alternatives for invasive carp management in the Upper Mississippi River.

Participants

The DNR invited a broad group of technical experts and stakeholders to participate in the process to ensure that the best available science and stakeholder values and objectives are represented. Diverse perspectives were included. People from the following organizations or groups were invited:

- Minnesota Senate Environment, Climate, and Legacy Committee
- Minnesota House Environment and Natural Resources Finance and Policy Committee
- Stop Carp Coalition
- MN-FISH
- Friends of the Mississippi River
- Lake Pepin Legacy Alliance
- Wild Rivers Conservancy
- University researchers
- Tribal Natural Resource Agencies
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. Army Corps of Engineers
- Wisconsin DNR
- Iowa DNR
- Minnesota DNR

Process

SDM process participants discussed and evaluated many different combinations of strategies to manage invasive carp in the Mississippi River. The participants also prioritized 12 objectives as most important to achieve with invasive carp management actions:

- Decrease invasive carp abundance
- Minimize impacts to native fish
- Minimize implementation time
- Maintain recreational opportunities
- Minimize carp threats to public safety
- Minimize negative effects on native mussels
- Minimize impacts to native flora
- Minimize negative impacts to Minnesota river-based economies
- Minimize management threats to public safety
- Minimize negative impact to cultural practices
- Minimize prevention and control costs of the action
- Maintain access for under-served populations

Experts scored each strategy's expected performance on each of 12 criteria. The criteria were weighted by a group of stakeholders. Weights and scores were combined to produce overall scores. More information about the process will be available in the USGS report on the structured decision-making process, available in early 2024.

Outcomes

The results of the SDM process were used to inform many of the actions in this plan. Table 1 below shows the components that were included in each of the overall highest-rated management strategies from the 2023 structured decision-making planning process. The strategies in the table include, from left to right:

- The top-rated strategy, "Maximize removal," maximizes invasive carp removal, includes a deterrent at LD 19, as well as increasing several other strategies
- The second-highest rated strategy, "Unconstrained," maximizes removal, includes deterrents at six different locks and dams, and includes a variety of additional research and monitoring actions. This combination of actions was built by SDM participants into a strategy that maximized effort without assuming resource or time constraints; indeed, participants rated this strategy poorly with respect to minimizing cost.
- The third-highest rated strategy, maximize removal + LD 5 deterrent, includes a deterrent at Lock and Dam 5 in addition to the actions in the maximize removal strategy.
- The fourth-highest rated strategy is "Maximize removal + research and development." It includes a variety of research actions in addition to the actions in the maximize removal strategy.
- The fifth-highest rated strategy is "Maximize removal + LD 8 deterrent." It includes a deterrent at Lock and Dam 8 in addition to the actions in the maximize removal strategy.

As illustrated in the table below, the top five ranked strategies from the structured decision-making planning process all included maximizing removal. A permanent deterrent at Lock and Dam 19 (in the Mississippi River between Iowa and Illinois) was identified by the 2023 SDM planning process as such an important management action that it was included in all management scenarios assessed except for the current strategy, which included the deterrent temporarily located at Lock and Dam 19.

Experts involved in the planning process agreed that the efficacy, cost, and timeline of installing deterrents are highly uncertain. While it may not be practical or desirable to install deterrents at all locks and dams, the planning process results provide insight into which to pursue first and where to target research efforts.

Table 1. Components included in the five highest overall scoring management strategies from the invasive carp planning process.

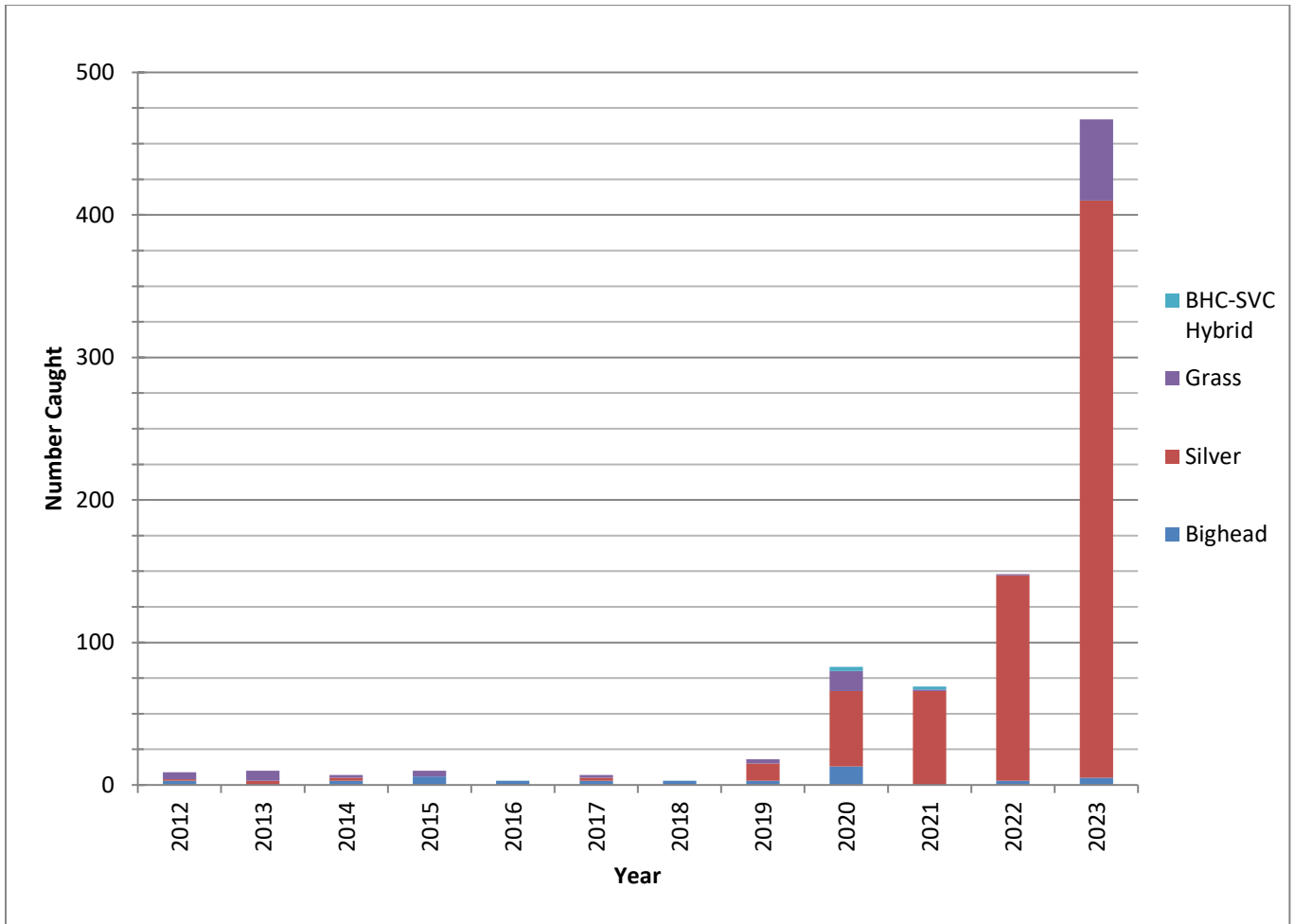
Strategy short names:	Maximize Removal	Unconstrained	Maximize Removal + LD 5 Deterrent	Maximize Removal + Research & Development	Maximize Removal + LD 8 Deterrent
Deterrent at Lock and Dam (LD) 19	✓	✓	✓	✓	✓
Deterrent at LD 2		✓			
Deterrent at LD 4		✓			
Deterrent at LD 5		✓	✓		
Deterrent at LD 8					✓
Deterrent at LD 14		✓			
Deterrent at LD 15		✓			
Dam removal at LD 1		✓			
Minimize invasive carp passage at spillway gates at LD 5 and 8	✓		✓	✓	✓
Minimize invasive carp passage at spillway gates at LD 2, 4, 5, 14, and 15		✓			
Maximize native fish passage at LD 2, 4, 5, 14, 15, 19		✓			
Maximize removal in Pools 2-8 prioritizing highest density areas	✓	✓	✓	✓	✓
Maximize removal in all pools of the Upper Mississippi River (UMR)		✓			

Strategy short names:	Maximize Removal	Unconstrained	Maximize Removal + LD 5 Deterrent	Maximize Removal + Research & Development	Maximize Removal + LD 8 Deterrent
Continue ongoing native habitat restoration and predator protection in Minnesota waters	✓	✓	✓	✓	✓
Additional native habitat restoration and native predator protection throughout the UMR		✓			
Agency-led removal events with multiple crews (2 pools/year)		✓			
Research recruitment dynamics to disrupt reproduction		✓			
Research efficient capture techniques	✓		✓	✓	✓
Develop disposal approaches	✓		✓	✓	✓
Research deterrent effectiveness				✓	
Research selective fish passage at LD 5	✓		✓	✓	✓
FluEgg modeling in Pools 1-9	✓	✓	✓	✓	✓
FluEgg modeling in all pools of UMR		✓			
Develop deterrents for spillway gates		✓		✓	
Identify interbasin connections with the Minnesota River	✓		✓	✓	✓

Strategy short names:	Maximize Removal	Unconstrained	Maximize Removal + LD 5 Deterrent	Maximize Removal + Research & Development	Maximize Removal + LD 8 Deterrent
Research new technology (genetic biocontrol, attractants)	✓	✓	✓	✓	✓
Research native and invasive fish passage timing: LD 14 and 15	✓	✓	✓	✓	✓
Research native and invasive fish passage timing: all UMR		✓		✓	
Monitor population via commercial fishing catch: all UMR	✓		✓	✓	✓
Egg/larval monitoring: Pools 5A and 8	✓	✓	✓	✓	✓
Egg/larval monitoring: all UMR		✓			
Telemetry (tagging and tracking): all UMR	✓	✓	✓	✓	✓
Outreach to increase public reporting: MN	✓	✓	✓	✓	✓
Outreach to increase public reporting: all UMR		✓			
Engagement with the public to reduce spread across the UMR	✓	✓	✓	✓	✓
Provide equipment to agency partners to maximize efforts	✓	✓	✓	✓	✓
Coordinate with agency partners on regulations	✓	✓	✓	✓	✓
Partner with other agencies on outreach	✓	✓	✓	✓	✓

Strategy short names:	Maximize Removal	Unconstrained	Maximize Removal + LD 5 Deterrent	Maximize Removal + Research & Development	Maximize Removal + LD 8 Deterrent
Coordinate on the invasion front: Pools 14, 15, 19	✓	✓	✓	✓	✓
Coordinate on the invasion front: all UMR		✓			
Coordinate with partners on egg/larval monitoring: Pools 14 and 15	✓	✓	✓	✓	✓
Coordinate with partners on egg/larval monitoring: all UMR		✓			
Maximize influence on downstream management to align with MN priorities: Pools 14, 15, 19	✓	✓	✓	✓	✓
Maximize influence on downstream management to align with MN priorities: all UMR pools		✓			
Provide resources for interjurisdictional coordination		✓			

Appendix C – Invasive Carp Captured in Minnesota and border waters, 2012-2023



Total numbers of confirmed invasive carp in Minnesota, 2012-2023. Captures include Minnesota waters of both the Mississippi River and Missouri River basins. Note that the total for 2022 includes 140 invasive carp carcasses from a fish kill below Lake Bella in the Missouri River basin.

Appendix D - Map of Locks and Dams on the Mississippi River



Map created by USGS and reprinted with permission.