Final Abstract

Final Report Approved on November 4, 2024

M.L. 2021 Project Abstract

For the Period Ending June 30, 2024

Project Title: Evaluating Minnesotas Last Best Chance to Stop Carp

Project Manager: Peter Sorensen

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Funding Source:

Fiscal Year:

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 06f

Appropriation Amount: $424,000

Amount Spent: $414,264

Amount Remaining: $9,736

Sound bite of Project Outcomes and Results

This study used fish tracking to show that invasive carp typically pass Lock and Dam 5 via its lock and an engineering evaluation to demonstrate that a lock deterrent could be installed. Learning of this work, the legislature funded a carp lock deterrent to protect the river and its fisheries.

Overall Project Outcome and Results

In the late 1960s several species of invasive carp were imported from China to Arkansas which soon escaped into the Mississippi River. One of the most notable of these is the Silver Carp, Hypopthalmichthys molotrix ("Invasive carp"), a fish that feeds voraciously on plankton (i.e. the base of the food chain), thereby causing the collapse of native fisheries. The Silver Carp is also notable because it can jump to great heights, endangering boaters. Unfortunately, it has done well in the Mississippi River, where is presently reproducing and migrating north causing enormous damage to river fisheries. By 2020, Silver Carp were turning up in the waters of southern Minnesota. This study, which built upon previously funded LCCMR work, examined the possibility that the Silver Carp invasion might be substantially delayed at Lock and Dam 5 (LD5; Minnesota City). This particular location was of special interest both because: 1) it is at the leading edge of the Silver Carp invasion; 2) unlike most LDs, LD5's spillway gates typically open less than a few days a year suggesting its

spillway dam might not allow carp to pass through it and forcing all carp through its lock; and 3) its lock appeared amenable to a deterrent system. To address these issues this study: 1) tracked nearly 200 carp and other fishes below LD5 to document whether and how carp might pass this structure, and 2) worked with an engineering company to determine if an effective Carp deterrent known as a bioacoustic fish fence (BAFF) might be placed into its lock. We found no evidence that any fish could pass LD5's dam in any of our study summers (discharges < 100,000cfs) and that a BAFF could indeed be installed in LD5's lock for about $11 million. These results were summarized in reports.

Project Results Use and Dissemination

Our work was summarized by three articles in the Minneapolis StarTribune and the Outdoor News. It was also reported on the radio (NPR) as well as TV (KSTP). Finally, we made several presentations on our findings to the MN legislature as well as the annual meeting of the MN American Fisheries Society. A technical report on the BAFF was completed by Barr Engineering Co. and shared with numerous agencies. Finally, an article on how fish pass LD5's lock is now being written for the North American Journal of Fisheries Management, a scientific peer-reviewed journal.

Environment and Natural Resources Trust Fund

M.L. 2021 Approved Final Report

General Information

Date: December 6, 2024

ID Number: 2021-217

Staff Lead: Michael Varien

Project Title: Evaluating Minnesotas Last Best Chance to Stop Carp

Project Budget: $424,000

Project Manager Information

Name: Peter Sorensen

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Project Reporting

Final Report Approved: November 4, 2024

Reporting Status: Project Completed

Date of Last Action: November 4, 2024

Project Completion: June 30, 2024

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 06f

Appropriation Language: $424,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota, in cooperation with the United States Army Corps of Engineers and the Department of Natural Resources, to evaluate invasive carp passage and the costs, processes, and potential for a state-of-the-art deterrent system installed at Mississippi River Lock and Dam Number 5 to impede passage of invasive carp at this location to protect the upper river.

Appropriation End Date: June 30, 2024

Narrative

Project Summary: Invasive carp have breached Minnesota's southern border. The last place they can be stopped is Lock&Dam 5 but time is of the essence. This proposal enables this solution.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

In November 1963, invasive carp were imported from China to Arkansas. Within a decade these fish had been moved to about 30 other states, and by the early 1990s they had escaped into the central region of the Mississippi River where they now dominate food webs while native fisheries have collapsed. Because adult carp in the Mississippi River must pass through locks and dams, these structures have become the focus of efforts to stop these species from moving upriver. While the University of Minnesota (with funding from the LCCMR) has been conducting a test of an experimental sound/light carp deterrent at Lock&Dam 8 (LD8) on Minnesota's southern border, flooding 5 times more than average has been allowing carp to swim through its spillway gates and two overflow submersible spillways (unpublished data). On March 13, 2020, 51 adult invasive carp, more than enough to permit reproduction, were captured by a commercial fisher just a few miles upstream of LD8 in Pool 8. It is now clear that carp can no longer be stopped at LD8 and Pool 8. Fortunately, one very good opportunity remains, Lock & Dam 5.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

Lock & Dam 5 (LD5) is an extremely promising place to stop carp and has long been Sorensen's focus. Located upstream of LD8, the likelihood of LD5 flooding is less than 10% that of LD8; LD5 does not have overflow spillways, and the pool above it is too short to allow reproduction and is suitable for carp removal. A deterrent here is uniquely able to stop carp advancing into Lake Pepin, sparing the Minnesota, St Croix and upper Mississippi rivers. Further, LD5s lock appears suited to installing the sound/light/air bubble system (a bio-acoustic fish fence or BAFF) that the University (LCCMR funding) has shown to be 97% effective in the laboratory, and which is now being installed in Kentucky. Based on invasive carp movement rates downstream, it is likely they will take 5-10 years to reach LD5, enough time to install a BAFF if planning starts immediately. Mr. Fronhauer, DNR Invasive Fish Coordinator, states that "as a technical expert, I believe this is a solid project" but the DNR is "neutral as an agency"; it is seemingly unable to act at this time. This proposal fills this void and is submitted here because MAISRC does not support construction.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

This project will critically assess the fundamental suitability of LD5 as a site to install a BAFF carp deterrent, so that work could be completed before carp reach this location. A deterrent system at LD5 could protect the northern two-thirds of Minnesota from these species, which have decimated river fisheries in other states. We will evaluate the promise of this location, the construction challenges and costs (by completing a 10% design), and institutional processes that need to be involved. We would make it possible for a full feasibility study and construction to occur in time to make a difference.

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

In the Future

Activities and Milestones

Activity 1: 1.Determine the biological feasibility of stopping carp at LD5 -- assessing the permeability of its spillway gates to invasives

Activity Budget: $309,000

Activity Description:
Lock and Dam 5 (LD5) is 1612 feet long, of which only 110 feet is the lock (7%) and 1512 feet is spillway gates though which carp can also pass. (Fortunately LD5 has only 4 small overflow culverts that can be blocked). There is no point in adding a BAFF to LD5's lock if carp can pass through its adjacent spillway gates. Fortunately, the UMN's numeric models suggest that water velocities through spillway gates are too high for carp to pass except in rare times of flood when the gates are out of the water, but empirical proof is lacking. The proposed study will collect this proof by acoustically-tagging and releasing adult common carp (a good proxy for invasive silver carp) below LD5 for 2 full seasons (the minimum needed) and tracking their movement using automated archival receivers and manual boat tracking, focused on key locations upstream (the lock and large spillway gates). A small number of native fishes of concern to the state will also be examined. This approach has been successfully deployed at LD8 by the UMN and now in Kentucky. The UMN will be responsible for this activity and will have a draft report completed in 2022.

Activity Milestones:

Description	Approximate Completion Date
Identify locations to monitor carp passage and collect fall 2021 data	January 31, 2022
Track and analyze fall 2021 carp passage through the spillway gates and lock at LD5	May 31, 2022
Track and analyze carp and native fish passage rates in 2022 to assess LD5 permeability	November 30, 2022
Track and analyze carp and native fish passage in 2023, Complete final report on permeability	December 31, 2023

Activity 2: 2. Determine the feasibility and maximum cost of installing a state-of-the-art BAFF carp deterrent at Lock and Dam 5.

Activity Budget: $105,000

Activity Description:
While effective, BAFF technology is sophisticated and relatively expensive. It entails installing a speaker, light and air bubbler system along the river bottom at an angle downstream of locks in a manner that is protected from shipping. A 2015 visit by Fish Guidance Systems Ltd (FGS), developer of the BAFF, suggested it is feasible at LD5 but that costs could range between 2-5 million dollars depending on many variables. To provide a reasonable estimate of possible costs and identify risks to help the Legislature make an informed decision, information must be obtained on the needs of a BAFF installation relative to existing lock and dam infrastructure (platforms, power supplies, conduit leads, etc.), as well as bottom bathymetry and water velocities. The permitting process must also be examined with the U.S. Army Corps of Engineers, MN DNR, and other key stakeholders. A review of what a BAFF is and the promise of this technology is needed. Accordingly, a 10% design (the information needed to make critical decisions) will be completed by Barr Engineering Co. along with an AACE Class 3 cost estimate. Barr has experience with BAFF systems (in KY with FGS) and LDs in Minnesota.

Activity Milestones:

Description	Approximate Completion Date
Report on engineering requirements, feasibility, and 10% system design	January 31, 2022
Report on probable costs (with range), risks and suitability of a BAFF, and stakeholderange)	May 31, 2022

Final engineering report with complete assessment of BAFF technology and suitability	June 30, 2022

Activity 3: 3. Produce a report with a recommendation to the state on installing a BAFF deterrent at Lock and Dam 5

Activity Budget: $10,000

Activity Description:
Produce a report for the Legislature and others that summarizes both the engineering and biological assessment results as well as risks and costs of installing a BAFF at LD5. A recommendation will be included.

Activity Milestones:

Description	Approximate Completion Date
Draft data report on possible costs, risks and promise of a BAFF at LD5 for	March 31, 2023
Summary report on possible costs, risks, feasibility, and promise of a BAFF at LD5	June 30, 2023
Comprehensive report on the costs, risks, feasility, and promise of a LD5 BAFF carp deterrent system	December 31, 2023

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
Information will be provided as the project progresses to the Star Tribune and the Minnesota Aquatic invasive Species Center (this likely will be "partner" project). If results are novel, they will be published in scientific literature. Environment and Natural Resources Trust Fund will be acknowledged through use of attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgment Guidelines

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?
By early 2022 a draft report will be completed on the feasibility and likely cost (10% design) of installing a BAFF at Lock and Dam 5 (LD5), while data on carp passage and the suitability of the project will also be available so that rapid action could be taken by the 2022 Legislature to stop invasive carp from invading Minnesota. A final report will be completed in 2023 with additional data on fish passage at LD5. It is reasonable the next step after this study would be a 100% engineering assessment by the DNR (similar to LD1 in 2011).

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Install and Evaluate an Invasive Carp Deterrent for Mississippi River Locks and Dams	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 06e	$998,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Undergraduate summer field assistant		support for spring data analysis and summer data collection			0%	0.3		$25,000	-	-
Researcher 1		Field support staff for year 2 (key year) - to be provided by MN DNR as inkind support			36%	1		-	-	-
Research 4		Field scientist			36.5%	0.13		$8,200	-	-
Principle Investigator		To direct and manage the project while guiding the science			36%	0.9		$87,800	-	-
							Sub Total	**$121,000**	**$119,378**	**$1,622**
Contracts and Services										
Barr Engineering Company	Professional or Technical Service Contract	A team of engineers is needed to assess feasibility/cost of installing a BAFF which is complex/multi-faceted and then coordinate an online workshop/forum. Barr was selected after considering three firms and found the only company with all skill sets (engineering, fisheries, installation experience). Barr's rates were found competitive.				0.5		$105,000	$105,000	-
Make 2 custom-made metal hangers to hold fish tag receivers for use in the lock to detect carp	Internal services or fees (uncommon)	We need someone make to metal hangers to mount the receivers we use to detect fish tags inside of the lock's ladder wells. These need to be custom made. The University's machine shop can make these as an internal service				0		$6,500	$6,100	$400
Carp Solutions LLC	Professional or Technical Service Contract	This contractor will assist us capturing and tagging carp in the Mississippi River. This firm is uniquely qualified to do this work				0.32		$32,000	$31,167	$833

Part-time statistical consultant	Professional or Technical Service Contract	Hep us analyze new carp tagging data				0.14		$10,000	$10,000	-
							Sub Total	**$153,500**	**$152,267**	**$1,233**
Equipment, Tools, and Supplies										
	Tools and Supplies	200 implantable acoustic fish tags (@$400), 14 fish tag receivers (@$2500), misc field supplies (nets, boots, gas, etc; $9000), field laptop for data ($1000), software for data analysis ($1000) lab supplies to keep fish for testing, also field supplies ($3000)	We need acoustic tags to track the fish, tag receivers to detect/locate the fish, and misc field supplies for boat monitoring/setup to track carp as the fish attempt to swim through Lock and Dam 5, a field coputer to download data and software to run it. Also lab supplies to hold and test fish tags and fishthis effort					$129,000	$126,832	$2,168
							Sub Total	**$129,000**	**$126,832**	**$2,168**
Capital Expenditures										
							Sub Total	**-**	**-**	**-**
Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**
Travel In Minnesota										
	Miles/ Meals/ Lodging	travel to our field site, Lock and dam 5	need to get to field site from the university					$11,000	$8,855	$2,145
	Conference Registration Miles/ Meals/ Lodging	1 DNR fisheries conference	report results to the DNR and other agencies					$1,000	$542	$458

							Sub Total	**$12,000**	**$9,397**	**$2,603**
Travel Outside Minnesota										
							Sub Total	**-**	**-**	**-**
Printing and Publication										
	Publication	journal publication	disseminate information					$2,000	$524	$1,476
							Sub Total	**$2,000**	**$524**	**$1,476**
Other Expenses										
		Repairs	We will need to repair our field equipment (boat and truck)					$6,000	$5,756	$244
		Boat and equipment storage	We need store our boats, equipment and truck at our field site to save on transport expense					$500	$110	$390
							Sub Total	**$6,500**	**$5,866**	**$634**
							Grand Total	**$424,000**	**$414,264**	**$9,736**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount	$ Amount Spent	$ Amount Remaining
State						
			State Sub Total	**-**	**-**	**-**
Non-State						
			Non State Sub Total	**-**	**-**	**-**
			Funds Total	**-**	**-**	**-**

Attachments

Required Attachments

Visual Component

File: 5d3d1473-02f.pdf

Alternate Text for Visual Component

Lock and Dam 5 shown. It is located just south of Lake Pepin and in a location that it would shield the lake as well as the St. Croix River, Minnesota River and upper Mississippi River - most of Minnesota- from invasive carp. Its design (no overflows, short upstream pool)...

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
Letter of support from the Stop Carp Coalition (11 signatories)	b2eb8b6f-d72.pdf
Letter of support and partnership from U.S. Fish & Wildlife Service	d903eb54-cb2.pdf
Approval letter U of Minnesota	f600c2f7-0a4.pdf
Revised carp proposal "Evaluating Minnesota's last chance to stop carp"	374f23fa-bc7.pdf
Background check	9cfaa581-162.pdf
First Draft - Preliminary Engineering Assessment	d27c1299-73b.pdf
Engineering Assessment of the Feasibility and Estimated Cost of Installing a State-of-the-Art BAFF Carp Deterrent at Mississippi Lock and Dam 5 Mississippi River Lock and Dam No. 5	3edac6de-87c.pdf
Feely, Jane R., and Peter W. Sorensen. "Effects of an ensonified bubble curtain and a cyclic sound on blocking 10 species of fishes including 4 invasive carps in a laboratory flume." Biological Invasions 25.6 (2023): 1973-1989.	9eba43e2-87c.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Aside from minor editing, all changes are budgetary (the project was reduced by 75K). Fortunately, we were able to procure in-kind support from the MN DNR for a fish biologist (eliminating the need for a researcher 1 at the U). Barr Engineering then absorbed a $10 cut as did the U (salary, mostly Sorensen)

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Explanation & justification for Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	• Budget • Attachments • Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Printing and Publication • Budget - Other	No change in work just budget. The DNR pointed out we can improve the project by adding new tracking effort by tagging and monitoring carp on the east side of Lock and Dam 5 where we identified a small creek. To accomplish this we now need: 1) 4 additional tag receivers, misc supplies, undergrad help; 2) to hire a part-time statistician to help with analysis (services). Significant funds are available from travel which was over-budgeted.	December 20, 2022	Yes	January 30, 2023
2	Amendment Request	• Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences	I need another 15 carp tags ($400 x 15= $6000). To fund this I request moving $3000 from travel (not needed) and $3000 from contracts (not needed). thanks.	June 4, 2023	Yes	July 12, 2023
3	Completion Date	Previous Completion Date: 12/31/2023 New Completion Date: 04/30/2024	We need more time (and help - will ask for an amendment) to analyze the data	December 6, 2023	Yes	December 6, 2023
4	Amendment Request	• Budget - Professional / Technical Contracts	We request additional funding of $5000 to hire a statistical consultant to complete data analysis for Activity #1 in a timely fashion. This sum could come from the service portion of the budget which has a surplus because extreme weather prevented us from a contractor to sample fish this year as much as wanted/ had budgeted.	December 15, 2023	Yes	January 3, 2024
5	Completion Date	Previous Completion Date: 04/30/2024 New Completion Date: 06/30/2024	We need extra time to finish data analysis and possible collect and include spring-time data now that silver carp are present.	December 14, 2023	Yes	January 3, 2024
6	Amendment Request	• General Information • Other • Budget - Personnel	The project ends in 3 months and we need an increase in funding allocated to Personnel (PI and UG: +$20,000 to fully	March 14, 2024	Yes	April 10, 2024

		• Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Other	analyze and publish 3 years of results), while less funds are now needed for Field supplies/Equipment (-$6000), Contracts/services (-$11500), Other (Repairs -$2000 & Storage -$500) because only two one-day field trips now remain and one workshop to attend. This is a re-budget only, no change to deliverables.			

Status Update Reporting

Final Status Update August 14, 2024

Date Submitted: August 29, 2024

Date Approved: October 15, 2024

Overall Update

All three activities are now complete. Briefly, data analysis has been completed for all fish tracking (Activity #1). These analyses of 2020-2023 data show that no tagged fish passed Lock and Dam 5 (LD5) by any pathway other than by the lock. Further, of those fish that attempted to pass the lock most failed with only 25 of those that entered the lock passing and not silver carp. Most passages occurred with commercial vessels (see detailed report for Activity #1 below). A report on the feasibility of constructing a bioacoustic fish fence (BAFF) carp deterrent at LD5 was completed in 2023 (Activity #2). Finally, we prepared reports early 2024 on the BAFF carp deterrent for the legislature which were well received; the legislature eventually funded this project (Activity #3). We are now finishing a manuscript for peer-review (on our own time) which describes the passage data.

Activity 1

Data analysis of fish tag data collected in 2023 has now been completed. The results are interesting and promising as they describe how no fish passed LD5 again in 2023 except by its lock with no silver carp passing at all. Intriguingly nearly twice as many fish (common carp, bowfin, silver carp) entered the lock with commercial vessels than expected. In 2023, 36 of 44 common carp (69%) located below the lock entered it, but only 8 (21%) of these passed upstream with 73% of these doing so with a commercial barge even though barge traffic only comprised 33% of lock traffic. Similarly, in 2023, 9 of 10 (90%) bowfin found below the lock entered it, but only 3 (25%) passed, with 67% passages occurring with commercial vessels. Finally, 63% of all silver carp that entered the lock also did so with commercial vessels (none passed). Likely, a sill in the lock was blocking upstream passage and most fish entered with commercial vessels because they were louder than recreational vessels. Using our extension, we were able to place tag receivers on LD5 again in 2023 to capture information on passage during times of flooding which the DNR will harvest.
(This activity marked as complete as of this status update)

Activity 2

A detailed report on the carp deterrents was completed in late 2022 and then revised in early 2023.
(This activity marked as complete as of this status update)

Activity 3

Reports on the carp deterrent were submitted to the legislature in late 2023 and then again in spring 2024.
(This activity marked as complete as of this status update)

Dissemination

A Minneapolis StarTribune article was written on this work this past spring (Feb 15, March 22). A poster describing its findings was also presented at the Minnesota Chapter of the American Fisheries Society (February 26, 2024). Additional StarTribune articles were published March 22 and then again may 22 2024 that mention this work

Additional Status Update Reporting

Additional Status Update February 14, 2024

Date Submitted: March 14, 2024

Date Approved: April 10, 2024

Overall Update
not applicable (project is not complete yet- I am asking for extension through June 2024 please)

Activity 1
not applicable

Activity 2
not applicable

Activity 3
not applicable

Dissemination
not applicable

Status Update Reporting

Status Update December 1, 2023

Date Submitted: December 15, 2023

Date Approved: January 3, 2024

Overall Update

The project continues to go very well. We continue to work on Activity #1 (Assessing the permeability of Lock and Dam 5's spillway gates to carp passage), having already completed Activity #2 (Obtaining an estimate of installing a state of the art carp deterrent in Lock and Dam 5) as well as Activity #3 (Providing a report to the legislature about this project). Another summer of data was collected for Activity #1 and it is now being analyzed for the final report (see below). Fish tracking data clearly show that during the period we were able to sample (May-September) carp and other fishes cannot pass through the spillway gates at this key location although they do enter the lock, and will about 25% of the time then pass the lock. This is the third summer we have witnessed this trend: were a lock deterrent to be installed at Lock and Dam 5, it would have a large effect on overall invasive carp passage. To assist with detailed analysis, we have requested a 6 month extension, after which we will ask for funds to be allocated for analysis work via an amendment.

Activity 1

Nearly 100 common carp and native fish were captured this past summer (since our June report) by the UofMN, tagged and released below Lock and Dam 5 and then tracked using acoustic receivers as they moved upstream, and then attempted to pass this key dam. Initial analysis suggests of the 74 fish we released, 47 entered the lock, but only 14 passed upstream. No fish were seen to follow other pathways (spillway gates or culverts). We also collected data on 11 silver carp released by the MN DNR and USGS, and found that while 7 entered the lock, none of these passed this lock and dam when we were monitoring. Some of these fish were detected soon after the springtime floods we had this year. We are now analyzing lock passage in greater detail but it appears that a lock deterrent would be extremely effective at this location to stop invasive carp. Data analysis will be complete in a couple of months (hopefully with an amendment to allow for additional statistical analysis) for a final report.

Activity 2

This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 3

This activity was previously marked complete.
(This activity marked as complete as of this status update)

Dissemination

We gave a talk to the Minnesota senate this summer and entertained their visit to Lock and Dam 5.

Status Update Reporting

Status Update June 1, 2023

Date Submitted: June 4, 2023

Date Approved: July 12, 2023

Overall Update

For outcome #1, we have been accessing the permeability of the spillway gates at Lock and Dam #5 (LD5) to fish passage to assess whether a lock deterrent would be effective at this location; analysis of 2022 data found that it would because of 65 common carp released below LD5, not one passed via its spillway gates while 22 went through the lock. For Outcome #2, Barr Engineering Company has determined that a BAFF carp deterrent could be added to the lock and LD5 and provided AACE Class 4 cost estimates. Finally, for Outcome #3, a written and oral report on the possibility and cost of stopping invasive carp at LD#5 was provided to the Mn legislature and various other groups including the MN DNR.

Activity 1

1.Determine the biological feasibility of stopping carp at LD5 -- assessing the permeability of its spillway gates to invasive carp.

1) Track and analyze carp and native fish passage rates in 2022. Data analysis is now complete. 65 common carp were released below LD5, 22 of which passed upstream via its lock and 0 via its spillway gates. 29 native fish from 3 species were also released, 10 of which passed upstream via its lock while none passed via the spillway gates.

2) Track carp in 2021. Complete. 31 common carp released, 10 passed via the lock and 0 via the spillway gates.

3) Study design. Completed in 2021

4) Track and analyze carp and native fish passage in 2023. 18 tag receivers were deployed across LD5 in May 2023 as well as immediately upstream and downstream of this critical location. Since that time, we have tagged and released 8 common carp below LD5 while the MN DNR has released at least 6 silver carp (a large influx of adult silver carp occurred just below LD5 this year). The receivers are functioning collecting invaluable data now that will be shared. We hope to release 70-100 tagged fish this summer.

Activity 2

2. Determine the feasibility and maximum cost of installing a state-of-the-art BAFF carp deterrent at Lock and Dam 5, Barr Engineering Company was contracted to perform a 10% design for a BAFF, while examining permitting processes and contacting stakeholders. The final report shows it is both feasible and reasonable to add a BAFF to LD5.

1) Initial report. Complete (June 2022).

2) Final report. Completed (December 2022, see below)

3) Report on engineering requirements, feasibility and 10% design. The final report was complete November 2022 and was accepted, and distributed in December. It shows that it is both feasible and reasonable to add a BAFF to LD5's lock. It specifically demonstrates how such a system could designed (10% level) as well as costs for leasing (16.367 million/5 years) or purchasing (13.177 million). Permitting and maintenance are addressed, while a tentative construction schedule (2-4 years) is outlined.

(This activity marked as complete as of this status update)

Activity 3

3. Produce a report for the Legislature and others that summarizes both the engineering and biological assessment results as well as risks and costs of installing a BAFF at LD5. A recommendation will be included.

1) A powerpoint presentation was produced in April 2023 that summarized how a BAFF deterrent could be engineered and added to Lock and Dam #5 and how and why it would be reasonable to take this action from an ecological/biological perspective. A recommendation to install a BAFF was made. This report was presented orally to the Minnesota Senate

Committee on the Environment and a copy left for their records.
(This activity marked as complete as of this status update)

Dissemination

The findings of this study have been disseminated in several manners since December 2021:

1) A talk to the Minnesota American Fisheries Meeting
2) A talk to the Izaak Walton League
3) Two conversations and then articles with the Minnesopolius Star Tribune
4) A radio interview with MN MPR
5) A talk with the MN senate (see above)
6) A peer review publication:

Feely, Jane R., and Peter W. Sorensen. (2023) Effects of an ensonified bubble curtain and a cyclic sound on blocking 10 species of fishes including 4 invasive carps in a laboratory flume." Biological Invasions 25.6 (2023): 1973-1989.

Status Update Reporting

Status Update December 1, 2022

Date Submitted: December 20, 2022

Date Approved: January 30, 2023

Overall Update

The project is progressing very well. Protocols were established to catch, tag and track carp below Lock and Dam 5 (LD5) in 2021. Next, preliminary data on common carp movements around and through LD5 in 2021 were found to support the hypothesis that carp cannot pass the spillway gates of LD5, meaning that a lock deterrent would be effective. New fish tracking data from 2022 using common and invasive carp as well invasive carp, bolstered this hypothesis (Activity 1). Finally, initial design work for a possible carp deterrent in LD5's lock has been completed by Barr Engineering Company (Activity 2). In their final report Barr describes how installation of a BAFF carp deterrent in the lock at LD5 is both feasible and reasonable, and that this location is the only location south of Lake Pepin which could stop invasive carp. Cost is presently estimated to be about 16.367 million dollars with a precision of 30%. A public forum in July 2022 that included agencies addressed the possibility of installing a carp deterrent at LD5 and received positive feedback while no fatal flaws were identified. The concept is now being developed in a bill by the MN senate.

Activity 1

For Lock and Dam 5 to stop invasive carp it must block carp passage through its spillway gates and lock. This activity is examining the first possibility by catching, tagging, releasing, and tracking fish. Initial 2021 experiments suggested that carp do not normally pass through the spillway gates. A recently completed 2022 experiment adds further support for this possibility along with information on native fishes

-Milestone 1. Track carp and native fish passage rates in 2022.

65 common carp were tagged/released, 63 of which were detected with 53 swimming upstream into the lock, which 23% passed. No carp passed LD5 via the spillways. One silver carp was tracked into the lock 6 times but did not pass. 9 Bowfin were tagged, of which 7 entered the lock and 33% passed. 9 Drum were tagged, of which 8 entered the lock and 33% passed).

- Milestone 2. Track carp passage in 2021. Complete. See June report- no common carp passed via the lock but not the spillways gates.

-Milestone 3. Identify locations to monitor passage. Complete 2021.

-Milestone 4. Track and analyze passage in 2023. Not started.

Activity 2

If carp do not pass through LD5's spillway gates (Activity 1), then this invasion can be halted by blocking carp passage through LD5's lock. Activity 2 evaluated this by examining the feasibility of adding a deterrent system including a bioacoustic fish fence (BAFF) to LD5's lock. To provide an accurate estimate of costs and possible risks, Barr Engineering Company was contracted to perform a 10% design for a BAFF, while examining permitting processes and contacting stakeholders. The final report shows it is both feasible and reasonable to add a BAFF to LD5.

-Milestone 1. Initial report.

Complete (June 2022).

-Milestone 2. Final report.

Completed (see below)

- Milestone 3. Report on engineering requirements, feasibility and 10% design.

The final report is complete and shows that it is both feasible and reasonable to add a BAFF to LD5's lock. It specifically demonstrates how such a system could designed (10% level) as well as costs for leasing (16.367 million/5 years) or purchasing (13.177 million). Permitting and maintenance are addressed, while a tentative construction schedule (2-4

years) is outlined. Barr conducted listening sessions with MN DNR, USACE, and the general public and these forums, which did not identify significant flaws,

Activity 3
This activity has not yet started (as planned).

Dissemination
A manuscript on BAFF function (Feely and Sorensen) is currently in review at the Journal of Biological Invasions
As part of their contract, Barr Engineering held a virtual public stakeholder meeting July 12, 2022 to review their draft final report and any concerns about the possibility of installing a BAFF at LD5. All agencies and various environmental coalitions as well scientists and engineers were invited. There were approximately 200 attendees and great deal of largely positive feedback. No fatal flaws were disclosed. This information has been saved to website https://invasive-carp-forum-mn.barrevents.com/registration/form.

The MN DNR also held an online listening session the Barr final report November 15 2022. All local state and federal agencies were invited as well as Barr and the UMN. No significant flaws were seemingly identified.

Status Update Reporting

Status Update June 1, 2022

Date Submitted: May 17, 2022

Date Approved: May 19, 2022

Overall Update

The project has started and is progressing well. Protocols were established to catch, tag and track carp below Lock and Dam 5 in late summer 2021. Initial data supports the hypothesis that carp cannot pass the spillway gates of this lock and dam, and more data is now being collected (Activity 1). Additionally, initial design work for a possible carp deterrent in Lock and Dam 5's lock has now been completed by Barr Engineering Company (Activity 2). In their initial report about this work Barr Engineering describes how installation of a BAFF carp deterrent in the lock at LD5 is both feasible and reasonable, and that this location is the only one south of Lake Pepin which could stop invasive carp. The cost is presently estimated to be about 11.8 million dollars with a precision of 30%, with an increase in precision expected in the final report.

Activity 1

For Lock and Dam 5 to stop invasive carp it must block their passage through both its spillways gates and lock. This part of the project is examining the first possibility by catching, tagging, releasing, and tracking adult common carp (a proxy for invasive carp) below LD5's spillway gates. Protocols to accomplish this were established in 2021 and initial experiments conducted which show that carp cannot normally pass through the spillway gates:

-Milestone 1. Track and analyze carp and native fish passage rates in 2022.

Work is underway. A dozen common carp and native fish have been captured, tagged and released. Although we were not able to catch many carp, it may be because it is spring.

- Milestone 2. Track and analyze carp passage in 2021. 31 adult common carp were captured, tagged and released. 90% of these carp were detected again below LD5, with 81% entering the lock but only 26% passing. No carp were found to pass via the spillways.

-Milestone 3. Identify locations to monitor carp passage. We identified 8 locations (buoys and ladder wells) that carp can be monitored and implemented by attaching receivers.

-Milestone 4. Track and analyze passage in 2023. Not started.

Activity 2

If carp do not pass through LD5's spillway gates (Activity 1), then the invasion of these species would be halted if their passage through the lock were to be blocked. Activity 2 is evaluating this possibility by examining the feasibility of adding deterrent systems including a bioacoustic fish fence (BAFF) to LD5's lock. To provide an accurate estimate of costs and possible risks, Barr Engineering Company is performing a 10% design for a BAFF, while examining permitting processes and contacting stakeholders. An initial report has been completed and describes how it is both reasonable and possible to add a BAFF to LD5 and that this action would be highly likely to block carp and need not harm native fish:

-Milestone 1. Initial report on probable costs, risks and suitability of a BAFF.

This analysis/report has been completed and shared with the MNDNR, USACE, and LCCMR. It suggests that a BAFF is suitable at LD5 and would cost about 11.8 million dollars.

-Milestone 2. Final engineering report with complete assessment.

Underway.

- Milestone 3. Report on engineering requirements, feasibility and 10% design.

This analysis/ report is complete; initial construction design has been completed and engineering requirements identified.

Activity 3

This activity has not started (as planned).

Dissemination

The following papers have been published in peer-review literature:

1. Zielinski, D and P.W. Sorensen. 2021, Numeric simulation demonstrates that the upstream movement of 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), 10. doi.org/10.3390/fishes6020010
2. Riesgraf, A.T., Finger, J.S., Zielinski, D.P., Dennis III, C.E., Whitty, J.M., and P.W. Sorensen. (2022). Evaluation of a broadband sound projected from the gates of a navigation lock in the Mississippi River shows it to be a weak deterrent for common carp and unable to block passage. Management of Biological Invasions 13(1), 220-232. https://doi.org/10.3391/mbi.2022.13.1.13
3. Whitty, J.M., Riesgraf, A.T., Zielinski, D.P., and P.W. Sorensen. (2022). Movements of a model fish, the common carp, through a generic Mississippi River lock and dam demonstrate how fish swimming performance, behavior, and discharge-driven flow-fields determine fish passage rates in ways that can be predicted and modified using fish passage models. River Research and Applications. 38(4): 670-683.