

**Environment and Natural Resources Trust Fund  
2017 Request for Proposals (RFP)**

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**Project Title:**

**ENRTF ID: 195-K**

Lock-and-Dam #5 carp deterrent engineering and environmental groundwork

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**Category:** D. Aquatic and Terrestrial Invasive Species

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**Total Project Budget:** \$ 1,298,580

**Proposed Project Time Period for the Funding Requested:** July 2017 to December 2019

**Summary:**

This project implements two components of the carp deterrents at Lock and Dam #5 (native fish assessment/management, optimized gate operations) and accelerates the third (sound) with the DNR and USACE

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**Location**

**Region:** Statewide

**County Name:** Statewide

**City / Township:**

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**Alternate Text for Visual:**

Lock and Dam #5 where an invasive carp deterrent could be placed

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____ %



**PROJECT TITLE: Environmental and engineering groundwork for a carp deterrent at Lock and Dam #5**

**I. PROJECT STATEMENT**

Millions of bighead and silver carp (invasive carp) are living in the Mississippi River south of the Iowa border and moving north. Should they establish here, these voracious filter feeders would have lasting, detrimental ecological and economic impacts in Minnesota. It is critical to stop this invasion because there is no known technique to reduce carp numbers; adults are already entering Minnesota waters and could reach the threshold needed for successful breeding at any time. The Sorensen research team developed an integrated approach to stop carp based on the premise that: (1) strong native fish communities that consume carp eggs and young could be enhanced; (2) adult bighead and silver carp passage through the gates of locks and dams could be reduced by 90% or more by strategically altering gate operations to accelerate flows in ways that take advantage of their unremarkable swimming abilities and which are acceptable to the US Army Corps of Engineers (USACE); and (3) complex sounds strongly deter carp and could be played, perhaps with air curtains, in front of locks.

Lock and Dam #5, south of Lake Pepin, is the perfect location for this strategy because its gates are rarely out of the water (allowing near complete control of velocity), it lacks uncontrolled spillways, its lock appears suitable for sound, and it would shield the Minnesota, St. Croix, and Mississippi rivers. In March, the Sorensen team wrote a proposal for immediate implementation of this experimental scheme at Lock and Dam #5 using leased equipment but unexpectedly discovered that the University needed us to perform due diligence by completing a complex 5-part assessment before it could approve a proposal for any type of construction. Subsequently, a small proposal to conduct lab work on sound was hastily submitted to the LCCMR (117-D) to meet its deadline; the MN DNR has expressed interest in eventually pursuing yet-to-be-identified component(s) of the project after a feasibility study; and new ways to accelerate this complex administrative and scientific process have been identified. This proposal immediately addresses all of these processes including: (1) Assessing native fish communities above and below Lock and Dam #5 and their movement through it to determine whether and how it might be improved while also reducing carp passage (this would have immediate benefit as native fish passage here is problematic); (2) Testing and modeling sound in its lock (initial tests using gate-mounted speakers alone do not require construction, would inform/accelerate a feasibility study, and could stop carp while possibly saving millions if we eventually find an sound-air-curtain system is not necessary); (3) Developing an optimal set of sound and other cues for playback (replacing our earlier proposal 117-D); (4) Modeling gate function and fish passage at Lock and Dam #5 and working to implement these changes immediately (MAISRC has pledged to support this work if needed by re-budgeting but direct/full funding is preferred); and (5) Assisting the DNR with a feasibility study and design. If approved, this project would implement two key components of the carp deterrent in a year as well as accelerate the third, greatly advancing the overall project by what could be years.

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1:** *Assess fish community structure, abundance and passage at Lock and Dam #5, make recommendations to the DNR about how to enhance it and reduce carp numbers* **Budget:** \$592,030

Fish (including egg/ larval predators) will be surveyed above/ below Lock and Dam #5 for the first time using electrofishing and nets to determine community health and how it could be improved to stop carp. We will also monitor for invasive carp and collect samples for eDNA. Several hundred fish will also be tagged and passage through Lock and Dam #5 monitored to determine exactly how native fish passage could be enhanced in a targeted manner. Recommendations will be made; the first component of our deterrent will be implemented.

Outcome	Completion Date
1. Survey and enhance native fish community and movement near Lock and Dam #5	December 2019

**Activity 2:** *Quantify, model and test sound in and around the lock at Lock and Dam #5* **Budget:** \$194,520

We will measure background sound levels in and around Lock and Dam #5 to accelerate design of an acoustic deterrent and hence the feasibility study. Sound mapping will identify sources of noise that could mask the



**Environment and Natural Resources Trust Fund (ENRTF)**

**2017 Main Proposal**

**Project Title:** *Environmental and engineering groundwork for a carp deterrent at Lock and Dam #5*

deterrent. We will temporarily mount a speaker array on the lock gates to test their efficacy on common carp (a surrogate) using different sounds (Activity #3) with high resolution sonar and tagging (Activity #1) when the lock operates. The USACE will permit this work which will accelerate final implementation of sound and stop carp.

Outcome	Completion Date
1. <i>Measure ambient sound levels prior to deterrent installation</i>	<i>June 2018</i>
2. <i>Evaluate potential of speaker array to keep carp out of lock</i>	<i>December 2019</i>

**Activity 3:** *Identify the optimal combination of sound, light, and bubble curtains to deter invasive carp but not native fish* **Budget:** \$310,890

In the lab we will identify the characteristic(s) of sound that deters carps most efficiently and consistently and that affects native fish the least. Different sound spectra, temporal patterns, lights, and bubbles will be tested in partnership with Fish Guidance Systems Ltd., a company with over 20 years of experience implementing sound/light/bubble curtain deterrents. Ultimately this work must move to the field because fish and sound behave differently there, but work in the lab will provide proof-of-concept. This activity is also described in LCCMR project 117-D but it seems reasonable to integrate it with this project. It advances final implementation.

Outcome	Completion Date
1. <i>Test different frequencies and temporal patterns of sound on carp and 2 native fish in lab</i>	<i>June 2018</i>
2. <i>Test a combined light-sound-bubble curtain on carp and 2 native fish in lab</i>	<i>December 2018</i>

**Activity 4:** *Identify and implement changes to gate operation that stop carp passage* **Budget:** \$179,920

Dr. Zielinski will develop a new computational fluid dynamics model specifically for Lock and Dam #5 and then use his fish passage model to determine if and how carp and other fishes pass through it. He will use data from Activity #1 to improve the model and provide recommendations to the USACE by 2018 to modify gate operations to stop carp and allow native fish passage. Only Dr. Zielinski has the skills required to perform this analysis. This activity will implement the second key component of our invasive carp deterrent.

Outcome	Completion Date
1. <i>Model fish passage through Lock and Dam #5, initial recommendations to USACE</i>	<i>June 2018</i>
2. <i>Test, improve and revise fish passage analyses and recommendations for to USACE</i>	<i>December 2019</i>

**Activity 5:** *Assist with a feasibility study and possible design* **Budget:** \$21,220

We will provide recommendations to the MN DNR on how best to design, implement, and test a deterrent system. The feasibility study could also be used to determine if the University of Minnesota might install the carp deterrent as a leased demonstration project, an option that might have distinct administrative advantages.

Outcome	Completion Date
1. <i>Provide recommendations to design, implement, and test a carp deterrent</i>	<i>December 2019</i>

**I. PROJECT STRATEGY**

**A. Project Team/Partners**

**Receiving ENRTF money:** Sorensen- P.I. 8% salary; Zielinski – co-PI, engineering, modeling, 100% salary; 1 graduate student; 1 post-doctoral associate; 2 technicians, 1 MAISRC administrator

**Partners and collaborators:** MN DNR, USACE, USFWS, Fish Guidance Systems Ltd.

**B. Project Impact and Long-Term Strategy:** This project provides the groundwork to implement two components of an invasive carp deterrent scheme while accelerating the design of the third component. This one-of-a-kind system has genuine potential to protect Minnesota from bighead and silver carp for decades. Information will be applicable to other locks and dams in the Mississippi and Great Lakes Basins.

**C. Timeline Requirements:** This is a 2.5 year project (2017-2019).

## 2017 Detailed Project Budget

Project Title: *Environmental and engineering groundwork for a carp deterrent at Lock and Dam #5*

### IV. TOTAL ENRTF REQUEST BUDGET 2.5 years

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
<b>Personnel:</b>	
PI Sorensen (66.3% salary, 33.7% benefits), 8% FTE x 2.5 yr	\$ 41,000
co-PI Zielinski (66.3% salary, 33.7% benefits), 100% FTE x 2.5 yr	\$ 257,000
Post-doctoral Associate (77.6% salary, 22.4% benefits) 100% FTE x 2.5 yrs	\$ 157,000
Grad student (37% tuition, 9% benefits), 50% FTE x 2 yrs	\$ 85,000
2 x Technician (72.6% salary, 27.4% benefits) 100% FTE x 2 yrs	\$ 232,000
Undergraduate assistant (100% salary, 0% benefits), 0.24% FTE x 2 yrs	\$ 15,000
MAISRC Administrator (66.3% salary, 33.7% benefits) 2.5% FTE x 2.5 yrs	\$ 12,500
<b>Professional/Technical/Service Contracts:</b>	
Divers to install speakers (15k), Electrician (8k), USFWS Sidescan Sonar (Service Contract) (20k), Fish Lab Use Fee MAISRC (10k), and Equipment rental from Fish Guidance Systems (Lease extension) (14k)	\$ 67,000
<b>Equipment/Tools/Supplies:</b>	
Telemetry Equipment, batteries, and 450 CART tags (\$300 ea)	\$ 181,500
Field supplies (nets, gas for boat, anchors, etc.)	\$ 35,000
Noldus Fish Tracking System (lab) with dedicated computer for this and related data collection (Capital equipment)	\$ 25,000
Hydrophone array and portable recorder (Capital equipment)	\$ 7,000
Fish and Fish care supplies	\$ 15,000
Laboratory (20k) and office (500) supplies	\$ 25,500
<b>Travel:</b>	
Mileage, trunk lease, ins., fuel, lodging and meals for 5 workers at Lock and Dam #5 over 2 yrs	\$ 81,580
MN (7k) and domestic (18.5k) Travel to field sites in MN and adjacent states. Also attend workshops to present research findings and gather information on new advances in the field and share information with agencies. Travel includes lodging, food, mileage and vehicle lease/ rent	\$ 25,500
<b>Additional Budget Items:</b>	
Repairs and refurbishment for boat, nets, transmitters, electrofishing unit, hydrophones (30k), Boat Storage (2k), Shipping Fish Guidance Systems supplies from England (4k)	\$ 36,000
<b>TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =</b>	<b>\$ 1,298,580</b>

### V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
Other Non-State \$ To Be Applied To Project During Project Period:	N/A	
Other State \$ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period: <i>USACE will implement gate changes</i>	N/A	
<b>Funding History:</b> <i>ENRTF2012 ( \$1,032K for carp); ENRTF2013 (eDNA work \$703K); ENRTF2014 (\$854K), MN DNR (\$880K); USGS (\$130K)</i>	\$ 3,599,000	
<b>Remaining \$ From Current ENRTF Appropriation:</b> <i>\$203K unspent from ENRTF2013 Phase II; (also about \$180K from ENRTF2012 but fully obligated; \$398K from ENRTF2013 (Phase I) but fully obligated; about \$350K from ENRTF2014 but fully obligated)</i>	\$ 1,131,000	<i>203,000 available &amp; unobligated; \$928,000 fully obligated. The \$203,000, although not obligated, these funds are tentatively being held by Dr. Sorensen for a PhD student in case the 2017 requests are not funded</i>

**PROJECT TITLE:** Environmental and engineering groundwork for a carp deterrent at Lock and Dam #5 and Dam #5

Location of Lock and Dam #5 just downstream of Lake Pepin. When a carp deterrent system is implemented at this location, the entire state upstream of that location will be protected from invasive carp. This will include the St. Croix, Minnesota and Upper Mississippi rivers as shown by the dashed ring.



Lock and Dam #5

**PROJECT TITLE:** Environmental and engineering groundwork for a carp deterrent at Lock and Dam #5

**PETER W. SORENSEN, PROJECT MANAGER - QUALIFICATIONS**

Professor Peter Sorensen (Dept. Fisheries, Wildlife and Conservation Biology, U of MN) will assume overall responsibility for this project while working closely with Dr. Dan Zielinski, who will serve as co-Project Manager (see below). Dr. Sorensen is currently directing three other LCCMR projects on carp, including one on deterrents ends in 2017 and this one extends. Dr. Sorensen is the major professor for the Ph.D. graduate student, Clark Dennis, who will conduct the behavior experiments. Dr. Sorensen founded the Minnesota Aquatic Invasive Species Research Center (MAISRC) and was its director until 2014 before returning to the Faculty.

***Interests and expertise:***

Peter is broadly interested in aquatic invasive species and their control as well as the physiological basis of fish behavior and its ramifications for controlling invasive fish. Sensory cues including sound are of special interest as are pheromones, chemical signals that pass between members of the same species. He has been studying invasive fish since 1989. His goal is stop the invasion of bigheaded carps.

***Professional preparation:***

Bates College (Maine), Biology, B.A. 1976  
University of Rhode Island, Biological Oceanography, Ph.D., 1984  
University of Alberta, Zoology/Medical Science, Postdoctoral Fellow, 1984-1988.

***Recent experience:***

Assistant professor, 1988- 1993  
Associate professor, 1993-1997  
Professor, 1997-

***Grant management:*** Dr. Sorensen has received over 80 competitive grants while at the University of Minnesota worth over 25 million dollars.

***Publications:*** 145 peer-reviewed publications, 26 book chapters, 1 patent (sea lamprey pheromone identification and its use in control), 1 book, 30+ non-peer reviewed publications

***Graduate students:*** 26 total, 20 postdocs

***Teaching:*** Fish Physiology & Behavior, Marine Biology

**PROJECT ORGANIZATION**

Dr. Sorensen will serve as the scientific director for this project while Dr. Dan Zielinski will serve as co-Project Manager (and co-PI) and has a Ph.D. in engineering. Dr. Zielinski will oversee day-to-day operations of the entire project as well as reporting while also focusing on engineering components (Activities 2, 4, 5). Dr. Sorensen will oversee the activities of the Ph.D. student (Clark Dennis III) while working with Dr. Zielinski to coordinate activities with project partners including the MN DNR, U.S. Army Corps of Engineers, USFWS, and Fish Guidance Systems Ltd. Peter and Dan will meet weekly with the Post-doctoral associate and PhD student weekly and other partners monthly. The Associate Director of the MAISRC will also assist with project administration. We will have regular coordination meetings amongst all key collaborators and partners.