Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2014 Work Plan

Date of Report: May 21, 2014

Date of Next Status Update Report: February 28, 2015

Date of Work Plan Approval:

Project Completion Date: June 30 2017

Does this submission include an amendment request? _N_

PROJECT TITLE: Blocking Bighead, Silver, and Other Invasive Carp by Optimizing Lock and Dams

Project Manager: Peter Sorensen

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Location: Statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$854,000**
	Amount Spent:	**$0**
	Balance:	**$854,000**

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 04a

Appropriation Language:
$854,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to collaborate with the United States Army Corps of Engineers to develop ways, including new technologies, to modify the operations of Lock and Dam Numbers 2 to 8 to optimize their ability to impede invasive carp movement into the Minnesota, St. Croix, and Mississippi Rivers. This appropriation is available until June 30, 2017, by which time the project must be completed and final products delivered.

Note to reader: Silver (Hypophthalmichthys molitrix) and Bighead carp (H. nobilis) are collectively referred to as "Bigheaded carps" due to the fact that they both belong to the same genus, Hypophthalmichthys. Both of these fishes come from Asia and are invasive in the United States. Rather than use the common term "Asian carp," this proposal uses the more precise and appropriate term of "Bigheaded carp" to refer to these two species collectively. When describing a specific species, this proposal uses the species name.

I. PROJECT TITLE: Blocking Bighead, Silver, and Other Invasive Carp by Optimizing Lock and Dams

II. PROJECT STATEMENT:

Untold millions of invasive Silver and Bighead carp presently inhabit the Mississippi River below the Iowa border from where they threaten to invade Minnesota. This project proposes to solve this problem by developing a scheme to modify lock and dam structures in Minnesota by enhancing their deterent properties through four key, linked steps which are first summarized below and then explained in greater detail:

1) Activity #1 will install a safe carp deterrent in front of the lock at Lock and Dam #8 located at the Iowa border while guiding efforts to enhance and optimize velocity fields to stop carp movement through its gates while having minimal effects on native fishes.
2) Activity #2 will quantify the swimming capabilities of both species of adult Bigheaded carps, thereby producing the data needed to optimize dam function.
3) Activity #3 will identify acoustical deterrent systems that best deter carp from entering lock chambers which have minimal effects on native fishes.
4) Activity #4 will develop numeric solutions to eventually optimize dam operation at all Minnesota lock and dams (#2 through #8) to prevent Bigheaded carp invasion state-wide while having minimal effects on native fishes.

At present, the only impediment to the upstream invasion of Bigheaded carp into the Upper Mississippi River and its tributaries including the Minnesota and St. Croix Rivers are the lock and dams maintained by the US Army Corps of Engineers (USACE) (see Figure 1 for locations of lock and dams). These structures, which stretch the entire width of the river and can be tens of feet tall, function as a relatively complex system to control flows while maintaining constant depth to facilitate navigation. Each lock and dam contains a lock chamber which permits navigation and a series of gated spillways to regulate flow. The USACE is responsible for these structures and has for decades managed them using simple technologies and approaches to maintain minimal flows to reduce velocity and scour. However, the very characteristics that the USACE seeks to maintain (minimal velocity) are exactly those that promote carp passage. Surprisingly, the relatively simple possibility that lock and dam operation might be modified to both maintain their intended function and to deter Bigheaded carp movement has not yet been evaluated. It has generally been assumed that Bigheaded carps can readily traverse the lock and dam structures, yet emerging information on carp swimming performance shows this not to be correct (Hoover, Zielinski and Sorensen, unpublished): slight modifications to lock and dam function which slightly increase velocities to a constant level might hold them back. Recent discussions with the local St. Paul office of the USACE show that it is very willing to seriously consider modifying local lock and dam operations to impede carp movement if this can be accomplished without risking structural integrity, function, or safety (see below). The overarching objective of the project is thus to address the possibility that Minnesota can be spared from an invasion of Bigheaded carps by slightly modifying lock and dam structures and operations while have little effect on native fishes. A longer-term goal is to eventually further modify lock and dam operation to enhance native fish populations while also controlling the Bigheaded carps. This larger objective will require further study in the future. The Mississippi, St. Croix, and Minnesota rivers and their tributaries are invaluable biological resources that must be protected and enhanced for future generations.

The appropriation of $854,000 will be used to accomplish four closely related activities, whose final objective is to make explicit recommendations with (and to) the USACE for optimization of all Minnesota lock and dams (#2 through #8) to block the invasion of Bigheaded carps while still serving USACE needs and having minimal effects in native fishes. Activity #1 seeks to immediately block Bigheaded carps at Lock and Dam #8 (near the Iowa border) by identifying modifications to the gate operations to safely maximize velocities through the dam (higher velocities should deter Bigheaded carps) and installing an acoustic deterrent system, which has

special promise but is inexpensive and safe, in its lock chamber. Activity #2 will work with the research arm of the USACE to determine the actual swimming capabilies of adult Bigheaded carps (which have never been formally studied but appear unremarkable), so that they can be factored into optimizing lock and dam function – the USACE does not want higher velocities than absolutely necessary because of risks associated with safety and scour. Activity #3 will test various state-of-the-art acoustic deterrent systems, including water-guns, in a decommissioned lock chamber at Lock and Dam #1 (St. Paul, MN), to determine which might be most effective at repelling carps in a manner that is affordable and acceptable to the USACE and have minimal effects on native fishes. Finally, Activity #4 will apply the swimming performance data collected in Activity #2 with a statistical model of velocities in and around Lock and Dam #2 (Hastings, MN) and adapt a statistical model to identify modifications that might be made to gate operations for the Lock and Dam #2 through #8 in Minnesota to stop carp without causing scouring problems and having minimal effects on native fishes. The USACE has expressed great interest in this project by working with the University of Minnesota and to: 'cooperate …by providing staff support to share data, provide engineering drawings, assist in velocity measurements and participate in technical reviews… and evaluating suggested operational changes … and determining whether they could be implemented without adverse effect to navigation or undue risk to Corps infrastructure.' (R. Snyder, Project Manager USACE, May 31, 2013). Modifying lock and dam function is a safe and cost-effective solution to the 'Asian Carp' problem while having minimal impact on navigation or native fishes (unlike proposed electrical barriers). This project is the first step of a larger plan by Sorensen to eventually improve all fisheries in the Mississippi River by improving how all Minnesota Lock and Dams function though a series of coordinated field and laboratory studies.

III. PROJECT STATUS UPDATES:

Project Status as of 2/28/2015:

Project Status as of 8/31/2015:

Project Status as of 2/29/2016:

Project Status as of 8/31/2016:

Project Status as of 2/28/2017:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Immediate Development and Implementation of a Deterrent Strategy for Lock and Dam #8

Description: The goal of this activity is to immediately and safely maximize water velocity through the gates of Lock and Dam #8 near the Iowa border while deploying a simple and safe acoustical deterrent system in its lock chamber as a stop-gap measure. Stopping Bigheaded carps at this location is critical because once they move north, there are no good options to stop their further advance. Although several Bigheaded carps have been caught north of Lock and Dam #8 over the past 15 years, there is no indication of biologically-significant infestation or reproduction although their eggs were recently sampled below this location. This action is timely and might start before July 1, 2014 using funds from ongoing MAISRC projects. Work will proceed in several steps. First, we will install an array of acoustical deterrents (high-frequency underwater transducers [i.e. sophisticated speakers]) to prevent Bigheaded carp movement through the lock chamber. These devises, which are the highest amplitude sound devices we can obtain and afford, will be placed into extant slots in the lock chamber by divers who will also be guided by the USACE. Next, a 3-dimensional statistical model

(computational fluid dynamics [CFD] model) will be developed on the University supercomputer to calculate velocities in and around the structure under a wide range of environmental (temperature, river discharge, etc.) and operational conditions. Data provided by our partner, the USACE, will be used to validate the model. We will then identify changes to gate operation to safely maximize velocity through the gates because we assume that high velocities deter Bigheaded carps. Finally, we will optimize gate function by developing a novel computational tool to search through 3-D flow data from the CFD model, identify potential passageways (specific paths that fish might swim) through the dam, and pair these data with swimming capabilities of Bigheaded carps (Activity #2) to determine if successful passage is possible under varying conditions and then, if appropriate, how to stop it without increasing scour. Models would then be re-run to examine possible effects on native fish passage in a biologically meaningful manner. Limited time and resources restrict us to use two species as models for native fish in this initial project. Given this limitation, we need species that reflect a range of abilities and for which both swimming data and hearing thresholds are already available or can easily be obtained. Accordingly, Lake sturgeon (*Acipenser fulvescens*) and Brown trout (*Salmo trutta*) will be used since the swimming abilities of these fish are: 1) already well established (i.e.we do not need to collect new data and extant data can be easily integrated into the computer model) and represent the spectrum of fish swimming abilities (while the former has modest swimming abilties and is of special interest in the Mississippi River, the latter is able to maintain aerobic high swim speeds), and 2) both are available from hatcheries and/or wild fisheries for tests of deterent species-specificity (Activity #3). Notably, the swimming abilities of Lake Sturgeon are similar to another important native, the Shovelnose sturgeon (*Scaphirhynchus platorynchus*).. Although not of particular importance in the Mississippi River, the Brown trout was selected as a model species that represents the upper range of swimming abilities that are very similar to the native Brook trout (*Salevelinus fontinalis*), an important salmonid. Model results of Brown trout passage will be used to gauge the upper limit of fish swimming abilities on proposed gate modifications. Model results of sturgeon passage will be used to gauge the lower limit of fish swimming abilities on proposed gate modifications. Both Lake sturgeon and Brown trout are found in the vicinity of Lock and Dam #8. With assistance from the USACE, we will maintain and operate the deterrent system in Lock and Dam #8 during the 2015 and 2016 shipping season. The performance of this deterrent system on native and invasive fishes will also be evaluated as part of Activity #3 and by the U.S. Fish and Wildlife Service (USFWS) who have agreed to place monitoring stations in the vicinity for tagged native fish for us.

Summary Budget Information for Activity 1:

ENRTF Budget: $141,764
Amount Spent: $ 0
Balance: $141,764

Activity Completion Date:

Outcome	Completion Date	Budget
***1a**. Install acoustic deterrent array in lock chamber* ***1b.** Develop and validate computer model of Lock and Dam #8*	February, 2015	$59,276
2. *Make recommendations to USACE to improve gate operation at #8*	August, 2015	$42,492
***3**. Make recommendations to USACE to optimize gate operation at #8 using data from Bigheaded carp and native fish (Lake sturgeon and Brown trout)*	February, 2016	$39,996

Activity Status as of 2/28/2015:

Activity Status as of 8/31/2015:

Activity Status as of 2/29/2016:

Final Report Summary:

ACTIVITY 2: Quantify Adult Bigheaded Carps Swimming Capabilities

Description: Swimming performance data for adult carps are essential to accurately forecast passage and optimize gate function so that velocities are not higher than they needed (i.e. minimize scour). Although these data are available for juvenile Bigheaded carps (Hoover *et al.,* 2012), they are currently not available for adults and the USACE has no plans to collect them as they are not needed at the Chicago barrier for protecting the Great Lakes. The USACE research facility in Vicksburg (MS) is the only U.S. laboratory with the equipment (large swim tunnels) and expertise (Dr. Jan Hoover) needed to address this critical data gap. Swim speed-fatigue curves for a range of velocities, temperatures, and adult sizes of both species will be generated. Data will be collected during cool water temperatures (10±2°C) in the winter and warm water temperatures (25±2°C) in the summer, as swimming performance varies with water temperature. These experiments will provide essential relationships for modeling hypothetical Bigheaded carp passage through lock and dam structures (last step in Activity #1 and Activity #4), and thus how to block it. The Hoover lab will function as a partner and subcontractor. This laboratory has already generated promising preliminary data for the University of Minnesota using internal USACE funding.

Summary Budget Information for Activity 2:

ENRTF Budget: $ 156,454
Amount Spent: $ 0
Balance: $156,454

Activity Completion Date:

Outcome	Completion Date	Budget
1. *Evaluate swimming ability of Bigheaded carps at high temperatures*	February, 2015	$78,227
2. *Evaluate swimming ability of Bigheaded carps at low temperatures*	August, 2015	$78,227

Activity Status as of 2/28/2015:

Activity Status as of 8/31/2015:

Final Report Summary:

ACTIVITY 3: Test and Develop New Accoustical Deterrent Systems for Locks that Deter Carp and Have Minimal Effects on Native Fishes.

Description: Lock chambers present a potential way for Bigheaded carps to pass upstream, irrespective of gate function. Presently, the MN DNR is funding experiments on possible low voltage electrical fields ('sweeping') that might be placed into lock chambers to serve this purpose but these systems are experimental, extremely expensive (up to 8 million dollars per chamber), and not guaranteed to be approved for use by the USACE because of possible safety issues. An alternative approach would be to employ sound (acoustic) deterrents, but we do not yet know which acoustic technologies might be most effective or how to deploy them. Sound deterrents have special promise because carps are 'hearing specialists'; i.e. they have physiological specializations that make them uniquely sensitive to sound, and sound sources are safe (to humans and fish), relatively easy to mount, and inexpensive (costs are in the tens of thousands of dollars versus millions). We have been working with acoustical deterrents (ex. bubble curtains) for several years as have several other research groups. Three technologies have special promise: High-frequency underwater transducers (specialized underwater speakers,[these will also be installed at Lock and Dam #8]); 'hydro-' or 'water-' guns (implosive sound production devices used in oceanic seismic exploration) which produce pulsed acoustic waves; and 'boomer plates' (another oceanic seismic exploration device) which produce pulsed low frequency acoustic waves, will be considered as ways to exclude fish from the lock chambers without negatively impacting lock structures or navigation. This activity will have several steps and have both laboratory and field components.

Laboratory studies will evaluate the use of sound as a deterrent and allow us to develop it in ways that are not possible in the field because of logistical issues (ex. Bigheaded carps cannot be released and Lake Sturgeon are difficult to catch). Lab studies will also examine whether accoustical deterents might also repel Lake sturgeon, a low performance native fish of special interest and Brown trout, a high performance fish in lab arenas (these data will match up with Activity #1, see above). This work would take place in the winter and spring. Field work would take place in the summer in a decommissioned lock. In the first step of the field work , we will conduct pilot tests in a lock in 2014 to determine the best way to monitor fish (Common carp) near these technologies and pick one (or two) for formal testing in 2015. Underwater transducers will be initially tested in 2014 because they do not require special expertise and they will already be in placed in Lock and Dam #8. We will work with Dr. Jackson Gross from the research arm of Smith-Root Inc. (developer of water-gun and boomer plate concept, Vancouver, WA) at this time to identify technologies to be tested in 2015. As a second step in 2015, intensive study of at least one deterrent system will take place in a lock. All work will be conducted in a decommissioned auxiliary lock (Lock and Dam #1 [the 'Ford Dam'] in St. Paul) which the USACE has made available for our exclusive use and is providing assistance. Common carp will be used as a surrogate for Bigheaded carps because their hearing abilities and behaviors are seemingly identical to Bigheaded carps and they are already present in the river. The MN DNR will provide one part-time technician with a boat to capture carp. Advanced Telemetry Systems (ATS, Isanti, MN) will also be our partner and will provide expertise and if needed, fish tracking equipment gratis. Although the precise nature of the tracking gear and experiments has yet be determined (pilot experiments and the initial report in 2014 will accomplish this), it will involve capturing, tagging and then placing dozens of tagged adult common carp into the decommissioned lock chamber where their distribution and behavior will be monitored while acoustic devices are tested.

Summary Budget Information for Activity 3:

ENRTF Budget: $461,656
Amount Spent: $ 0
Balance: $464,646

Activity Completion Date:

Outcome	Completion Date	Budget
1a. *Pilot tests in a lock and evaluation of a variety of acoustical technologies including transducers and a report /decision on the most promising one(s) (Field).* **1b**. *Understand if native Lake sturgeon are repelled by sound in the same manner as carps (lab)*	February, 2015	$136,522
2. *Testing and documentation of effectiveness of at least one technology (likely water-gun) to repel carp within lock chamber #1 (Field).*	August, 2015	$152,939
3a. *Testing and documentation of effectiveness of another promising technology (likely boomer plates) to repel carp from lock chamber #1 (Field)* **3b**. *Understand if Brown trout are repelled by sound in the same manner as carps (lab)*	February, 2016	$118,128
4. *Report on the best technology to repel and exclude carp which should have minimal effects on native fish provided to USACE*	August, 2016	$54,068

Activity Status as of 2/28/2015:

Activity Status as of 8/31/2015:

Activity Status as of 2/29/2016:

Activity Status as of 8/31/2016:

Final Report Summary:

ACTIVITY 4: Develop Solutions to Address Weaknesses in Lock and Dam #2 and then Optimize Gate Operation for Lock and Dams #2 through #8

Description: The purpose of this activity is to identify potential weaknesses (scenarios by which carp might swim through the lock and dams) in Lock and Dam #2 (Hastings, MN) and then optimize gate operation to block Bigheaded carps throughout the entire lock and dam system in Minnesota including Lock and Dam #2 through #7 (Lock and Dam #8 is addressed by Activity #1). Lock and Dam #2 is of special interest because it maintains higher velocities than other dams, is ideally situated far from the invasion front, and is located downstream of the Minnesota River. As described in Activity #1, this work will proceed in several steps: 1) development of a 3-dimensional statistical model (computational fluid dynamics [CFD] model) to calculate velocities in and around the dam under a variety of operational conditions and river discharges; 2) acquisition of field measurements of velocities near the dam and use them to validate the CFD model; 3) development and then implementation of a new computational tool to search through 3-D velocity fields to identify specific weaknesses (i.e. swimming pathways) for Bigheaded carps and 4) pairing this information with swimming performance data (Activity #2) to determine how best to block carp passage without causing undue scour ('optimization') and having minimal effects on native fishes (Sturgeon and Trout). Fortunately, Lock and Dams #3 through #8 have similar geometries and operational characteristics so the computational model already developed for Lock and Dam #8 (Activity #1) can be used to optimize these structures. Results will be used in collaborative work with the USACE to develop new gate operation plans that optimally block Bigheaded carps throughout the Mississippi River while minimizing scour and which we fully expect the USACE will consider and then deploy.

Summary Budget Information for Activity 4:

ENRTF Budget: $94,126
Amount Spent: $ 0
Balance: $94,126

Activity Completion Date:

Outcome	Completion Date	Budget
1. *Develop and validate CFD model of Lock and Dam #2*	August, 2016	$42,063
2.*Identify weakness at Lock and Dam #2 and develop solutions to optimize gate operation based on Bigheaded carps swimming ability (Activity #2), report*	February, 2017	$42,063
3. *Identify weaknesses at Lock and Dams #3 through #7 and develop solutions to optimize gate operation based on Bigheaded carp and native fish, report.*	June, 2017	$10,000

Activity Status as of 2/28/2015:

Activity Status as of 8/31/2015:

Activity Status as of 2/29/2016:

Activity Status as of 8/31/2016:

Activity Status as of 2/28/2017:

Final Report Summary:

V. DISSEMINATION:

Description:
Results will be disseminated through technical reports to the USACE, scholarly publications in peer-reviewed journals such as *Fisheries Management and Ecology*, *Water Resources Research*, and *Ecological Modeling*. Results from the research project will also be presented at regional and national conferences such the *American Fisheries Society* conference. Results will also summarized on the Minnesota Aquatic Invasive Species Research Center's Webpage and Facebook pages.

Activity Status as of 2/28/2015:

Activity Status as of 8/31/2015:

Activity Status as of 2/29/2016:

Activity Status as of 8/31/2016:

Activity Status as of 2/28/2017:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview: .

Budget Category	$ Amount	Explanation
Personnel:	$ 412,677	Faculty: 6 weeks $18,600; 0.12 FTE Faculty: 2 weeks $12,000; 0.08 FTE Professional & Admin: $65,654 x 1 yr; 1 FTE) Post Doctoral Fellow: $60,600 x. 1.5 yr; 1.5 FTE Scientist: $48,000 x 2.25yr; 2.25 FTE Undergraduate: $2,000 (180 hrs) 0.1 FTE Undergraduate: $24,000 (20h/wk x 100 wk); 0.62 FTE
Professional/Technical/Service Contracts:	$326,651	(1) Services- office & gen oper. costs that are specific to the project $1,100 (printing/duplication, shipping, etc.) (2) Professional Services- lab & medical (Super-computing Intsitute (MSI) Resources) $2000 (3) Professional Services & contracts- Activity 2: $150,000 (US Army Corps of Engineers, Swimming performance tests of adult Bigheaded carps at Engineer Research and Development Center in Vicksburg, MS (Activity #2): Jan Hoover (Research Fisheries Biologist). Cost includes: Personnel (91%), Travel to field site (5%), Misc. equip. for swim tunnel (4%))

		(4) Professional Services & contracts- Activity 3: $20,000 DNR: 1 field technician and electrofishing boat(8mo over 2 summers) (5) Professional Services & contracts- Activity 3: $17,658 Smith Root Inc Pilot hydrogun test and predesign report (Senior biologist and travel) (6) Professional Services & contracts- Activity 3: $130,993 Smith-Root Water gun and boomer plate tests with report (6 wk equipment, supplies, biologist, technician; or UofMn Hydro) (7) Repairs- lab & field ACTIVITY 1: (speaker repair), ACTIVITY 3: various repair $4,900
Equipment/Tools/Supplies:	$59,804	(1) Supplies- office & gen oper. costs that are specific to the project (Software - modeling, misc. office supplies) $500 (2) Supplies- lab & field ACTIVITY 3: $47,054(Fish for lab and field experiments; fish holding supplies (food, nets, filters, etc); fish behavior supplies (cameras, recording devices); 2 x 200ft of 14/3 SO Cable for transducers; 2 Pontoon floats and supplies ($1000 ea)- for transducers; 150 radiotags (ATS F1835C - could also be accoustic)- fish radio tracking @$164.70; 1 receiver case (ATS)- fish radio tracking; AC-DC power supply (ATS)- fish radio tracking; coaxial cable for antennas-fish radio tracking; surgical supplies for implanting tags (sutures, scalpels, anethestec); misc field supplies; misc lab supplies) (3) Equipment- non capital lab & field ACTIVITY 1: $1,500 (Computer (high powered desktop)-modeling,) (4) Equipment- non capital lab & field ACTIVITY 3: $10,750 (11x Ant switchbox (x11) (14219 ATS)- fish radio tracking; 2 divider nets (12 x 60ft);Laptop Computer - for data collection;2 x CDi2000 amplifier to drive transducers ($1300 ea) – implementation;C75 Hydrophone and calibration ($1800 ea)- accoustical measurement for transducers;Portable recording device for use with hydrophone)
Capital Expenditures over $5,000:	$33,800	(1) Cap expenditures over $5,000: ACTIVITY 3: 2 LL1424HP under water transducers

		($8200 ea) - implementation, 3 Coded receiver datalogger- fish radio tracking ($5,800ea)
Other	$2,800	(1) Research-specific utilities ACTIVITY 1: (electricity to power transducers at Lock & Dam #8 (approx. cost 2 of 3 years), charge for phone line for alarm)
Travel:	$18,268	(1) Travel - MN ACTIVITY 1: $2,468 (8 trips (LD 8) x 350 miles/trip x 0.56/mi); Lodging (200/person/wk x 2days);Conference (Travel and Lodging) for researcher to formally present research findings and gather information on new advances in the field) (2) Travel - MN ACTIVITY 3: $2,628 38 wks x 100miles/wk x 0.56/mi), Conference Travel and Lodging (x2) for researcher to formally present research findings and gather information on new advances in the field (3) Travel - MN ACTIVITY 4: $672 6 trips (LD 2) x 200miles/trip x 0.56/mi) (4) Travel - Domestic ACTIVITY 1: $2,500 Conference (Travel and Lodging) for researcher to formally present research findings and gather information on new advances in the field (5) Travel - Domestic ACTIVITY 2: $2,500 (Airfare to Vicksburg, MS (2 x 600), Travel in Vicksburg, MS (a car x 1 wks), Lodging (1000/person/wk x 4 days)) (6) Travel - Domestic ACTIVITY 3: $5,000 Conference (Travel and Lodging) for researcher to formally present research findings and gather information on new advances in the field (7) Travel - Domestic ACTIVITY 4: $2,500 Conference (Travel and Lodging) for researcher to formally present research findings and gather information on new advances in the field **The scientific conferences budgeted here are for the researchers (only) to participate in formal presentations of project findings, as required by LCCMR policy. One of the most important ways for scientists to get ideas and feedback for advancing their work is to attend and present at scientific conferences. Conferences provide a unique and critical**

		opportunity for exchange of ideas that will likely lead to higher quality techniques, approaches, and outcomes on this project.
TOTAL ENRTF BUDGET:	**$854,000**	

Add or remove rows as needed

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than $5,000:
High-amplitude transducers ($8200 ea) are needed to safely produce sound that can repel carps in locks chambers. The two transducers are requested here for experiments at Lock and Dam #1 (Activity #3), and serve as back-ups for the system installed at Lock and Dam #8. 3 Coded receiver dataloggers ($5800 ea) are needed for fish radio tracking during the acoustic deterrent testing in the lock chamber at Lock and Dam #1 (Activity #3). After which time the dataloggers will continue to be used for invasive carp research at the Minnesota Aquatic Invasive Species Research Center.

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:
5.7 FTE

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:
4.25 FTE

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
US Army Corps of Engineers	$10,900	$10,900	For preliminary tests of Bigheaded carps swimming ability using the USACE swim tunnel in Vicksburg, MS, in Fall 2013
Smith Root Inc	$250,000	$0	In kind support including technician and equipment use (dollar value is an estimate and will not be tracked in this workplan)
ATS	$80,000	$0	In kind support including technician and equipment use (dollar value is an estimate and will not be tracked in this workplan)
State			
2012 ENRTF MAISRC	$69,700		For expedited purchase and installation of transducers at L&D #8
Private			
	$5,300	$	For expedited purchase and installation of transducers at L&D #8
TOTAL OTHER FUNDS:	**$ 415,900**	**$10,900**	

VII. PROJECT STRATEGY:

A. Project Partners:

US Army Corps of Engineers (USACE) - St. Paul (MN) office (R. Snyder): The USACE is providing us with all of their data from all lock and dam structures and offered to get more gratis. Their engineers will also review all of our models and work with us on reports. Additionally, they have offered to help maintain transducers at Lock and Dam #8. Full access for two years has been granted to the auxiliary lock chamber at Lock and Dam #1 along with limited technical support gratis. They already funded a Bigheaded carps swimming study for us. Finally, and most importantly, they will consider the possibility of implementing all suggestions from reports we generate together on lock and dam operations. All assistance is gratis. (Activities #1,2,3 and 4)

US Army Corps of Engineers (USACE) – Vicksburg (MS) office (Dr. J. Hoover): The USACE will conduct Bigheaded carp swimming tests at cost ($150,000 contract). (Activity #2)

MN DNR- St. Paul (MN) office (Nick Frohnauer). The MN DNR will provide one part time technician to help run experiments at Lock and Dam #1 (Activity #3) at cost ($20,000 contract). (Activity #3)

Smith Root Inc. (SRI) – Vancouver (WA) office (Dr. Jackson Gross). SRI is providing us with over $100,000 of biologist and technican time and approximately $150,000 of acoustic equipment for use in testing in Activity #3 as in-kind match. We will fund two contracts with them at cost, one for approximately $17,000 for a pre-report and set of recommendations on acoustic deterrent tests, another for about $130,000 if such tests are conducted. (Activity #3)

Advanced Telemetry Inc. (ATS) – Isanti (MN) office (Jon Amseth). ATS has offered to provide us with several weeks of engineering help gratis setting up fish tracking devises for Activity #3. They are also offering to provide us with nearly $80,000 of tracking equipment gratis and provide help with data analysis. (Activity #3).

US Fish and Wildlife Service: The USFWS has agreed to monitor fish movement in front of Lock and dam #8 for us using acoustic telemetry.

B. Project Impact and Long-term Strategy: This project will protect the Upper Mississippi, Minnesota, St. Croix rivers and their tributaries from the threat of Bigheaded carps while preserving native fish populations. Initially, this is accomplished by providing US Army Corps of Engineers with new operating procedures for lock and dams as well as recommendations for sound deterrents. With additional funding, modeling could eventually be conducted to maximize native fish passage. This project is a natural extension of previous work on fish deterrent systems and of current work at the Minnesota Aquatic Invasive Species Research Center to protect Minnesota's waters from invasive species including Bigheaded carps.

C. Spending History:

Funding Source	M.L. 2008 or FY09	M.L. 2009 or FY10	M.L. 2010 or FY11	M.L. 2011 or FY12-13	M.L. 2013 or FY14
ENRTF M.L. 2009 Chp.143, Sec. 2, Subd. 6d.		300,000			
Ramsey Washington Metro Watershed District: $207,600 (Common carp control, $100, 000 for barriers)		100,000			
Clean Water Fund M.L. 2012				1,800,000	

Chp. 264, Art. 2, Sec 4 (for the MAISRC)					
ENRTF M.L. 2012, Chp. 264, Art.4, Sec. 3 (for the MAISRC)				2,000,000	
ENRTF M.L. 2013, Chp. 52, Sec. 2, Subd. 06a (for the MAISRC)					8,700,000

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. VISUAL ELEMENT or MAP(S): Attached

X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET: N/A

XI. RESEARCH ADDENDUM: Attached

XII. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than 2/28/2015, 8/31/2015, 2/29/2016, 8/31/2016, and 2/28/2017. A final report and associated products will be submitted between June 30 and August 15, 2017.

Environment and Natural Resources Trust Fund

M.L. 2014 Project Budget Aquatic Invasive Species Research Center

Project Title: Blocking Bighead, Silver, and Other Invasive Carp by Optimizing Lock and Dams

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 04a

Project Manager: Peter Sorensen

Organization: University of Minnesota – Minnesota Aquatic Invasive Species Research Center

M.L. 2014 ENRTF Appropriation $ 854,000

Project Length and Completion Date: 3 Years, June 30, 2017

Date of Report: May 21, 2014

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	*Activity 1: Immediate Development and Implementation of a Deterrent Strategy for Lock and Dam #8*			*Activity 2: Quantify Adult Bigheaded Carps Swimming Capabilities*			*Activity 3: Test and Develop New Acoustical Deterrent Systems for Locks*			*Activity 4: Develop Solutions to Address Weaknesses in Lock and Dam #2 and then Optimize Gate Operation for Lock and Dams #2 through#8*					
BUDGET ITEM	**Activity 1 Budget**	**Amount Spent**	**Activity 1 Balance**	**Activity 2 Budget**	**Amount Spent**	**Activity 2 Balance**	**Activity 3 Budget**	**Amount Spent**	**Activity 3 Balance**	**Activity 4 Budget**	**Amount Spent**	**Activity 4 Balance**	**TOTAL BUDGET**	**TOTAL SPENT**	**TOTAL BALANCE**
Personnel (Wages and Benefits) - Total	$128,096		$128,096	$3,954		$3,954	$190,773		$190,773	$89,854		$89,854	$412,677	$0	$412,677
Professor: Peter Sorensen 6 weeks $18,600 (80.17%Salary, 19.83% benefits, 0.12 FTE [1 wk Activity 1, 1 wk Activity 2, 4 wks Activity 3,]															
Professor: Vaughan Voller 2 weeks * 1 yr $12,000 (80.17%Salary, 19.83% benefits, 0.08 FTE [2 weeks Activity 1]															
Professional & Admin: $ + $65,654 x 1 yr ((66.4 %Salary, 33.6% benefits, 1 FTE) [Activity 4]															
Post Doctoral Fellow: Dan Zielinski $60,600 x. 1.5 yr; (79.25 % salary, 20.75% benefits) 1.5 FTE [Activity 1]															
Scientist: $48,000 x 2.25yr (79.25% salary, 20.75% benefits) 2.25 FTE [Activity 3]															
Undergraduate Student: $24,000 (20h/wk x 100wk x $12/h) (93% salary, 7% benefits) 0.5 FTE [Activity 3]															
Undergraduate Student: $2000 (93% salary, 7% benefits) 0.1 FTE [Activity 4]															
Professional/Technical Services and Contracts - Total	$3,900	$0	$3,900	$150,000	$0	$150,000	$171,651	$0	$171,651	$1,100	$0	$1,100	$326,651	$0	$326,651
Services- office & gen oper. (printing/duplication, shipping, etc.)			$0			$0	$1,000		$1,000	$100		$100	$1,100	$0	$1,100
Services- lab & medical (Super-computing Intsitute (MSI) Resources)	$1,000		$1,000			$0			$0	$1,000		$1,000	$2,000	$0	$2,000
Professional Services & contracts- Activity 2: (US Army Corps of Engineers, Swimming performance tests of adult Asian carp at Engineer Research and Development Center in Vicksburg, MS (Activity #2): Jan Hoover (Research Fisheries Biologist). Cost includes: Personnel (91%), Travel to field site (5%), Misc. equip. for swim tunnel (4%))			$0	$150,000		$150,000			$0			$0	$150,000	$0	$150,000
Professional Services & contracts- Activity 3: DNR: 1 field technician and electrofishing boat(8mo over 2 summers)			$0			$0	$20,000		$20,000			$0	$20,000	$0	$20,000
Professional Services & contracts- Activity 3: Smith Root Inc Pilot hydrogun test and predesign report (Senior biologist and travel)			$0			$0	$17,658		$17,658			$0	$17,658	$0	$17,658
Professional Services & contracts- Activity 3: Smith-Root water gun and boomer plate tests with report (6 wk equipment, supplies, biologist, technician; or UofMn Hydro)			$0			$0	$130,993		$130,993			$0	$130,993	$0	$130,993
Repairs- lab & field ACTIVITY 1: (speaker repair), ACTIVITY 3: various repair	$2,900		$2,900			$0	$2,000		$2,000			$0	$4,900	$0	$4,900

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	*Activity 1: Immediate Development and Implementation of a Deterrent Strategy for Lock and Dam #8*			*Activity 2: Quantify Adult Bigheaded Carps Swimming Capabilities*			*Activity 3: Test and Develop New Acoustical Deterrent Systems for Locks*			*Activity 4: Develop Solutions to Address Weaknesses in Lock and Dam #2 and then Optimize Gate Operation for Lock and Dams #2 through#8*					
BUDGET ITEM	**Activity 1 Budget**	**Amount Spent**	**Activity 1 Balance**	**Activity 2 Budget**	**Amount Spent**	**Activity 2 Balance**	**Activity 3 Budget**	**Amount Spent**	**Activity 3 Balance**	**Activity 4 Budget**	**Amount Spent**	**Activity 4 Balance**	**TOTAL BUDGET**	**TOTAL SPENT**	**TOTAL BALANCE**
Equipment/Tools/Supplies - Total	$2,000	$0	$2,000	$0	$0	$0	$57,804	$0	$57,804	$0	$0	$0	$59,804	$0	$59,804
Supplies- office & gen oper. (Software - Act #1 modeling, misc. office supplies)	$500		$500			$0	$0		$0	$0		$0	$500	$0	$500
Supplies- lab & field ACTIVITY 3: (fish for lab and field experiments; fish holding supplies (food, nets, filters, etc); fish behavior supplies (cameras, recording devices); 2 x 200ft of 14/3 SO Cable for transducers; 2 Pontoon floats and supplies ($1000 ea)- for transducers; 150 radiotags (ATS F1835C - could also be accoustic)- fish radio tracking @$164.70; 1 receiver case (ATS)- fish radio tracking; AC-DC power supply (ATS)- fish radio tracking; coaxial cable for antennas-fish radio tracking; surgical supplies for implanting tags (sutures, scalpels, anethestec); misc field supplies; misc lab supplies)			$0			$0	$47,054		$47,054			$0	$47,054	$0	$47,054
Equipment- non capital lab & field ACTIVITY 1: (Computer (high powered desktop)-modeling)	$1,500		$1,500									$0	$1,500	$0	$1,500
Equipment- non capital lab & field ACTIVITY 3: 11x Ant switchbox (x11) (14219 ATS)- fish radio tracking, 2 divider nets (12 x 60ft), Laptop Computer - for data collection, 2 CDi2000 amplifiers to drive transducers - implimentation, C75 Hydrophone and calibration-accoustical measurement for transducers)			$0			$0	$10,750		$10,750			$0	$10,750	$0	$10,750
Capital Expenditures Over $5,000 - Total	$0	$0	$0	$0	$0	$0	$33,800	$0	$33,800	$0	$0	$0	$33,800	$0	$33,800
Cap expenditures over $5,000: ACTIVITY 3: 2 LL1424HP under water transducers ($8200 ea) - implimentation, 3 Coded receiver datalogger-fish radio tracking ($5800ea)			$0			$0	$33,800		$33,800			$0	$33,800	$0	$33,800
Other	$2,800	$0	$2,800	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,800	$0	$2,800
Research-specific utilities (when needed at a ROC e.g. for a research pond; specifics required for LCCMR approval); ACTIVITY 1 (electricity to power transducers at Lock & Dam #8 (approx. cost 2 of 3 years), charge for phone line for alarm)	$2,800		$2,800			$0	$0		$0			$0	$2,800	$0	$2,800
Travel - Total	$4,968	$0	$4,968	$2,500	$0	$2,500	$7,628	$0	$7,628	$3,172	$0	$3,172	$18,268	$0	$18,268
Travel - MN ACTIVITY 1: (8 trips (LD 8) x 350 miles/trip x 0.56/mi); Lodging (200/person/wk x 2days);Conference (Travel and Lodging) for researcher to formally present research findings and gather information on new advances in the field)	$2,468		$2,468			$0			$0			$0	$2,468	$0	$2,468
Travel - MN ACTIVITY 3: 38 wks x 100miles/wk x 0.56/mi), Conference Travel and Lodging (x2)			$0			$0	$2,628		$2,628			$0	$2,628	$0	$2,628
Travel - MN ACTIVITY 4: 6 trips (LD 2) x 200miles/trip x 0.56/mi)			$0			$0			$0	$672		$672	$672	$0	$672
Travel - Domestic ACTIVITY 1 Scientific Conference for researcher to formally present project findings for researcher to formally present research findings and gather information on new advances in the field (Travel and Lodging)	$2,500		$2,500			$0			$0			$0	$2,500	$0	$2,500
Travel - Domestic ACTIVITY 2 (Airfare to Vicksburg, MS (2 x 600), Travel in Vicksburg, MS (a car x 1 wks), Lodging (1000/person/wk x 4 days))			$0	$2,500		$2,500			$0			$0	$2,500	$0	$2,500
Travel - Domestic ACTIVITY 3 Scientific Conference for researcher to formally present project findings for researcher to formally present research findings and gather information on new advances in the field (Travel and Lodging)			$0			$0	$5,000		$5,000			$0	$5,000	$0	$5,000
Travel - Domestic ACTIVITY 4 Scientific Conference for researcher to formally present project findings for researcher to formally present research findings and gather information on new advances in the field (Travel and Lodging)			$0			$0			$0	$2,500		$2,500	$2,500	$0	$2,500
COLUMN TOTAL	**$141,764**	**$0**	**$141,764**	**$156,454**	**$0**	**$156,454**	**$461,656**	**$0**	**$461,656**	**$94,126**	**$0**	**$94,126**	**$854,000**	**$0**	**$854,000**

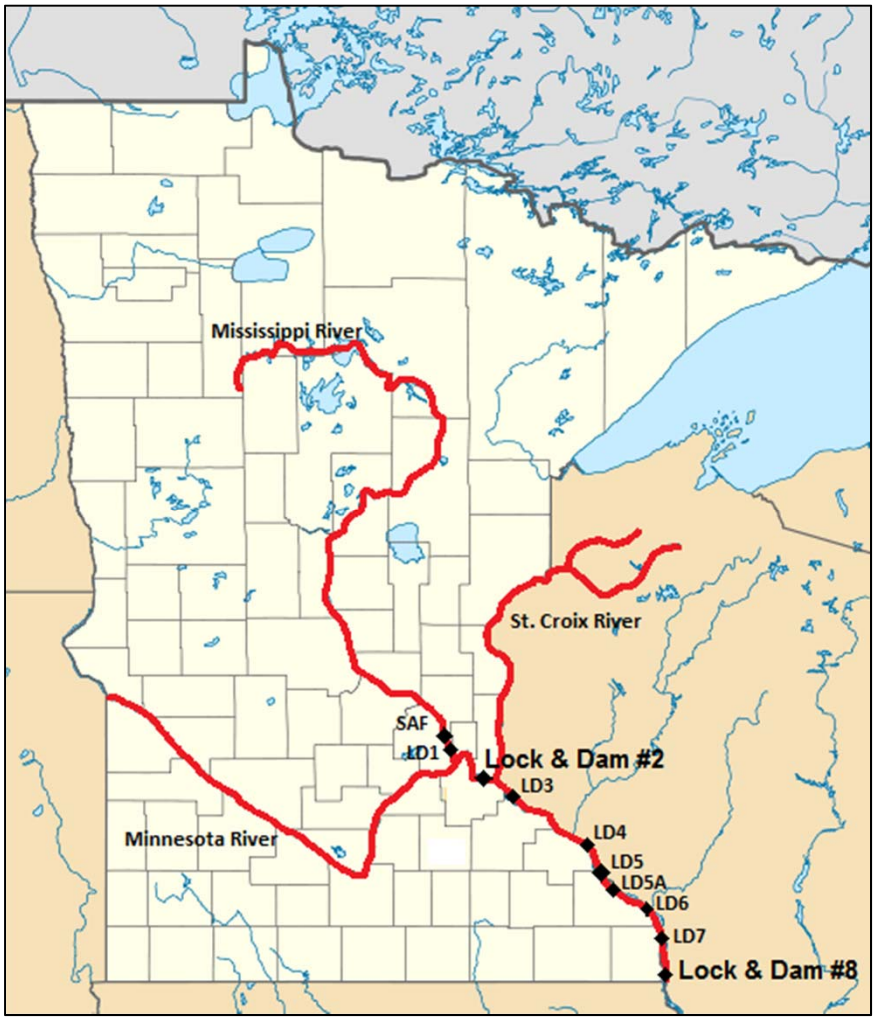

Figure 1. Map of large Minnesota rivers vulnerable to an invasion of Bigheaded carps, and dam structures that stand in the way. Presently, an electrical barrier is under evaluation for use at Lock and Dam #1 (LD #1)(St. Paul) which would only protect the Mississippi River. Optimizing Lock and Dam #2 (Hastings) through #8 (MN-IA border), through structural or operational modifications, would extend protection to nearly two-thirds of Minnesota.

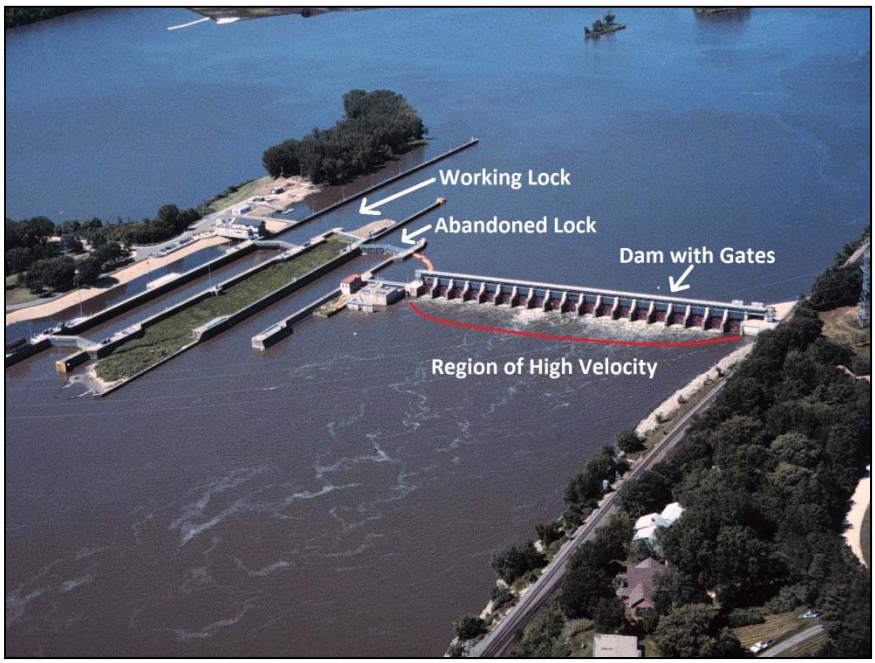

Figure 2. Upstream view of Lock and Dam #2. LD #2 maintains high head differentials which result in high discharge velocities that persist 10-20 m downstream, capable of deterring Bigheaded carps passage. Analysis of computational models will identify operational modifications to be implemented to enhance the deterrent function of Lock and Dam #2 through #8. Acoustic deterrents will also be examined for use in working lock chambers.