Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **097-D**

Blocking Asian Carp by Optimizing Lock and Dams

Category: D. Aquatic and Terrestrial Invasive Species

Total Project Budget: $ 463,449

Proposed Project Time Period for the Funding Requested: 3 Years, July 2014 - June 2017

Summary:

Working with the Army Corps of Engineers to develop simple ways to modify two lock and dams to stop Asian carp from invading the Minnesota, St. Croix, and Mississippi Rivers

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

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

PROJECT TITLE: Blocking Asian Carp by Optimizing Lock and Dams

I. PROJECT STATEMENT

Untold millions of Asian carp live in the Mississippi River below the Iowa border from where they threaten to invade Minnesota. Until control techniques can be developed, all that stands in their way is the lock and dam systems maintained by the US Army Corps of Engineers (USACE). The MN DNR is presently evaluating the possibility of adding a graduated electric field and sweeping field (considered experimental) to the lock at Lock and Dam #1 in St. Paul but it would not protect the Minnesota or St. Croix Rivers. Also, although electrical fields are effective, they are not 100% effective and their use may not be approved by the USACE. Surprisingly, the relatively simple possibility of evaluating and then optimizing the operations of the downstream lock and dams #2 (Hastings) and #5 (Winona) to block carp has not yet been considered. Rather, it has been generally assumed that carp can readily traverse them when their gates are open during high flows and that the USACE would be unwilling to modify operations to deter upstream movement. New information shows that these assumptions are likely not correct. First, recently released data on Asian carp swimming performance (Hoover *et al.* 2012) show that carp swimming abilities are rather ordinary (ex. sub-adult swimming speeds are 0.75 m/sec for 1 min). Second, hydraulic data we have obtained from USACE on Lock and Dams #2 and #5 shows that velocities are extraordinarily high (9 m/ sec) within 10 m of the gates. Further, our preliminary evaluation of the aforementioned data sets shows that Asian carp probably cannot pass the gates when open. New low-cost acoustical technologies (acoustic pulsed pressure technology ['hydro guns'] and continuous wave low frequency sonar) have recently become available and are able to push carp (which are highly sensitive to sound) out of the locks in Chicago (USACE , 2013). Additionally, the USACE has expressed willingness to work with the U of MN and: '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 USACE, May 31, 2013). The fact that carp took decades longer to move upstream through a series of dams (with spillways) than to move downstream (where there are no dams) suggests these structures have inherent ability to deter. Modifying lock and dam function could conceivably have no additional impact on commercial traffic, human safety, or native fish (unlike proposed new electrical barriers).

Our overarching goal is to develop inexpensive and safe means to block Asian carp passage into the Minnesota, Mississippi and St Croix Rivers by enhancing the deterrent properties of Lock and Dams #2 and #5 which are optimally positioned, have high velocity, and can be further manipulated. We will ascertain to what extent these lock and dams already deter passage of Asian carp and then determine whether carp passage can be further deterred by simple, acceptable changes in operations (ex. opening gates in different orders or extents) and/ or making minor structural changes (ex. adding sound speakers) while simultaneously developing new affordable means to prevent carp passage through associated lock structures.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Quantify Adult Asian Carp Swimming Capabilities **Budget: $172,489**

Swimming performance data for adult carp are essential to accurately forecast passage. Although these data are available for juvenile carp, they are currently not available for adults and the USACE has no plans to collect them as they are not needed in Chicago. 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 adult Asian carp sizes and temperatures will be generated. These experiments will provide essential relationships for modeling Asian carp passage through dam structures. A PhD at the U of MN will result. This information will be extremely useful in the construction of other carp barriers.

Outcome	Completion Date
1. Evaluate swimming capabilities of adult Asian carp at a high temperature	*Fall 2014*
2. Evaluate swimming capabilities of adult Asian carp at a low temperature	*Summer 2015*

Budget: $101,088

Activity 2: Evaluate the Current Ability of Lock and Dams to Block Asian Carp

A 3-dimensional computational fluid dynamics model (CFD) will be developed and then used to calculate hydraulics in and around Lock and Dams #2 and #5 under a wide range of environmental (temperature, flow, etc.) and operational conditions (ex. extent of gate opening). These data will then be analyzed together with fish swimming data (Activity #1) using a super computer to identify vulnerable pathways fish of different sizes might exploit under various conditions, evaluate whether carp are indeed blocked by the dams, and then how deterrence can be enhanced by making small changes to gate operations and/or minor structural modifications.

Outcome	Completion Date
1. Develop and validate CFD model of Lock and Dams #2 and #5	*Fall 2014*
2. Identify vulnerable pathways for Asian carp passage through the dams	*Summer 2015*
3. Evaluate ability of Asian carp passage under normal and modified operating conditions	*Spring 2016*

Activity 3: Develop New Lock Chamber Exclusion Technologies **Budget: $153,590**

Independent of the deterrent function of dams, lock chambers present a potential pathway for upstream passage for Asian carp. New low cost acoustic deterrent technologies such as hydro guns and low frequency acoustic sonar plates will be investigated as ways to herd fish out of lock chambers without negatively impacting lock structures. We will work with Dr. Jackson Gross of the research arm of Smith-Root Inc. (developer of this concept) to determine and optimize the effectiveness of these systems by performing *in situ* tests in the auxiliary lock chamber with common carp in Lock and Dam #1 (permission for use already granted by USACE).

Outcome	Completion Date
1. Complete in situ evaluation of hydro gun and low frequency sonar plates on carp	*Fall 2015*

Activity 4: Develop Modifications to Dam Operation to Optimize Ability to Impede Asian Carp Movement **Budget: $36,382**

Based on the findings of Activities #2 and #3, we will work with USACE to identify simple and acceptable operational (order, number and extent of gate opening) and /or minor structural modifications (addition of behavioral deterrents) to Lock and Dam #2 and #5 function that can improve their ability to block Asian carp.

Outcome	Completion Date
1. Final operational or structural modifications to optimize deterrent function	*Spring 2017*

III. PROJECT STRATEGY

A. Project Team/Partners

U of MN: Dr. Peter Sorensen (Professor): Project management, carp behavior; Dr. Vaughan Voller (Professor): Advice on modeling; Dr. Daniel Zielinski (Post-Doctoral Fellow): Modeling, fish passage analysis, coordination; **USACE –** Dr. Jan Hoover (Research Biologist, MS): Swimming performance (partner receiving funds and also providing in-kind support); Russ Snyder (Project Manager, St. Paul): cooperator providing in-kind staff support to obtain data on lock and dame operation and participating in technical reviews; **Smith Root Inc.:** Dr. Jackson Gross (Research Biologist): Lock chamber exclusion (partner receiving support and providing in-kind contribution of 50% salary and large equipment); **MN DNR –** Partner providing in-kind assistance with field tests.

B. Timeline Requirements

We need data on adult swim performance first. Lock deterrent information would be collected concurrently and implemented. Modeling will take a year and recommendations will follow. A total of 2.5 years is needed.

C. Long-Term Strategy and Future Funding Needs

Our long-term strategy is to develop intelligent, low-cost and socially acceptable ways to deter Asian carp invasion. At the very least, this project will provide enabling new information on Asian carp biology that can inform barrier design and management across the state as well as enabling information for risk analysis. Optimally, it will provide new, inexpensive and uncontroversial ways to block Asian carp using existing structures. The later scenario may require some additional applied research on carp biology and minor modifications to lock and dam structures as well as operations. Information will be applicable to other dams.

2014 Detailed Project Budget

Project Title: *Optimizing Lock&Dams Function to Impede Asian Carp Invasion*

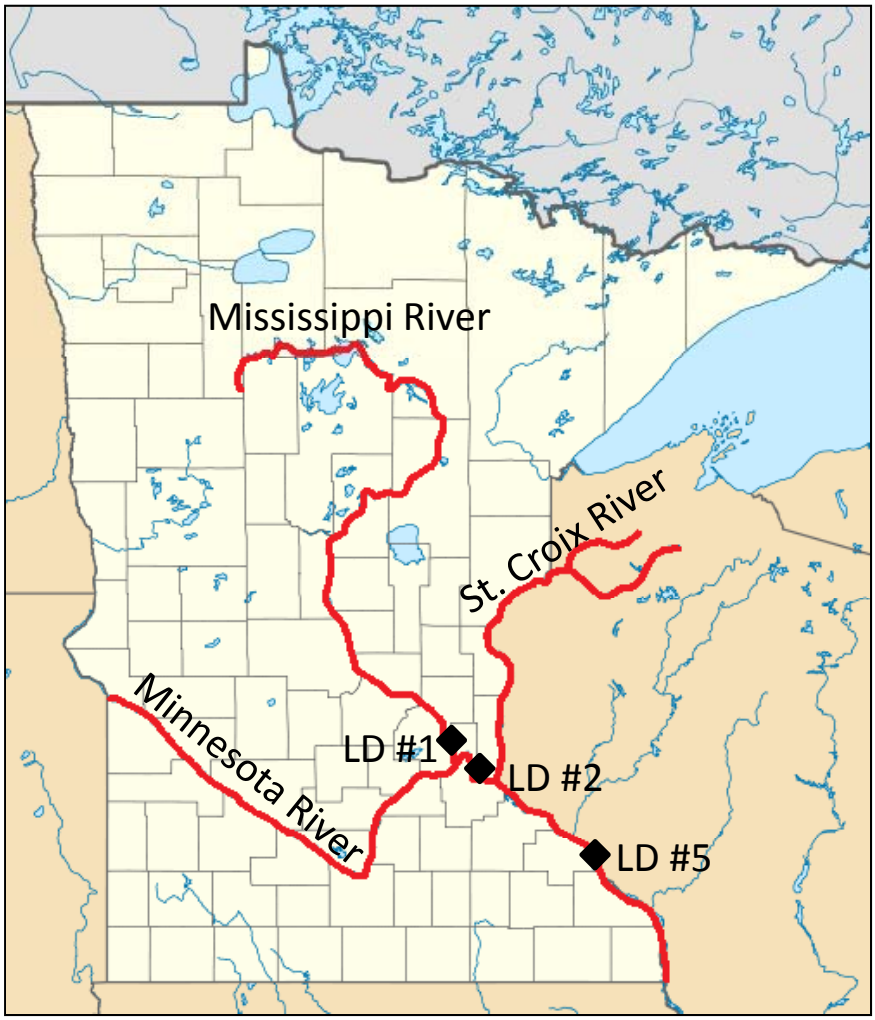
IV. TOTAL ENRTF REQUEST BUDGET 2 years 6 months

BUDGET ITEM	AMOUNT
Personnel:	$ 180,712
Professor: Peter Sorensen (33.07% benefits, 1wk/yr, yr 1 & 2.5) (1wk Activity #1, 1 wk Activity #4) (currently funded part time through the MN AIS Research Center) - $7,190	
Professor: Vaughan Voller (33.7% benefits,1 wk/yr, yrs. 1-2) (Activity #2) -$7,190	
Post-Doctoral Fellow: Daniel Zielinski (22.04% benefits, fulltime, yrs. 1-2.5) (10% Activity #1, 60% Activity #2, 10% Activity #3, 20% Activity #4)- $152,550	
2 Undergraduate Assistants (7.5% benefits, 160 hrs, yr 1) (Activity #3)- $4,472	
2 Field Technican (45% benefits, 1 month, yr 1) (Activity #3)- $11,600	
Contracts:	
US Army Corps of Engineers, Swimming performance tests of adult Asian carp at Engineer Research and Development Center in Vicksburg, MS (Activity #1): Jan Hoover (Research Fisheries Biologist). Cost includes: Personnel (91%) including U of MN student, Travel to field site (5%), Misc. equip. for swim tunnel (4%)	$ 150,000
Smith-Root Inc. *In situ* tests of water guns and Low Frequency Acoustic Plates to herd fish out of lock chamber (Activity #3): Dr. Jackson Gross (Research Scientist) Cost includes: Personnel (43%), Travel (28%), Equipment/monitoring devices (29%)	$ 97,205
Supplies	
Trap Net (Activity #3)	$ 10,000
Hydro-acoustics - Sidescan Sonar(Activity #3)	$ 15,000
Travel:	$ 7,532
Travel and lodging (2 weeks)for swimming performance tests in Vicksburg, MS (Activity #1)- $3,800	
Travel to Lock and Dam 2 and 5 (Activity #2)- $336	
Travel to Lock and Dam 1 (Activity #3)- $896	
Travel and lodging for Conference (Activity #4)- $2,500	
Additional Budget Items:	
Memory space purchase from Super Computing Institute (Activity #2)	$ 3,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 463,449

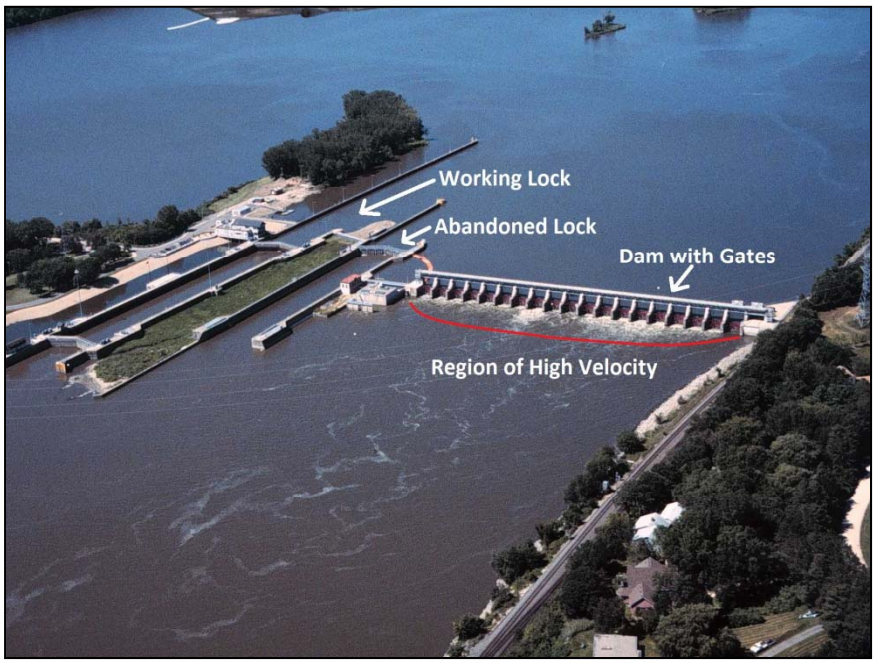
V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:.	*n/a*	*n/a*
Other State $ Being Applied to Project During Project Period: 52% MDTC	*$ 240,994*	*n/a*
In-kind Services During Project Period:		
US Army Corps of Engineers obtain velocity measurements around Lock&Dam 2 and 5 and time for consultation with US Army Corps of Engineers hydraulic engineers	*$ 9,000*	*committed*
Remaining $ from Current ENRTF Appropriation (for barriers):		
ENRTF: 2009 $300,000 (Carp barrier development)	*$ 45,000*	*obligated*
Remaining $ from Current ENRTF Appropriation (for MN AIS Research Center; does not include barrier work)		
ENRTF: 2012 $2,000,000 (Aquatic Invasive Species Cooperative Research)	*$ 1,713,094*	*committed*
ENRTF: 2013 $8,700,000 (Aquatic Invasive Species Research Center)	*$ 8,700,000*	*unspent*
Funding History (for barriers):	*$ 400,000*	
ENRTF: 2009 $300,000 (Carp barrier development)		
Ramsey Washington Metro Watershed District: 2009, $207,600 (Common carp control, $100, 000 for barriers)		
Funding History (for MN AIS Research Center; does not include barrier work):	*$ 12,500,000*	
Clean Water Fund: 2012 $1,800,000 (Aquatic Invasive Species Cooperative Research)		
ENRTF: 2012 $2,000,000 (Aquatic Invasive Species Cooperative Research)		
ENRTF: 2013 $8,700,000 (Aquatic Invasive Species Research Center)		

Sorensen(PI) – Blocking Asian Carp by Optimizing Lock and Dams



Map of large Minnesota rivers vulnerable to an Asian carp invasion, 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) and #5 (Winona), through structural or operational modifications, would extend protection to nearly two-thirds of Minnesota.



Upstream view of Lock and Dam #2. LD #2 and #5 maintain high head differentials on the gates which result in high discharge velocities, capable of deterring Asian carp passage. Analysis of computational models will identify operational modifications to enhance the deterrent function of gates. Acoustic deterrents will be examined for use in the working lock chambers.

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 which will join about a dozen others within the new Minnesota AIS Research Center (MAISRC) that he oversees. He has been directing MAISRC for the past year and has over two decades of experience studying invasive fish and directing projects that pertain to them. Mostly recently, he has served on Dan Zielinski's Ph.D. committee. Dan's Ph.D. is in civil engineering and is on carp barrier function.

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. Pheromones, chemical signals that pass between members of the same species, are of special interest as is their influence of fish movement and distribution. He has been studying invasive fish since 1989.

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-
Director of the MN AIS Research Center, 2012-

Grant management: Dr. Sorensen has received over 70 competitive grants while at the University of Minnesota and over 15 million dollars.

Publications: 125 peer-reviewed publications, 19 book chapters, 1 patent (sea lamprey pheromone identification and its use in control), 1 book, 25+ non-peer reviewed publications

Graduate students: 21 total, 19 postdocs

Teaching: Fish Physiology & Behavior, Marine Biology (guest lecturer)

PROJECT ORGANIZATION

Dr. Sorensen will serve as the scientific director of this project and oversee the activities of postdoctoral research associate, Dr. Daniel Zielinski, who will coordinate the day-to-day activities of the four sub-components while focusing on two and four which he will direct. Peter and Dan will meet weekly. The associate director of the MAISRC will also assist with project administration, bringing efficiencies. We will also have annual coordination meetings amongst all key collaborators (USACE, Smith-Root, U of MN) and to which we will invite the MN DNR.