

**Environment and Natural Resources Trust Fund
2012-2013 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 039-C1

Grounding the Flying Carp with Innovative Sound Technologies

Topic Area: C1. Invasive Species - Aquatic

Total Project Budget: \$ 256,169

Proposed Project Time Period for the Funding Requested: 3 yrs. July 2013 - June 2016

Other Non-State Funds: \$ 0

Summary:

To develop innovative sound technologies to determine what make carp jump and turn this behavior against the fish by using sound for fish detection, capture and developing boater safety devices.

Name: Allen Mensinger

Sponsoring Organization: U of MN - Duluth

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Duluth MN 55812

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Web Address: <http://www.d.umn.edu/biology>

Location

Region: Statewide, NE

County Name: Statewide, St. Louis

City / Township: Duluth

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



Environment and Natural Resources Trust Fund (ENRTF) 2012-2013 Main Proposal

PROJECT TITLE: Grounding the flying carp with innovative sound technologies

I. PROJECT STATEMENT

The Asian silver carp, one of four invasive carp species, is migrating north via the Mississippi River and threatening native fish in Minnesota rivers and lakes by outcompeting them for food supplies. Its unique jumping ability places recreational boaters in danger of being injured during collisions with airborne fish. However, this jumping ability is a weakness that can be exploited to detect, manage and control fish populations in addition to developing boater safety devices. The goals of this proposal are:

- 1) isolate the sound stimulus that causes the fish to jump and apply this information to develop identification and early detection systems**
- 2) develop management techniques to exhaust the fish on the surface or to herd the fish into shallow waters for capture and removal**
- 3) develop methods to modify the sound produced by boat motors or create devices that can be used by boaters to cause the fish to leap before the threat of impact**

We will determine the sound stimulus that causes the fish to jump. It is predicted that this sound will be of higher frequencies than most native and game fish and thus will not harm these species. Once the correct sound is determined, we will develop strategies to use underwater speakers to stimulate carp jumping in large outdoors tanks and then in infested rivers or lakes. The jumping episodes will be filmed with video cameras to ascertain if an early detection/identification system can be developed. We will then use sound to stimulate continuous jumping to exhaust the fish on the surface and/or use sound to herd the fish into shallow water or nets for easy capture. Finally, we will characterize the sound emitted by boat engines to determine if the sounds that cause the carp to jump can be reduced by modifying the sound produced by the motors. Additionally we will develop an inexpensive (<\$150) underwater speaker system that recreational boaters can use to amplify sounds using an iPod or smart phone to stimulate the carp to jump well in advance of the boat to eliminate the chance of collision.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: *Determining the sounds that make carp jump*

Budget: \$95,000

Silver carp of different size and age classes will be maintained at the UMD Research and Field Studies Center in large tanks. Both above and below water video cameras will be used to record fish behavior. Underwater speakers and hydrophones will generate and record sound respectively. Fish behavior (ie jumping) will be correlated with specific sound levels and frequencies. As fish behavior is related to age (size) and temperature, the sound will be tested on both juvenile and adult fish at different temperatures. Once the sound is characterized, we will travel to carp infested waters to determine if the sounds will initiate jumping in the wild. If so, then an early warning detection system will be developed consisting of a buoy with underwater speakers and above water cameras to monitor the presence or absence of carp in the system and their size and condition.

Outcome	Completion Date
1. <i>Determining the sound that makes carp jump</i>	<i>Summer 2014</i>
2. <i>Develop early warning/detection buoy system</i>	<i>Summer 2015</i>

Activity 2: **Using sound to exhaust and/or herd carp for easy capture**

Budget: \$90,000

Aerial jumps are energetically expensive for fish and salmon that migrate hundreds of miles upstream, need to rest before jumping successive water falls. If carp are stimulated to jump repeatedly, it may be

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possible to exhaust them to the point where they will float on the surface and easily be netted. Alternatively, several species of fish or aquatic mammals used sound to herd prey fish. Even if we cannot exhaust the fish, it is anticipated that multiple arrays of speakers could be used to concentrate the fish into shallows for capture. The advantage in using this technique for carp, is their jumping allows them to be tracked, and make the necessary adjustments to speaker location to corral the fish.

Outcome	Completion Date
<i>1. Using sound to stimulate multiple jumping in Silver carp to drive the fish to exhaustion for easy capture at the surface</i>	<i>Summer 2015</i>
<i>2. Using sound to drive or herd Silver carp onto the shore, into shallow water or into nets to remove carp from rivers and lakes</i>	<i>Summer 2015</i>

Activity 3: Boater safety

Budget: \$71,169

Carp are stimulated to jump by the sound of motorized watercraft. We will characterize the sound emitted by outboard motors to determine if the sound can be modified to decrease jumping. The initial tests will be conducted in the large tanks and if successful, field trials will be conducted in carp infested water. Additionally, we will develop a downloadable sound application for boaters to use with their smartphones that can be played through an inexpensive underwater speaker/amplifier to detect and/or stimulate carp to jump before the boat arrives in the area.

Outcome	Completion Date
<i>1. Modifying the sound emitted by outboard boat engines to reduce the chances of silver carp jumping</i>	<i>Summer 2016</i>
<i>2. Design a sound system for boaters that will cause the carp to jump well in advance of the boats and reduce injuries</i>	<i>Summer 2016</i>

III. PROJECT STRATEGY

A. Project Partners: Professor Allen Mensinger of the University of Minnesota Duluth who is an expert on fish sound and hearing will supervise all aspects of the project. Graduate students will come from the Integrated Biosciences Program and undergraduate students will be recruited from the Department of Biology at UMD. Mensinger will train the graduate students to develop the technology, conduct the experiments, and complete the field trials. Undergraduate students will be recruited to assist with the experiments. Mensinger will work with MN Sea Grant and the Great Lakes Aquarium to disseminate results to MN state residents.

B. Timeline Requirements: **Year 1** -Expansion of the outdoor aquatic facilities, sound testing experiments and develop carp detection systems using sound; **Year 2**- Experiments to exhaust the carp through repeated jumping or to herd them using sound to expedite capture and removal; **Year 3** – Develop boater safety strategies by modifying engine noise and developing early warning systems.

C. Long-Term Strategy: The overall goal of the project is to understand what make carp jump and turn this strategy against the fish. Outdoor tank and river/lake trials will be conducted to determine the efficacy of the above stated deliverables. These techniques/devices will be made available for interested parties (ie DNR) as part of a multipronged strategy to battle the invasive carp. When possible, the technology will be patented to provide future resources for the MN Environmental Trust Fund.

2012-2013 Detailed Project Budget

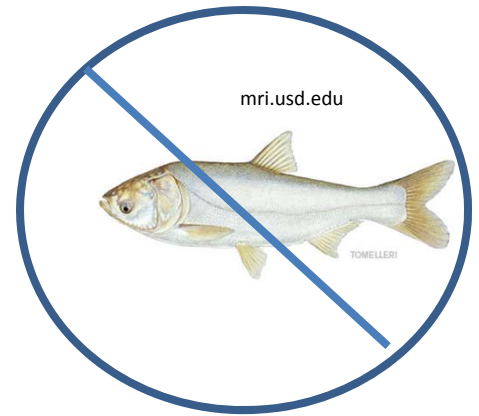
IV. TOTAL ENRTF REQUEST BUDGET 3 years

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
Personnel: PI Allen F. Mensinger PhD. The PI has a 9 month position at the University of Minnesota Duluth. A total of 3 months of summer salary (1 month /yr) is requested. Total reflects 73.5% salary and 26.5% fringe	\$ 34,960
Graduate student - support is requested for 36 months of support for one PhD graduate student. Total reflects 55.2% salary and 44.8% fringe	\$ 128,156
Graduate student summer salary. 50% summer salary is requested for one Masters student for 3 summers (total 4.5 months) 80.6% salary and 19.4% fringe	\$ 9,516
Undergraduate student summer salary: 2 months summer salary is requested for two undergraduate students each summer (total 12 months) 73.5% salary and 26.5% fringe	\$ 16,787
Equipment/Tools/Supplies:	\$ -
4 x 16' diameter above ground fish tanks @\$1800 each	\$ 7,200
Pumps, filters, heaters, chillers and plumbing for fish tanks	\$ 4,000
Fish food and water test kits (\$1000/year)	\$ 3,000
Underwater speakers, hydrophones and amplifiers	\$ 5,000
Video cameras (under and above water) and digital video recorders	\$ 5,000
Lumber to build tank observation platforms	\$ 2,500
Outboard boat motors to test what noise cause fish to jump	\$ 12,000
Travel - One week travel per summer for outdoor trials in areas of MN where the silver carp have been located. 3 trips * 2 people per trip. Rental car (\$300/week), lodging (\$750/week), meals (\$300/week)On	\$ 4,050
Additional Budget Items: Expand and secure the outdoor fish holding facilities at the UMD Research and Field Studies Center. A 40' x 40' concrete pad will be built to support the large fish tanks and surrounded by a 8' chain link fence to provide security for housing invasive species. Additionally, anti bird netting will be used to prevent birds from removing the fish. (note: these items will be retained at the end of the budget period to continue to investigate the effects of noise on native fish)	\$ 24,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 256,169

V. OTHER FUNDS

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
Other Non State \$ Being Applied to Project During Project Period: The Integrated Bioscience program will provide summer salary match for the masters student requested in the project (4.5 months summer salary)	\$ 9,516	<i>pending</i>
Undergraduate research opportunity grants are available from UMD to further support the undergraduate students selected for the this grant. Typically each student in the Mensinger lab is awarded \$1400 in support from this program each year	\$ 8,400	<i>pending</i>
UMD Indirect costs recovery funds from the UMD biology department. \$10,000 has been requested as a partial match to improving and expanding the fish holding facilities	\$ 10,000	<i>pending</i>
In-kind Services During Project Period: The PI (Mensingher) is on a 9 month academic appointment. He will provide two months of his academic year salary as in kind support for this proposal	\$ 79,324	secured
Remaining \$ from Current ENRTF Appropriation (if applicable): 2010 -2013 Bioacoustic Traps for Management of Round Goby \$175,000 The information gathered to date in this proposal has advanced our knowledge of using sound to control invasive species and will provide a solid foundation to continue this work in battling the silver carp	\$ 70,000	<i>Obligated to be spent on round goby grant by summer 2013</i>

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No carp zone = no fly zone

Determine what sound makes carp jump

- Detection
 - Use sound to detect and indentify carp
- Management , control and removal
 - Use sound to exhaust carp through jumping or
 - Herding them into shallows for easy capture
- Boater safety
 - Use sound to make carp jump in advance of boater collisions with airborne fish

Grounding the flying carp with innovative sound technologies

Dr. Allen Mensinger is a professor at the University of MN Duluth and is an expert on fish hearing. He has been working on sound producing fish and how fish interpret sound for over 20 yrs. He is currently developing with ENRTF funding a fish trap that uses sound to capture the invasive round goby. The laboratory recently has been the first to demonstrate the ability to lure round gobies into unbaited traps by just using sound and trials in the Duluth-Superior Harbor are scheduled this summer.

CURRICULUM VITAE

Allen F. Mensinger

Present position: Professor
University of Minnesota Duluth, Biology Department, Duluth, MN 55811

Areas of expertise: Fish bioacoustics, invasive fish and sensory physiology

Education: 1983 B.S. – Biology, Duke University, Durham, North Carolina
1991 Ph.D. University of California, Santa Barbara

Professional experience: 1991-94 Post-doctoral fellow, Vanderbilt University Nashville, TN.
1992 Grass Fellow in Neuroscience, Friday Harbor, Washington.
1994 Research Associate, Washington Univ. School of Medicine, St. Louis, MO.
1996-99 Research Instructor, Washington Univ. School of Medicine, St. Louis, MO.
1997-98 NASA Life Sciences Fellow, MBL, Woods Hole, MA
2000-05 Assistant Professor, University of Minnesota-Duluth
2005- Associate Professor, University of Minnesota Duluth
2010 Professor, University of MN Duluth

Relevant peer reviewed publications: (34 total publications)

- Lynch, M. P. and **A. F. Mensinger**. 2012. Temporal patterns in the growth and survival of the round goby (*Neogobius melanostomus*) over a 13 month period in the Duluth-Superior Harbor. *Journal of Fish Biology*. (submitted)
- Lynch, M. P. and A. F. Mensinger. 2012. Seasonal abundance and movement of the invasive round goby (*Neogobius melanostomus*) on rocky substrate in the Duluth-Superior Harbor of Lake Superior. *Ecology of Freshwater Fish*. 21:64-74.
- Bergstrom, M.A. and **A. F. Mensinger**. 2009. Interspecific resource competition between the invasive round goby and three native species: logperch, slimy sculpin and spoonhead sculpin. *Transactions of the American Fisheries Society*. 138:1009-1017
- Maruska, K. P. and **A. F. Mensinger**. 2009. Acoustic characteristics and variations in grunt vocalizations in the oyster toadfish *Opsanus tau*. *Environmental Biology of Fishes*. 84:325-337.
- Maruska, K. P., W. J. Korzan and **A. F. Mensinger**. 2009. Individual, temporal, and environmental-related variations in circulating 11-ketotestosterone and estradiol concentrations in the oyster toadfish *Opsanus tau*. *Comparative Biochemistry and Physiology A – Molecular and Integrative Physiology*. 152:569-578.
- Bergstrom, M. A., L. M. Evard and **A. F. Mensinger**. 2008. Distribution, abundance, and range expansion of the round goby, *Apollonia melanostoma*, in the Duluth-Superior Harbor and St. Louis River Estuary, 1998-2004. *Journal of Great Lakes Research*. 535-543.
- Palmer, L. M., M. Deffenbaugh and **A. F. Mensinger**. 2005. Sensitivity of the anterior lateral line to natural stimuli in the oyster toadfish, *Opsanus tau* (Linnaeus). *Journal of Experiment Biology*. 208:3441-3450.
- Richmond, H. E., T.R. Hrabik and **A. F. Mensinger**. 2004. Light intensity, prey detection and foraging mechanisms of age 0 year yellow perch. *Journal of Fish Biology* 65:195-205.

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