Environment and Natural Resources Trust Fund
2010 Request for Proposals (RFP)

LCCMR ID: 113-D

Project Title:

Bioacoustic Traps for Management of the Round Goby

LCCMR 2010 Funding Priority:

D. Invasive Species

Total Project Budget: $ $175,500

Proposed Project Time Period for the Funding Requested: 3 years, 2010 - 2013

Other Non-State Funds: $ $0

Summary:

We propose to develop a fish trap for the invasive round goby using novel bioacoustic technology, to provide early detection of its expansion, stop its spread, and reduce its population

Name: Allen Mensinger

Sponsoring Organization: U of MN - Duluth

Address: 1035 Kirby Dr

Duluth MN 55812

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Web Address:

Location:

Region: Statewide

County Name: St. Louis

City / Township: Duluth

_____ Knowledge Base _____ Broad App. _____ Innovation

_____ Leverage _____ Outcomes

_____ Partnerships _____ Urgency _____ TOTAL

MAIN PROPOSAL

PROJECT TITLE: Bioacoustic traps for management of the round goby

I. PROJECT STATEMENT

The round goby *Apollina melanostomus*, (formerly *Neogobius melanostomus*) is an aggressive, invasive fish that is firmly established throughout the Great Lakes. It competes directly with native benthic fish for food and space, and eats the eggs of important game species. Once established in an area, the population continues to expand and can drive native fishes to local extinction. Standard capture/control efforts such as trawling or poisoning are ineffective due to the round gobies' rocky habitat and wide distribution. Biological deterrents may offer the best chance at control, however effective predators have not been identified and potential pheromone control needs to be developed. Although underwater sound had been historically used as a fish deterrent (i.e. keeping fish away from power plant intakes), we propose to develop a novel bioacoustic trap that uses sound to capture the round goby. This novel technology will serve to: 1) stop further spread of the goby; 2) act as an early detection system to rapidly identify new infestations; 3) reduce round gobies population in infected areas and lessen the pressure on native fishes.

Although the round goby infestations were initially limited to the Great Lakes, the gobies are now migrating into pristine streams and tributaries of these Lakes (including Lake Superior) and threatening the Mississippi River watershed. This expansion pattern is consistent with the round goby population in the Duluth-Superior Harbor. Since their discovery in the harbor in 1994, round gobies have significantly impacted the native fish community and are migrating upstream into the St. Louis River and estuary. Their resiliency (i.e. they can survive for weeks in bait buckets, live wells), creates the potential for accidental or intentional infestation of Minnesota's lakes and streams where they could destroy entire ecosystems. Complicating the problem is that there is currently no reliable method to detect early invasions until they are already firmly established.

The overall goal of this project is to develop a bioacoustic trap to capture the round goby. Male round gobies use sound to attract females and therefore underwater sound can be used to lure gravid females to traps. One reason for the gobies' rapid increase is their prolific reproductive strategy, as females spawn multiple times throughout the spring and summer and overwhelm native fish which just spawn once per year. The bioacoustic traps will capture and destroy gravid females early in the year prior to spawning. Targeting the females will eventually stop migration or eliminate gobies in a given area and reduce competition for native species. The trap can be used as a tool for managers (ie DNR) to place at key chokepoints such as upstream in an infested river or in a newly invaded lake to remove gravid females from the population and prevent further spread. It can also be used as early detection tool that can sample for the round goby. The advantage of the trap is that it is species specific and will not harm native fish or the environment. It can also be used to control goby populations in an infested area by reducing their population and relieving the pressure on native fish.

A library of round goby sounds will be developed from hydrophone recordings in the field. Sound attraction experiments will be conducted in the laboratory to determine the optimal sound stimulus necessary to attract the round gobies. Traps will be manufactured and field trials will be conducted in the Duluth Superior Harbor and St. Louis River to test the efficacy of the traps. The field trials will allow us to continually modify the traps throughout the summer to maximize round goby capture.

II. DESCRIPTION OF PROJECT RESULTS

Result 1: Develop library of round goby sounds **Budget:** $ 52000

Multiple hydrophones will be placed throughout the Duluth Superior Harbor to record the sounds of the round goby. As fish vocalizations may be temperature and seasonally dependent, it is important to have an entire spawning season (May through September) of sounds. This will allow the sounds to be adjusted throughout the season in future years to optimally attract female gobies.

Deliverable	**Completion date**
1. Library of round goby sounds	June 2011

Result 2: Round goby sound attraction **Budget:** $ 53000

Underwater speakers will be placed in large (2 meter diameter) tanks in the laboratory. The round goby sounds (from result 1) will be played to female gobies. We will determine the optimal sound parameters (frequency, calling rate, amplitude) for round goby attraction.

Deliverable	Completion date
1. Optimal sounds to attract the round goby	December 2011

Result 3: Round goby bioacoustic traps **Budget:** $ 53500

Minnow traps will be modified into round goby bioacoustic traps that include an underwater speaker and large holding area (see attached figure). The traps will be placed throughout the Duluth-Superior Harbor and St. Louis River. Round goby sounds (result 2) will be played throughout the breeding season and the number female gobies captured will be compared to control traps (without sound).

Deliverable	Completion date
1. Round goby bioacoustic traps	October 2012

Result 4: Dissemination/publication of results **Budget:** $ 22000

All the results of the study will be published in peer reviewed publications. The round goby sound library will be placed on the PI's (Mensinger) web site and will be available for free download. Mensinger and the graduate student will present the results at the appropriate state, regional and national meetings. Mensinger also will be available to consult (at no charge) for the appropriate end users of this technology such as local, state and federal agencies including the DNR. The bioacoustic traps will be provided at cost to any interested party or agency in the state of Minnesota

Deliverable	Completion date
1. Peer reviewed manuscripts, sound library on website and presentations.	June 2013

III. PROJECT STRATEGY

A. Project Partners: Professor Allen Mensinger of the University of Minnesota Duluth will supervise all aspects of the project. He is an expert on fish bioacoustics and will assemble the bioacoustic library and plan the sound experiments. He will train the graduate student to conduct the sound experiments, build the traps and complete the field trials. Undergraduate students will be recruited to assist with the summer experiments.

B. Timeline Requirements: One complete spawning season (May to October) is needed to assemble the bioacoustic library. The mid summer start of the grant will delay its completion until 6/30/2011. We will begin laboratory sound experiments in January of 2011 with the partial library of goby sounds and complete the sound attraction experiments by December of 2011. The traps will be constructed in the winter of 2011-12 and deployed in the field throughout the spawning season of 2012. Modifications of the traps will continue throughout the 2012 season. Data analysis, manuscript preparation/publication and website generation will be completed by the summer of 2013.

C. Long-Term Strategy: The overall goal of the project is to develop a bioacoustic trap for the capture of round gobies. If successful, the appropriate state agencies (ie DNR) will be provided with the traps/acoustical library to manage this invasive species. The trap is designed to be lightweight, portable and economical (~$300 per trap) for use by a wide range of interested parties. A reasonable estimate at this time is that strings of 5 to 10 traps could be used to block upstream migration in rivers or streams and/or sample small lakes.

Project Budget

Bioacoustic traps for management of the round goby

IV. TOTAL PROJECT REQUEST BUDGET (3.0 yrs)

BUDGET ITEM *(See list of Eligible & Non-Eligible Costs, p. 13)*	**AMOUNT**
Personnel:	
PI Allen Mensinger Has 9 month appointment at University of MN Duluth one month summer salary is requested for 3 summers 75% salary, 25% fringe	$ 34,500
graduate research assistant 50% time, 36 months, 58% salary, 42% tuition/fringe	$ 109,000
Undergraduate research assistant 3 month summer stipend (2 summers) 75% salary, 25% fringe	$ 10,600
Contracts:	$ -
	$ -
Equipment/Tools/Supplies: hydrophones (5@$300) $1500; underwater speakers (10 @ $350), $3500; amplifiers 2 @$300, $600; data acquisition systems to record sounds and control speakers (2@$2500), $5000; fish traps (20@~$12), $250; supplies to modify traps/add holding area, $2000; gas for boat motor, $1000; electronics/cables supplies $1000; electronic storage device $250; large tanks/aquaria (2 m dia) (2@$500), $1000; water chiller for aquaria $2000; water test kits and chemicals $250.	$ 18,600
Travel: Travel by car with boat trailer to field sites. 2 spawning seasons (for sound library and traps). 80 miles rt per week. 20 weeks per year. @0.55/per mile	$ 1,800
Additional Budget Items: *In this column, list any additional budget items that do not fit above categories. List by item(s) or item type(s) and explain how number was reached.*	$ -
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$ 174,500

V. OTHER FUNDS

SOURCE OF FUNDS	**AMOUNT**	**Status**
The PI has a 9 month appt at UMD, 50% research/50% teaching. He will dedicate 2 months of academic year salary plus fringe per year as in kind support on the project for three years.	$ 66,300	

Bioacoustic traps for the management of the round goby

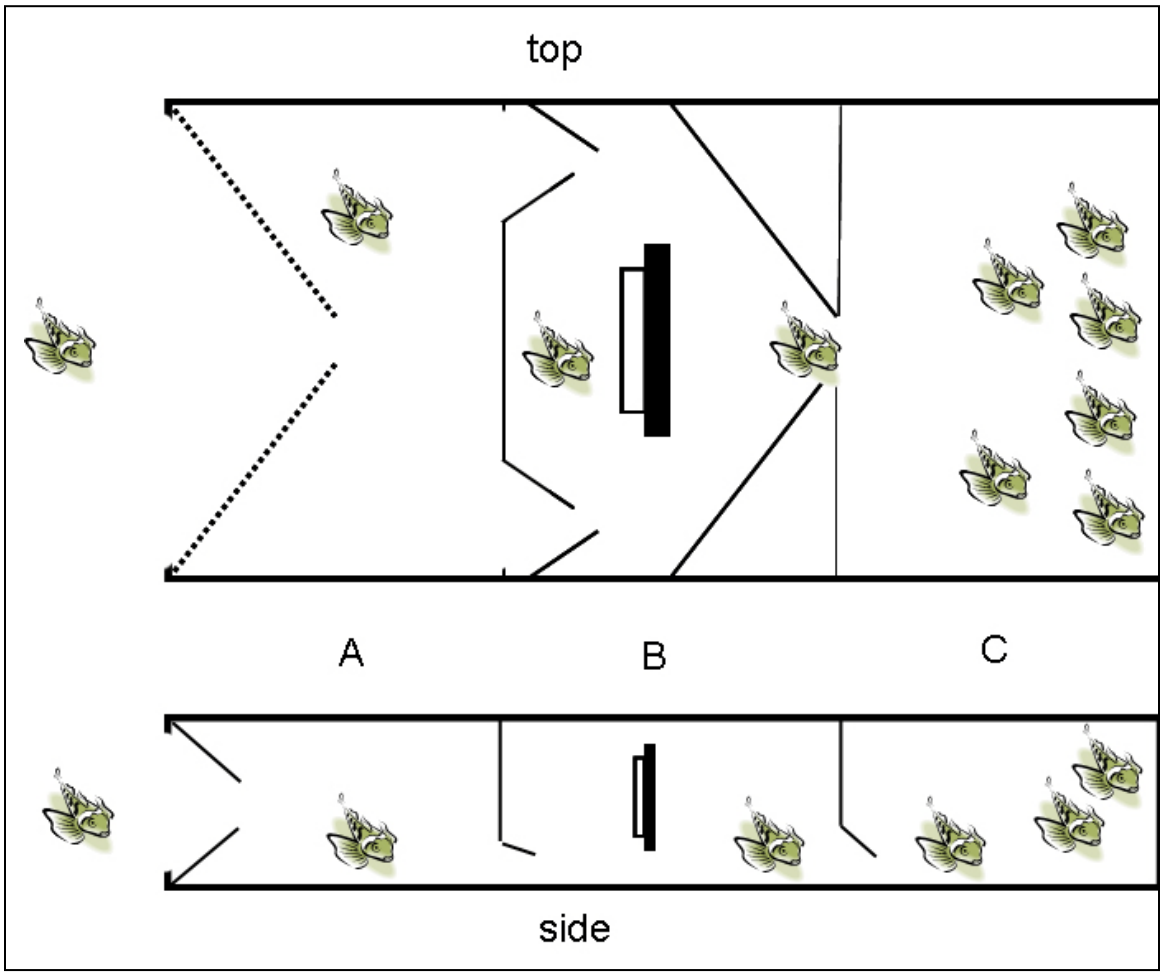

Figure 1 . Round goby bioacoustic trap. The schematic displays a top and side view of a prototype trap. The first two sections (A and B) are composed of fine wire netting from modified minnow traps. The terminal section C is opaque. One way funnel entrances/exits lead into each section of the trap. The speaker will be placed in section B and blocked from the fish's view by an opaque partition. Section A is the entrance to the trap, similar to a typical minnow trap. Section B contains the speaker and as gobies continue towards the sound, they will enter section B. As the sound will not be continuous, the gobies will seek a way out of the trap when sounds are not being broadcast and will be channeled into the end section. Section C is the terminal section which is "sealed" and detachable for holding large number of female gobies. Section C will be made of opaque material to prevent gobies from seeing large numbers of trapped females and prevent any spawning attempts by males outside the trap. It is designed as a "live" well which would need periodic (ie weekly) emptying and subsequent goby destruction. A more lethal design would need more frequent emptying and perhaps attract native fish to the decaying gobies.

CURRICULUM VITAE

Allen F. Mensinger

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

Areas of expertise: Fish bioacoustics, teleost sensory physiology and neural mechanisms of behavior.

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
2000-	Adjunct Scientist, Marine Biological Lab, Woods Hole, MA

Relevant peer reviewed publications: (33 total publications)

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*. In press.

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.

Palmer, L. M. and **A. F. Mensinger.** 2004**.** Effect of the anesthetic tricaine (MS-222) on nerve activity in the anterior lateral line of the oyster toadfish, *Opsanus tau. Journal of Neurophysiology*, 92: 1034 - 1041.

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.*

Mensinger, A. F. and M. Deffenbaugh. 2002. Acoustical neural telemetry from free-swimming-fish. *Bioacoustics*, 12:333-334.

Boyle, R., **A. F. Mensinger**, K. Yoshida, S. Usui, A. Intravaia, T. Tricas and S. M. Highstein. 2001. Neural readaptation to earth's gravity following return from space. *Journal of Neurophysiology*. 86:2118-2122

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