

2010 Project Abstract

For the Period Ending June 30, 2013

Project Manager: Allen F. Mensinger
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Web Site Address: <http://www.d.umn.edu/~amensing/toadfish.html>
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M. L. 2010, Ch. 362, Sec. 2, Subd. 6d

APPROPRIATION AMOUNT: \$ 175,000

Overall Project Outcome and Results

The bioacoustics of the round goby population in the Duluth-Superior Harbor were investigated over the course of three summers. The goal of the project was to assess the behavior and the sound production of this invasive species to develop a fish trap to target this invasive species. Fish were found to move offshore during the winter and thus subsequent concentrations were thought to have great potential for collection. However, fish were found to be inactive the majority of the winter and did not produce sound. Sound production coincided with the resumption of swimming activity and feeding in late spring with vocalization first recorded when water temperature exceeded 8 degrees C, which correlated with the initiation of spawning. Two choice experimental trials succeeded in attracting the fish to sound sources using both pure tones and round goby vocalizations, indicating that fish can find the origin of sound. Several different traps were produced and bioacoustical field trials were conducted. We were able to capture, for the first time, round gobies in unbaited traps using sound as the only stimulus and observed many round gobies approach sound sources but fail to enter the traps. As they readily enter the same traps when baited, it was concluded that although sound is an effective attractant, it is not the only sensory modality that round goby use to approach calling males. Future experiments that would combine sound with a large sexually mature fish and/or pheromones could significantly increase the number of fish that enter the trap and could prove to be an effective strategy.

Project Results Use and Dissemination

- 1) Project manager collaborated with the Great Lakes aquarium to produce a audio video exhibit on invasive fish**
- 2) Two master's student, Jared Leino (degree pending) and Elise Cordo (degree in progress), received funding from the project and five undergraduate students received funding for summer research.**

Manuscripts in preparation

Cordo, E and A. F. Mensinger. Seasonal changes in the bioacoustics of the round goby.

Leino, J. and A. F. Mensinger. Age and size distribution of the round goby (*Neogobius melanostomus*) in the Duluth-Superior Harbor. In revision for resubmission to Transactions of the American Fisheries Society

Leino, J. and A. F. Mensinger. Competitive interactions between the round goby and log perch in the Duluth-Superior Harbor.

Leino, J. and A. F. Mensinger. The benthic assemblage of fishes in the Duluth Superior Harbor from 1990 to 2012.

Bioacoustic Traps for Management of Round Goby

Environment and Natural Resources Trust Fund (ENRTF) 2010 Work Program Final Report

Date of Report: 12/1/2013

Final Report

Date of Work Program Approval: 6/20/2010

Project Completion Date: June 30, 2013

I. PROJECT TITLE: Bioacoustic Traps for Management of Round Goby

Project Manager: Allen F. Mensinger
Affiliation: University of Minnesota Duluth
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Web Site Address: <http://www.d.umn.edu/~amensing/toadfish.html>

Location: *The Duluth-Superior Harbor and Lower St. Louis River, St. Louis County, Carlton County, Duluth*

Total ENRTF Project Budget:	ENRTF Appropriation	\$ 175,000
	Minus Amount Spent:	\$ 166,382
	Equal Balance:	\$ 8,618

Legal Citation: M.L. 2010, Chp. 362, Sec. 2, Subd. 6d

Appropriation Language:

\$175,000 is from the trust fund to the Board of Regents of the University of Minnesota to evaluate bioacoustic technology specific to invasive round goby in Lake Superior as a method for early detection and population reduction. This appropriation is available until June 30, 2013, by which time the project must be completed and final products delivered.

II. FINAL PROJECT SUMMARY AND RESULTS:

The bioacoustics of the round goby population in the Duluth-Superior Harbor were investigated over the course of three summers. The goal of the project was to assess the behavior and the sound production of this invasive species to develop a fish trap to target this invasive species. Fish were found to move offshore during the winter and thus subsequent concentrations were thought to have great potential for collection. However, fish were found to be inactive the majority of the winter and did not produce sound. Sound production coincided with the resumption of swimming activity and feeding in late spring with vocalization first recorded when water temperature exceeded 8 degrees C, which correlated with the initiation of spawning. Two choice experimental trials succeeded in attracting the fish to sound sources using both pure tones and round goby vocalizations, indicating that fish can find the origin of sound. Several different traps were produced and bioacoustical field trials were conducted. We were able to capture, for the first time, round gobies in unbaited traps using sound as the only stimulus and observed many round gobies approach sound sources but fail to enter the traps. As they readily enter the same traps when baited, it was concluded that although sound is an effective

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attractant, it is not the only sensory modality that round goby use to approach calling males. Future experiments that would combine sound with a large sexually mature fish and/or pheromones could significantly increase the number of fish that enter the trap and could prove to be an effective strategy.

III. PROGRESS SUMMARY AS OF:12/31/2010

Hydrophone recording arrays have been developed and were placed in the Duluth-Superior Harbor in July and August 2010. Several putative round gobies sounds were recorded and are currently being analyzed. Additional round goby nesting sites were surveyed and identified for use in the 2011 field season.

As of 6/30/2011

Hydrophones have been placed throughout the harbor to record round goby sounds. Additional, large tanks/aquaria have been set up on the Duluth Research Farm. Round gobies have been placed in those tanks and we have been recording sound from them in this setting also. These tanks will also serve as the testing tanks for Activity 2.

As of 12/31/2011

Many putative round goby calls were recorded during the 2011 season. We are currently correlating the calls with water temperatures. As predicted, it appears that the calls are modulated with temperature. Once the data analysis is complete, we will be able to use the appropriate calls for specific temperature to optimize round goby attraction.

As of 6/30/2012.

The round goby calls have been analyzed. Progress continued on building the bioacoustical traps. Trap deployment was delayed due to severe flooding in the Duluth-Superior Harbor which made for unsafe operating conditions. It is anticipated that traps will be deployed in July-August.

As of 12/31/2012

Traps were deployed in late summer. The bioacoustics traps were successful in capturing round gobies in unbaited traps for the first time. However the traps with sound were not significantly more effective than traps without sound. Rock bass were also captured which was unexpected and may have discouraged round goby egress into the traps. It appears that round goby will approach the traps but are hesitant to enter them. We are planning to alter the trap entrances to allow easier entry of the round gobies and exclude the rock bass.

Round gobies are being overwintered at the Duluth Research Farm. This year de icers were added to tanks to prevent mortality due to tanks completely freezing last year. As of December 31, 99% of the fish were alive. Feeding ceased in mid November and feeding and movement return will be correlated with temperature and photoperiod. The

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goal is to record sounds as soon as they initiate calling in the spring as we do not have calls at water temperature below 14°C.

IV. OUTLINE OF PROJECT RESULTS:

RESULT/ACTIVITY 1: Round Goby acoustic library

Description: 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.

Summary Budget Information for Result/Activity 1: ENRTF Budget: \$53000
Amount Spent: \$52409
Balance: \$ 591

Deliverable/Outcome	Completion Date	Budget
1. An acoustic library of sounds emitted by the round goby in the field at various temperatures	6/30/2011	\$53000

Result Completion Date: 6/30/2011

Result Status as of 12/31/2010:

An agreement was reached with the US Coast Guard base in Duluth, MN to place our instrumentation in a secure area and use power from the base.

In July and August 2010, hydrophones were deployed in shallow water immediately adjacent to the base. A number of vocalizations were recorded and are currently being analyzed. The recording hydrophone array is being modified to sample a larger area.

One graduate student received partial summer support and is currently being supported during the academic year on the grant. Undergraduate students were employed to assist with sound collection and analysis

In the fall of 2010, a new graduate student, Jared Leino, set traps throughout the harbor to locate potential sound recording and scout for future placement of bioacoustic traps. His salary was covered by a graduate teaching assistantship at no cost to the grant.

Result Status as of 6/30/2011

To increase our call library several large fish tanks were established in the spring of 2011. Artificial habits were added to the tanks and recently captured male and female round gobies were added to the tanks in May of 2011. Several fish successfully

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spawned and the sound generated by these records has been recorded and is currently awaiting analysis.

Hydrophones have been placed since May 2011 in the Duluth Superior harbor and hundreds of hours of sound files have been recorded and the graduate student (Cordo) is currently analyzing these sound files to determine if goby sounds are present.

It is taking longer than anticipated to analyze the sound files due to their length. We have two undergraduates students starting July 1 with funding from the UMD to help analyze the files. We anticipate that the data will be analyzed by December 31, 2011. We will finish the data analysis by the overall end date of the project.

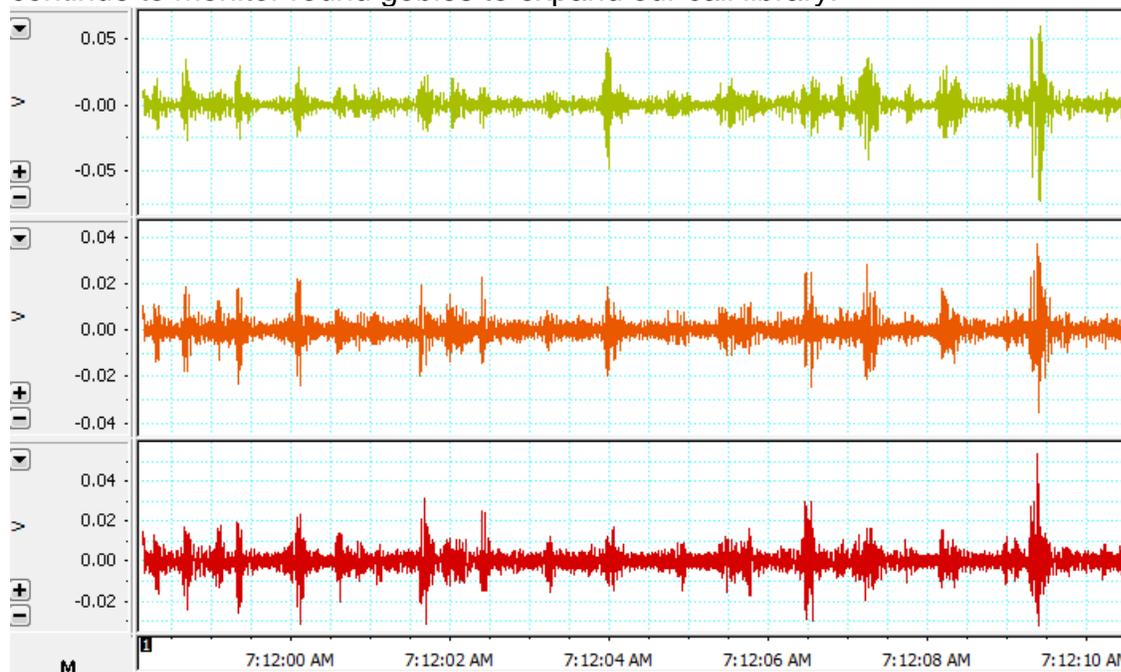
Additionally, the coast guard station location has provided excellent access to the goby population and we do not need the boat to access the site. The \$500 allocated for gasoline (boat) will be transferred to the lumber et al category for modifying fish traps.

Result Status as of 12/31/2011

We continued to successfully record round goby sounds throughout the late summer and early fall. We now have a library of round goby calls spanning spring through fall that are correlated with water temperature. We plan to use this library both in our lab and field experiments to optimize round goby attraction.

Result Status as of 6/30/2012

All calls have been analyzed and are currently be used to attract round gobies. We continue to monitor round gobies to expand our call library.



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Figure 1-1. Portion of a call on multiple hydrophones on Lab Chart 7 software (temporal waveform).

Twenty calls were recorded between May and September 2011 (17.3 to 27.9° C). After a dramatic temperature decrease at the beginning of October to under 8°C no more calls were recorded. Average fundamental frequency of calls was 180 hz, pulse length was 236 ms, call length was 29.5 seconds, and number of pulses per call was 33.7. In addition, call frequency was matched with temperature to determine if there was a correlative relationship. Regression indicates an insignificant negative relationship between temp and freq (R²=0.011, P=0.686).

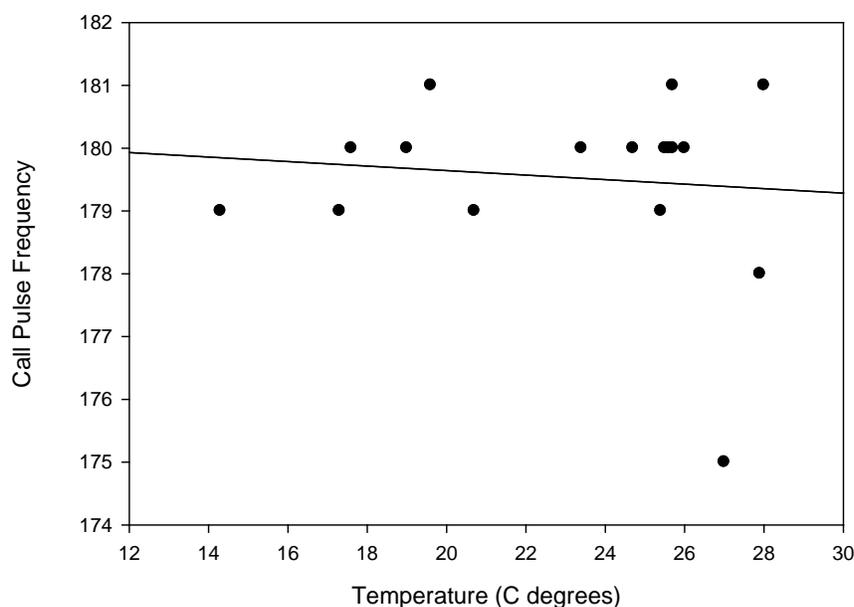


Figure 1-2. Plot of frequency of round goby vocalizations and water temperature. Linear equation of regression line is $\text{Hz} = 180.361 - (0.0359 T)$. There is no significant correlation between temperature and pulse frequency of round goby calls at the temperature range they were recorded, and although there is a downward trend it does not indicate any pattern.

It appears that round goby calls are relative insensitive to temperature. There was previous concern that round gobies calls would be temperature sensitive and therefore require adjustments of the call based on ambient temperatures. It is still unclear what mechanism is used to generate the sound. However, the insensitivity to temperature probably rules out muscle contraction.

The results were reported at the American Fisheries Society Meeting in Minneapolis in the summer of 2012 by graduate student Elise Cordo.

Result status 12/31/2012

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Due to the continued success of the outdoor ponds calling activities, we have overwintered 40 fish in 4 different tanks at the Duluth Research Farm. This year de icers were added to tanks to prevent mortality due to tanks completely freezing. As of December 31, 99% of the fish were alive. Feeding ceased in mid November and the return of feeding and movement will be correlated with temperature and photoperiod. The goal is to record sounds as soon as they initiate calling as we do not have sounds recorded from the 8 to 14 °C range which may be important during the initial mating season.

Cordo, E and Mensinger, A. F. 2013 Round goby sound production is temperature independent (working title). Manuscript in preparation.

Final Report Summary:

The maintenance of round gobies in large outdoor tanks at the University of Minnesota Research Farm provided an opportunity to observe natural round goby behavior and record sounds. Unlike round gobies, maintained in the laboratory, the outdoor population underwent seasonal rhythms primarily due to changes in water temperature and photoperiod. We were able to record round goby sounds from 8°C through 27°C. In contrast to the previous hypothesis, round goby calls appeared insensitive to temperature changes. However, this is positive development for potential bioacoustics management, as the same sounds could be played throughout the ice free months and no adjustment would be needed for water temperature as with other fish.

Previous work has indicated that round gobies will move offshore once ice forms in the harbor and which would concentrate the population and make them easy to capture. The round gobies in the outdoor tanks did show a substantial change in behavior as the water cooled below 4°C with animals refusing food and becoming inactive. The fish also became non responsive to sound. This finding is significant as it provides a guide to when round gobies could be attracted with sound. Thus bioacoustic trapping should be suspended once the water drops below 4°C as the round gobies are nonresponsive.

The behavioral data suggests an alternative management strategy that although not testable within this current grant, may be amendable to future investigation. Based on field observations and the current behavioral data, it is hypothesized that the round goby migrates just outside the ice formation zone in the harbor and as this is mostly soft bottom, which the large adults do not usually inhabit, it is likely that most of the population resides within a narrow band just offshore. As the fish are inactive and non responsive to most stimuli, it may be possible to use nets placed through the ice (as done with carp) and remove a large portion of the population. While this is probably not practicable in a large area such as the Duluth-Superior Harbor, if round gobies are found to invade smaller or narrower areas, winter collection could prove to be a viable option.

RESULT/ACTIVITY 2: Round goby sound attraction

Bioacoustic Traps for Management of Round Goby

Description: 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.

Summary Budget Information for Result/Activity 2: ENRTF Budget: \$58,177
Amount Spent: \$56,909
Balance: \$ 1,268

Deliverable/Outcome	Completion Date	Budget
1. Acoustic sound files of the best sounds to attract the round goby in the laboratory.	June 30, 2012	\$58,177

Result Completion Date: June 30, 2012

Result Status as of December 31, 2011

Phototaxis experiments were initiated in the summer of 2011. As the round goby call library was still being compiled, we used pure tone stimulus to attract the round gobies to the traps under laboratory conditions. We found 100 to 200 Hz pure tones to be most effective in luring round goby into unbaited traps. Higher frequency tones of 300 to 400 Hz were less successful and in some cases appeared to repel the round gobies. The lower frequency tones are consistent with the predominant energy spectrum in the putative calls and therefore it is anticipated that the actual calls may even be more effective.

The current data represents a significant milestone as it represents the first documented capture of a goby into an unbaited trap when just using sound as a stimulus. The results are preliminary due to the laboratory conditions but we are hopeful the same results will be obtained under field conditions in the summer of 2012.

Additionally, we have established year round outdoor tanks at the Minnesota Duluth Research Farm. While we do not expect the round gobies to remain active throughout the winter, no one has ever documented their behavior during the season and we will continue to monitor their calls and determine if they will enter traps. While the hypothesis is that they will not call or eat during the winter, if we find results to the contrary, it may provide another tool in which to manage the population. For example, if they overwinter in mass groups or specific spots and will enter traps, then targeted ice "fishing" could lead to removal during the winter months.

Result Status as of: June 30, 2012

Phonotactic experiments continued through the winter and late spring. Round gobies were successfully lured into unbaited trap openings in the lab. We are currently analyzing the data to determine which frequencies provide the optimal phonotaxis.

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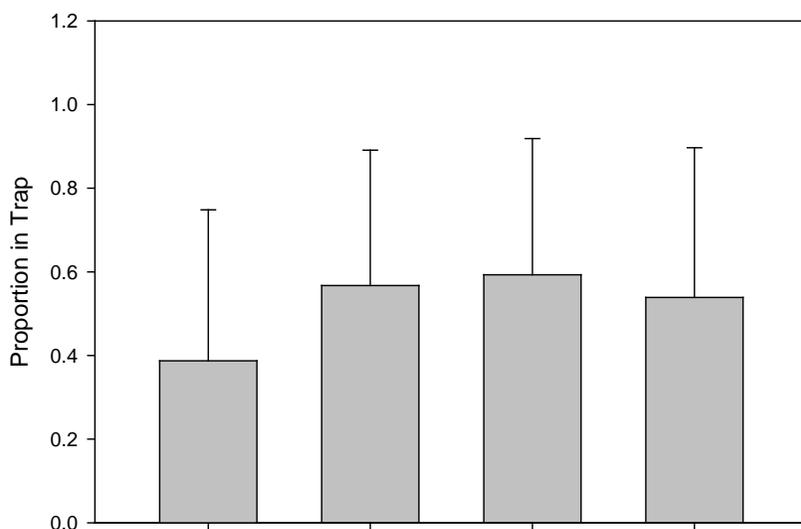


Figure 2-1. Proportion of fish entering trap over a 24-hour period of sound playback. Each group contained 5 fish of one sex. There was no significant difference between groups (ANOVA, $p=0.373$); however, females did enter the trap more often when sound was playing.

The experiments showed for the first time that fish will enter unbaited traps. However, their ability to localize the sound in the small tank may have been affected by echoes as fish will enter both traps playing sound and silent traps. There was no difference between the control and experiment traps for the males. This was expected as the males are the ones that usually call and therefore were not expected to prefer one trap over the other. Female fish did show a preference for the trap playing the sound. Recent bioacoustic work has demonstrated in other soniferous fish species, that freshly caught fish are much more motivated to show positive phonotaxis than fish held in captivity. Our goal is to concentrate future work on freshly caught gobies.

Additionally, we will need to try more frequencies to determine if we can increase our success rate.

Result Status as of: December 31, 2012

Phonotaxis experiments were conducted in large outdoor tanks at the UMD Research Farm. The stimulus was modified from continuous pulses to intermittent pulses to more closely resemble the round gobies calls. The tanks also allowed observations of round gobies with the trap entrances. Positive phonotaxis was observed but again the round gobies appears to have difficulty find the trap entrance. Modifications are planned to increase the number and size of trap opening.

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Final Report Summary: We were able to determine that round gobies 1) can detect sound from 100 to 400 Hz, 2) lower frequency sounds (100 to 200 Hz) were attractive while higher frequency sounds (> 300 Hz) were not attractive and in some cases repulsive, 3) can locate the origin of the sound.

The data suggest that round gobies are most responsive to sounds that approximate the frequency of their own calls and have the ability to localize the sound indicating the feasibility of bioacoustics for trapping. The negative response to higher frequency does suggest that these frequencies have the potential to jam or disrupt round gobies sounds and future research should explore this possibility.

RESULT/ACTIVITY 3: Round goby bioacoustic traps

Description: Minnow traps will be modified into round goby bioacoustic traps that include an underwater speaker and large holding area. 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).

Summary Budget Information for Result/Activity 3:

ENRTF Budget:	\$63,823
Amount Spent:	\$57,064
Balance:	\$ 6,759

Deliverable/Outcome	Completion Date	Budget
1. To develop a fish trap that will attract the round goby via sound recording developed in the result 1 and 2.	June 30, 2013	\$63,823

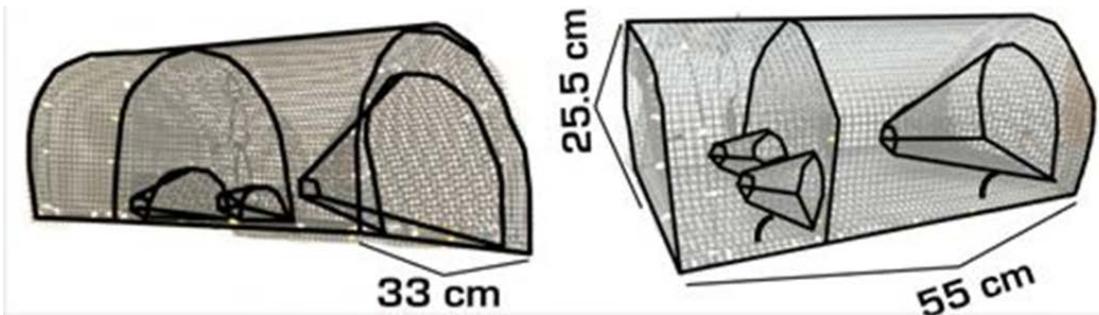
Result Completion Date: June 2013

Result Status as of 6/30/2011. June A UMD undergraduate was awarded a UROP grant from UMD in the spring on 2011 to help start on this project. A number of traps were constructed and he made several modifications in the trap openings to increase the number of fish entering the traps

Result Status as of 12/31/11

We continue to forge ahead on the trap designs as I hired two new graduate students in the Fall of 2011 that will be assisting on the project. One is the PhD student from St. Catherine's that was specially recruited for the project and has joined the lab after a one year delay working for General Mills. She received a 3M fellowship that will cover her entire salary for the first year at no cost to the grant.

Both students have been building prototype traps and plan to test them in the lab and field during 2012



Result Status as of: June 30, 2012

Figure 3-1 Bioacoustic trap prototypes

Several prototype traps were built during the winter and will be deployed July through September in the Duluth Superior Harbor. These traps will use the results of activity 1 and 2 to optimize capture rates.

Result Status as of December 31, 2012:

Traps were deployed in late summer. The bioacoustics traps were successful in capturing round gobies in unbaited traps for the first time in the field. However the traps with sound were not significantly more effective than traps without sound. Rock bass were also captured which was unexpected and may have discouraged round goby egress into the traps. It appears that round goby will approach the traps but are hesitant to enter them. We are planning to alter the trap entrances to allow easier entry of the round gobies and exclude the rock bass.



Figure 3-2 - Bioacoustic trap for round gobies

Bioacoustic Traps for Management of Round Goby



Figure 3-2 - Bioacoustic trap for round gobies deployed in Duluth Superior Harbor

We hypothesized that round gobies were attracted to the sound but were unable to locate the entrances. Multiple entrances leading to a single collection area should prove more effective in capturing the round gobies. Plans also include modifying the traps from the original design of uni-directional sound to omni directional sound. This will provide greater coverage and allow us to make multiple trap entrances that should circumvent the problem of the round goby not finding the trap entrance. As greater sound coverage will be achieved with laying the speaker flat (instead of vertically suspended) the sound presentation will be omnidirectional rather than uni directional. Additionally, the attraction of the rock bass to the sound was unexpected. Their presence may have inhibited the gobies from entering and as we modify the trap entrances, we will attempt to make entrances that exclude the rock bass,

Additionally, the unbaited traps with just sound may not be as effective as previously hypothesized. We plan to put a single male goby in breeding condition in the trap to provide potential chemical cues to augment the sound stimulus.

Result Status as of June 30, 2013

Final Report Summary: The results indicated that it is feasible to use sound as a mechanism to lure round gobies into a fish trap. However, conventional trap designs that work well with food stimulus was less than ideal for sound stimulus alone. We repeatedly observed round gobies approach the same trap under two conditions: 1) baited, no sound and 2) no bait plus sound, however the fish would consistently only enter the trap that contained food. Several modifications were made to the trap openings without additional success.

The results suggest that sound remains a positive attractant for round gobies to enter an area. However it is insufficient for them to consistently enter the trap. Two possibilities exist that could improve the success. Add an additional stimulus such as a

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mature round goby or pheromones to the trap. As the goal is to attract gravid females prior to spawning, both of these should provide added incentive for the females to enter the trap. Alternatively, modify the trap, so the large area in the front of the speaker acts as the containment portion of the trap. For example, this could take the form of a net placed on the bottom of the harbor that is quickly pulled up trapping the round gobies that were in front of the trap.

It was originally hypothesized that May/June would be the optimal months for field trapping. In many vocalizing fish species, the females are especially sensitive to sound early in the spawning season and become less responsive later in the season. Unfortunately, the last two springs had unusual weather patterns that may have impeded optimal testing of the bioacoustical traps. The high water and debris from flood of 2011 disrupted the entire harbor and negatively impacted other studies that the project manager was conducting in the harbor. Several traps were lost and access to prime goby habitat was delayed until well into the summer. Preliminary evidence from a long term trawling survey indicates a potential decline in the round goby population that correlates with the flood event and reproduction may have been depressed. In 2012, sustained cold weather and resultant long term ice, delayed trap deployment again which may have resulted in lower than normal catches

Bioacoustic Traps for Management of Round Goby

V. TOTAL ENRTF PROJECT BUDGET: 175,000

Personnel: \$ 154,100

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	\$ 35,000
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: N/A

Equipment/Tools/Supplies: \$ 18600

equipment	supplier	number	Cost per unit	Total
hydrophones	TBD	5	300	1500
speakers	Underwater sound	10	350	3500
amplifiers	WPI	2	300	600
Data acquisition systems	TBD	2	2500	5000
Fish traps	Aquatic Eco systems	20	~12	250
Supplies for making hydrophone stand, mounting speakers and modifying fish traps such as lumber, steel and PVC pipe	Home depot			2000
Gas for boat	various			1000
Electronics	Radio Shack			1000
Electronic storage device	Best Buy	1	250	250
Large aquaria	Red Ewald	2	500	1000
Water Chiller	Aquatic Eco systems	1	2000	2000
Test kits	Aquatic Eco systems			500
Total				\$18,600

Acquisition (Fee Title or Permanent Easements): N/A

Travel: \$ 1800

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

Additional Budget Items: \$ N/A

Bioacoustic Traps for Management of Round Goby

TOTAL ENRTF PROJECT BUDGET: \$ 175,000

Explanation of Capital Expenditures Greater Than \$3,500: Data acquisition systems are \$2500 each for a total of \$5000. These are needed to record data and control the speakers

VI. 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. Project Impact and 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.

C. Other Funds Proposed to be Spent during the Project Period:

The PI has a 9 month appt at UMD, that is divided approximately 50% research and 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. Total \$66,300

D. Spending History: The goby populations in the harbor and preliminary trapping has been conducted over the last several years. Mensinger has used University funds to pay the summer salary of two graduates students for a total of three summers. Approximately \$20K has been expended in this preliminary research

VII. DISSEMINATION:

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 MN DNR for the duration of the grant. Appropriate end users will also be offered the opportunity to purchase the traps from the PI for the cost of production.

1) Project manager collaborated with the Great Lakes aquarium to produce a audio video exhibit on invasive fish

2) Two master's student, Jared Leino (degree pending) and Elise Cordo (degree in progress), received funding from the project and five undergraduate students received funding for summer research.

Presentations

Bioacoustic Traps for Management of Round Goby

The results were reported at the American Fisheries Society Meeting in Minneapolis in the summer of 2012 by graduate student Elise Cordo.

12/31/2010 – Mensinger attended the MN-WN invasive species conference in St. Paul in the Fall of 2010 and presented a talk entitled “**Round gobies in the Duluth Superior Harbor**”

Manuscripts in preparation

Cordo, E and A. F. Mensinger. Seasonal changes in the bioacoustics of the round goby.

Leino, J. and A. F. Mensinger. Age and size distribution of the round goby (*Neogobius melanostomus*) in the Duluth-Superior Harbor. In revision for resubmission to Transactions of the American Fisheries Society

Leino, J. and A. F. Mensinger. Competitive interactions between the round goby and log perch in the Duluth-Superior Harbor.

Leino, J. and A. F. Mensinger. The benthic assemblage of fishes in the Duluth Superior Harbor from 1990 to 2012.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than _____. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS: See research addendum.

Final Attachment A: Budget Detail for 2010 Projects - Summary and a Budget page for each partner (if applicable)													
Project Title: Bioacoustic traps for the management of the round goby													
Project Manager Name: Allen Mensinger													
Trust Fund Appropriation: \$ 175000													
1) See list of non-eligible expenses, do not include any of these items in your budget sheet													
2) Remove any budget item lines not applicable													
2010 Trust Fund Budget	Result 1 Budget:	Revised Result 1 Budget (5/12/2013)	Amount Spent (date)	Balance (date)	Result 2 Budget:	Revised Result 2 Budget (5/12/2013)	Amount Spent (date)	Balance (date)	Result 3 Budget:	Revised Result 3 Budget (5/12/2013)	Amount Spent (date)	Balance (date)	
BUDGET ITEM	Round goby acoustic library		12/31/2012	12/31/2012	Round Goby Sound Attraction		12/31/2012	12/31/2012	Round goby bioacoustic traps		12/31/2012	12/31/2012	
PERSONNEL: wages and benefits PI-Allen F. Mensinger, PhD (nine month appointment at UMD) requesting a total of 3 months summer	11,600	11,600	11,600	0	11,700	11,700	11,700	0	44,700	16,827	16,317	510	
Eiise Cordo - Masters student 24 months support	34,000	34,000	34,000	0	38,000	38,000	38,000	0					
Graduate student - to be determined 12 months support				0					37,000	31,873	31,873	0	
Undergraduate research assistant - to be named - 6 months support (summer only)	3,000	3,000	3,000	0	4,500	4,500	4,500	0	3,100	3,100	2,659	441	
Capital equipment over \$3,500 two data acquisition systems are requested @ \$2500	5,000	0	0	0									
Supplies (list specific categories)				0									
hydrophones	1,500	1,500	1,397	103									
speakers				0	1,000	1,000	541	459	2,500	2,500	651	1,849	
amplifiers				0	300	300	300	0	300	1,123	300	823	
fish traps	250	250	250	0									
lumber, pipes, hardware supplies for modifying fish traps	500	500	500	0					4,500	4,000	2,641	1,359	
gasoline for boat	500	500	106	394					500	0	0	0	
electronic supplies (cables, wire)	500	500	500	0					500	1,000	500	500	
electronic storage device	250	250	250	0									
Large Aquaria				0	1,000	1,000	666	334					
Water chiller				0	2,000	1,177	1,177	0					
Sound acquisition systems 5/12/2013										2,500	2,123	377	
Water test kits				0	500	500	25	475					
Travel expenses in Minnesota travel to field sites	900	900	806	94					900	900	0	900	
Travel outside Minnesota if necessary some of the above field site travel may take place on the Wisconsin side on the St. Louis River				0									
COLUMN TOTAL	\$58,000	\$53,000	\$52,409	\$591	\$59,000	\$58,177	\$56,909	\$1,268	\$58,000	\$63,823	\$57,064	\$6,759	