

**Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 146-D

New Tools for Fight Against Zebra Mussels

Category: D. Aquatic and Terrestrial Invasive Species

Total Project Budget: \$ 539,323

Proposed Project Time Period for the Funding Requested: 2 years, July 2018 to June 2020

Summary:

We will validate, develop manuals and train people on the use of both a portable DNA detector and commercially available mapping technology for integration into their Zebra Mussel monitoring program.

Name: Jon Amberg

Sponsoring Organization: U. S. Geological Survey

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

The visual is a flowchart depicting the general work flow for both lines of study. On the molecular detector side, we will optimize the assay, followed by developing the field sampling protocol. This will lead into the development of a user's manual. On the mapping side, we will determine which fish-finding technology is best to map Zebra Mussels. We will then validate its use and create a user's manual. Once both of these lines are completed, we will conduct a workshop to train future users.

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



Environment and Natural Resources Trust Fund (ENRTF)

2018 Main Proposal

Project Title: Providing new tools to detect and assess Zebra Mussels in Minnesota waters

PROJECT TITLE: Providing new tools to detect and assess Zebra Mussels in Minnesota waters

I. PROJECT STATEMENT

We will optimize and deliver new tools for the detection and assessment of Zebra Mussels that can be used by the general public. These already existing tools will can be easily integrated into a statewide monitoring program to lessen the spread of Zebra Mussels and protect highly valued lakes throughout Minnesota. We propose to validate the use of a portable molecular detector and benthic mapping technologies, establish the standard operating procedures and conduct a workshop. This project will provide state-of-the-art tools to resource managers to deploy in a Zebra Mussel monitoring program.

Monitoring and early detection are key components to prevention and control of Zebra mussels. According to the [Minnesota Department of Natural Resources Infested Waters List](#), as of December 19, 2016, Zebra Mussels have infested 200 lakes throughout Minnesota and continue to spread throughout the state. The veliger stage enables them to be easily transported to new waterways and once established, they significantly impact the ecology and recreational opportunities for that lake. Traditional monitoring and early detection tools (i.e., light microscopy and visual observation) typically indicate well establish populations, which cannot be easily eradicated. Whole lake eradication treatments can be costly and impact Zebra Mussels and native mussels alike, while spot treatments can limit impacts on native organisms but they typically fail to eradicate Zebra Mussels. The failure is not due to the control agent but rather in detecting the invasion too late and a poor assessment of the invasion population. To help inform control efforts, resource managers need tools to detect the invasion early not only know that the waterbody is infested, but they also need to know the extent of the infestation.

Technologies that can detect an organism in water are now available and affordable. We developed a bigheaded carp assay for a portable DNA detection kit that is currently used to monitor for their presence in bait. This assay and kit were designed to be used by people with little to no experience in molecular biology or genetics. A similar assay is being developed to detect Dreissenid mussels in water shipments for use the portable DNA detector. Also, advancements in the hydroacoustic technology used in fish finders and for mapping bottom substrates (i.e., side-scan sonar, split-beam and multi-beam echosounders) now make it possible to differentiate structures in the water, including Zebra Mussels. However, the resolution of these three hydroacoustic technologies varies. Therefore, we propose to optimize the Dreissenid mussel assay for use with the portable DNA detection kit for use in open water and identify the best hydroacoustic technology to use to identify Zebra Mussels within a lake. Once completed, we will conduct a workshop to train interested parties on the proper use of these tools for early detection and monitoring Zebra Mussels.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Optimize and validate the Dreissenid mussel assay for use with the portable DNA detection kit for use in open water **Budget: \$144,634**

Much like we have previously done with the bigheaded assay for the portable DNA detector, we will determine the limit of detection and determine the optimal volume of water required for detection. We will test the use of the kit on samples collected from nine lakes ranging from non-infested to heavy infested. We will determine the optimal time of day and optimal time of year that samples should be collected. Lastly, we will determine the best locations within that lake for detection based upon weather. All of this information will be compiled into a single User’s Manual that can be provided to future users of the portable eDNA detection kit and presented during a workshop (Activity 3).

Outcome	Completion Date
1. Determine the limit of detection and optimal volume of water needed	September 2018
2. Optimization of use in the field	December 2019
3. Develop a User’s Manual	June 2020



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Activity 2: Identify which of three hydroacoustic technologies, side-scan sonar, split-beam or multibeam echosounders can best detect Zebra Mussels in a lake **Budget: \$294,710**

We will evaluate the use of three different hydroacoustic technologies that UMESC currently owns to identify locations of Zebra Mussels within a lake; side-scan sonar, split-beam and multibeam echosounders. Each technology will be evaluated on the ability to differentiate Zebra Mussels from common substrates within a lake and differentiate various sizes of mussels. Hydroacoustic data will be analyzed separately by three independent people. Analyses will be compared to identify which technology was the most consistent at differentiating Zebra Mussels. We will then validate this technology by mapping Zebra Mussels in a newly infested lake and then visually confirming positive locations. All of this information will be compiled into a User’s Manual and presented during a workshop (Activity 3).

Outcome	Completion Date
<i>1. Assess hydroacoustic technologies to differentiate ZMs from lake substrates</i>	<i>October 2018</i>
<i>2. Determine which of these technologies can differentiate mussel size</i>	<i>October 2018</i>
<i>3. Validate the use of the technique in newly infested lakes</i>	<i>October 2019</i>
<i>4. Develop a User’s Manual</i>	<i>June 2020</i>

Activity 3: Early detection on monitoring workshop **Budget: \$100,000**

We will organize and conduct a workshop to train interested parties on the use of the Dreissenid mussel assay with the portable DNA detection kit and how hydroacoustics could be used to help find the Zebra Mussels in a lake. During this workshop we will provide five portable DNA detectors.

Outcome	Completion Date
<i>1. Conduct training workshop</i>	<i>June 2020</i>

III. PROJECT STRATEGY

A. Project Team/Partners

This project will be conducted by scientists at the U.S. Geological Survey Upper Midwest Environmental Sciences Center in La Crosse, Wisconsin. Dr. Jon Amberg and Jennifer Dieck will provide oversight of the entire project. Christopher Merkes and one technician will evaluate the portable point-of-use detection kit. Jose Rivera, Jenny Hanson, Jayme Stone will conduct studies evaluating the use of side-scan sonar, split-beam echosounder and multi-beam imaging sonar to identify Zebra Mussels in a lake.

B. Project Impact and Long-Term Strategy

This project will be completed in two years and will result in increased surveillance and monitoring of Zebra Mussels throughout Minnesota. The deployment of this kit will allow for an effective monitoring program at a lower cost. Once the portable DNA detector is obtained, additional assays can be used. USGS is currently developing assays for detecting Spiny Waterflea and Round Goby and expect to continue to develop additional assays for species of concern. We will also provide a cost effective way to map Zebra Mussels populations and identify areas where controls could be used most effectively. Thus, the combination of the portable DNA detection kit and hydroacoustics will provide resource managers valuable information needed to make decisions on approaches for cost effective control of Zebra Mussels and limit their spread.

C. Timeline Requirements

This two year project will begin in July 2018 and conclude with the workshop in June 2020.

2018 Detailed Project Budget

Project Title: Early detection and assessment for the control of ZMs: The potential for integrating citizen science.

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Personnel:	\$ -
Jon Amberg, Research Fish Biologist, (79% salary, 21% benefits); 7% FTE Year 1&2, 4% FTE Year 3	\$ 35,276
Jennifer Dieck, Supervisory Biologist, (73% salary, 27% benefits); 16% FTE Year 1&2 and 8% FTE Year 3	\$ 99,012
Jenny Hanson, Biologist, (75% salary, 25% benefits); 27% FTE Year 1&2 and 13% FTE Year 3	\$ 91,137
Jayme Stone, Cartographic Technician, (72% salary, 28% benefits); 19% FTE Year 1&2 and 9% FTE Year 3	\$ 54,766
Chris Herkes, Geneticist, (75% salary, 25% benefits), 12% FTE Year 1&3 and 15% FTE Year 2	\$ 52,783
Matt Hoogland, Technician, (81% Salary, 19% Benefits), 23% FTE Year 1, 31% Year 2 and 12% FTE Year 3	\$ 52,207
Jose Rivera, Fish Biologist, (75% salary, 25% benefits), 19% FTE Year 1&2 and 9% FTE Year 3	\$ 45,429
JC Nelson, Biologist, (76% salary, 24% benefits), 2% FTE Year 1&2 and 1% FTE Year 3	\$ 8,735
Yer Lor, Geneticist, (77% salary, 23% benefits), 25% FTE Year 3	\$ 49,979
Professional/Technical/Service Contracts: <i>In this column, list out proposed contracts. Be clear about whom the contract is to be made with and what services will be provided. If a specific contractor is not yet determined, specify the type of contractor sought. List out by contract types/categories - one row per type/category. If an RFP will be issued, state that.</i>	\$ -
Equipment/Tools/Supplies: <i>In this column, list out general descriptions of item(s) or item type(s) and their purpose - one row per item/item type.</i>	
Handheld Detectors	\$ 50,000
Acquisition (Fee Title or Permanent Easements): <i>In this column, indicate proposed number of acres and name of organization or entity who will hold title.</i>	\$ -
Travel:	
Mileage, lodging and meals for travel to field sites on four different Minnesota lakes	
Additional Budget Items: <i>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 determined One row per type/category.</i>	\$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 539,323

V. OTHER FUNDS (This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period: <i>Indicate any additional non-state cash dollars secured or applied for to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.</i>	\$ -	<i>Indicate: Secured or Pending</i>
Other State \$ To Be Applied To Project During Project Period: <i>Indicate any additional state cash dollars (e.g., bonding, other grants) secured or applied for to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.</i>	\$ -	<i>Indicate: Secured or Pending</i>
In-kind Services To Be Applied To Project During Project Period: <i>Indicate any additional in-kind service(s) secured or applied for to be spent on the project during the funding period. For each type of service, list type of service(s), estimated value, and indicate whether it is secured or pending. In-kind services listed must be specific to the project.</i>	\$ -	<i>Indicate: Secured or Pending</i>
USGS overhead expenses (55.5%)	\$ 299,324	
Travel	\$ 25,000	
Equipment - previously purchased	\$ 100,000	
Past and Current ENRTF Appropriation: <i>Specify dollar amount and year of appropriation from any current ENRTF appropriation for any directly related project of the project manager or organization that remains unspent or not yet legally obligated at the time of proposal submission. Be as specific as possible. Indicate the status of the funds.</i>	\$ -	<i>Indicate: Unspent? Legally Obligated? Other?</i>
Other Funding History: <i>Indicate funding secured but to be expended prior to July 1, 2018, for activities directly relevant to this specific funding request. State specific source(s) of funds and dollar amount.</i>	\$ -	

2018 Detailed Project Budget

Project Title: Early detection and assessment for the control of ZMs: The potential for integrating citizen

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	Pay Periods	FY18 Cost Per Payperiod	FY18	FY19	FY20	Total
Personnel:						
Jon Amberg, Research Fish Biologist, (79% salary, 21% benefits); 7% FTE Year 1&2, 4% FTE Year 3	2	\$ 4,430	\$ 8,860	\$ 9,126	\$ 4,700	\$ 22,686
Jennifer Dieck, Supervisory Biologist, (73% salary, 27% benefits); 16% FTE Year 1&2 and 8% FTE Year 3	4	\$ 6,217	\$ 24,868	\$ 25,614	\$ 13,191	\$ 63,673
Jenny Hanson, Biologist, (75% salary, 25% benefits); 27% FTE Year 1&2 and 13% FTE Year 3	7	\$ 3,270	\$ 22,890	\$ 23,577	\$ 12,142	\$ 58,609
Jayne Stone, Cartographic Technician, (72% salary, 28% benefits); 19% FTE Year 1&2 and 9% FTE Year 3	5	\$ 2,751	\$ 13,755	\$ 14,168	\$ 7,296	\$ 35,219
Chris Merkes, Geneticist, (75% salary, 25% benefits), 12% FTE Year 1&3 and 15% FTE Year 2	3pp, 4pp, 3pp	\$ 3,185	\$ 9,555	\$ 13,759	\$ 10,630	\$ 33,944
Matt Hoogland, Technician, (81% Salary, 19% Benefits), 23% FTE Year 1, 31% Year 2 and 12% FTE Year 3	6pp, 8pp, 3pp	\$ 1,927	\$ 11,562	\$ 15,878	\$ 6,133	\$ 33,574
Jose Rivera, Fish Biologist, (75% salary, 25% benefits), 19% FTE Year 1&2 and 9% FTE Year 3	5	\$ 2,282	\$ 11,410	\$ 11,752	\$ 6,052	\$ 29,215
JC Nelson, Biologist, (76% salary, 24% benefits), 2% FTE Year 1&2 and 1% FTE Year 3	0.5	\$ 4,388	\$ 2,194	\$ 2,260	\$ 1,164	\$ 5,618
Yer Lor, Geneticist, (77% salary, 23% benefits), 25% FTE Year 3	6.5	\$ 2,160.00			\$ 14,040	\$ 14,040
			\$ 105,094	\$ 116,134	\$ 61,308	\$ 282,536

BUDGET ITEM	Pay Periods	FY18 Cost Per Payperiod	FY18	FY19	FY20	Total
Personnel:						
Jon Amberg, Research Fish Biologist, (79% salary, 21% benefits); 7% FTE Year 1&2, 4% FTE Year 3	2	\$ 6,889	\$ 13,777	\$ 14,191	\$ 7,308	\$ 35,276
Jennifer Dieck, Supervisory Biologist, (73% salary, 27% benefits); 16% FTE Year 1&2 and 8% FTE Year 3	4	\$ 9,667	\$ 38,670	\$ 39,830	\$ 20,512	\$ 99,012
Jenny Hanson, Biologist, (75% salary, 25% benefits); 27% FTE Year 1&2 and 13% FTE Year 3	7	\$ 5,085	\$ 35,594	\$ 36,662	\$ 18,881	\$ 91,137
Jayne Stone, Cartographic Technician, (72% salary, 28% benefits); 19% FTE Year 1&2 and 9% FTE Year 3	5	\$ 4,278	\$ 21,389	\$ 22,031	\$ 11,346	\$ 54,766
Chris Merkes, Geneticist, (75% salary, 25% benefits), 12% FTE Year 1&3 and 15% FTE Year 2	3pp, 4pp, 3pp	\$ 4,953	\$ 14,858	\$ 21,396	\$ 16,529	\$ 52,783
Matt Hoogland, Technician, (81% Salary, 19% Benefits), 23% FTE Year 1, 31% Year 2 and 12% FTE Year 3	6pp, 8pp, 3pp	\$ 2,996	\$ 17,979	\$ 24,691	\$ 9,537	\$ 52,207
Jose Rivera, Fish Biologist, (75% salary, 25% benefits), 19% FTE Year 1&2 and 9% FTE Year 3	5	\$ 3,549	\$ 17,743	\$ 18,275	\$ 9,412	\$ 45,429
JC Nelson, Biologist, (76% salary, 24% benefits), 2% FTE Year 1&2 and 1% FTE Year 3	0.5	\$ 6,823	\$ 3,412	\$ 3,514	\$ 1,810	\$ 8,735
Yer Lor, Geneticist, (77% salary, 23% benefits), 25% FTE Year 3	6.5	\$ 7,689	\$ -	\$ -	\$ 49,978.50	\$ 49,979
			\$ 163,421	\$ 180,588	\$ 95,334	\$ 439,344

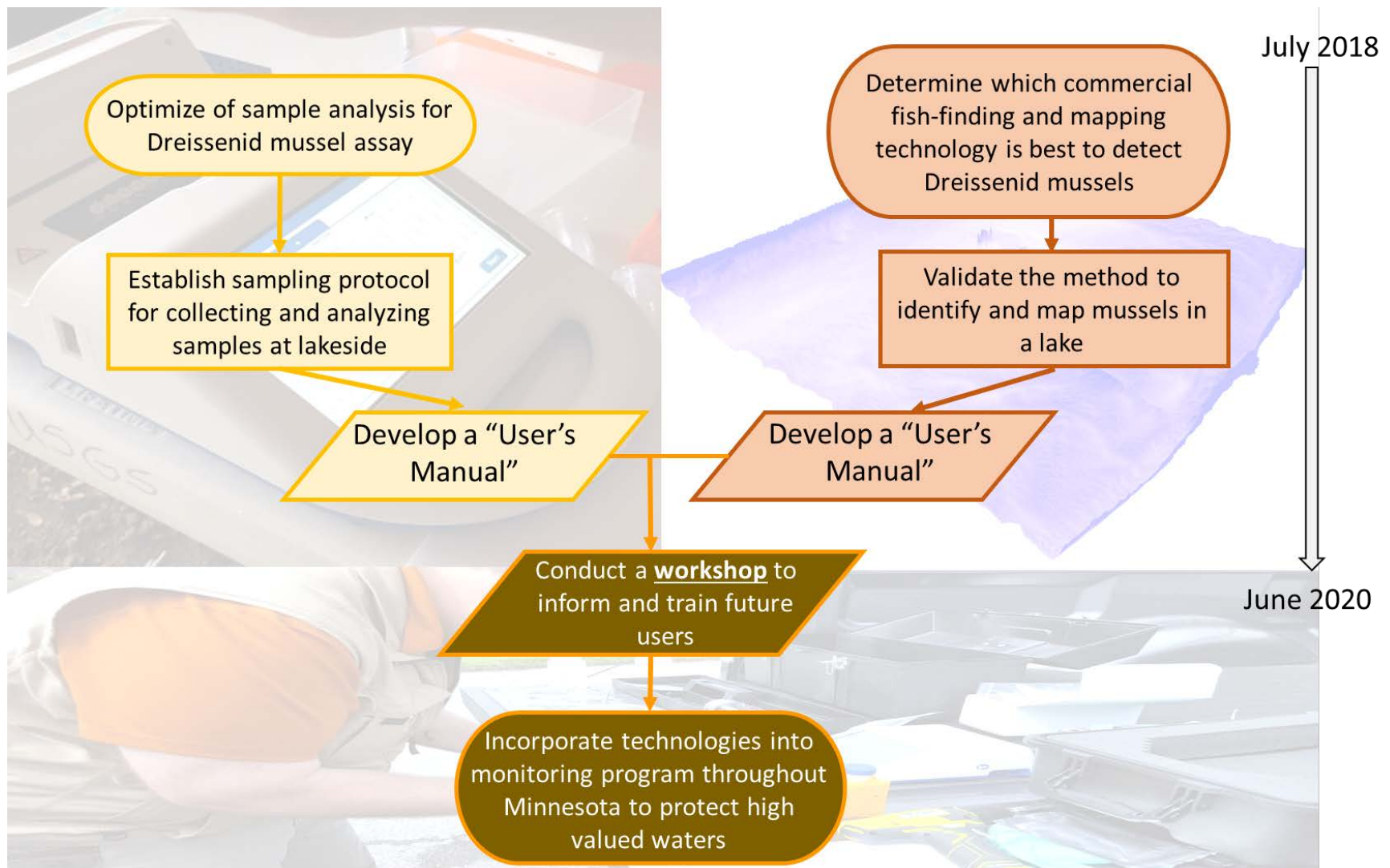


Figure 1. The expected work flow for the optimization of the Dreissenid mussel assay and portable DNA detector (yellow) and the validation of a commercial fish finder and bottom mapper (orange). The workshop (brown), the public outreach component for this project, will be conducted at the conclusion of this study in 2020.

JON J. AMBERG

Research Fish Biologist

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EDUCATION

PhD	2008	University of Idaho
MS	2001	Michigan State University
BS	1996	Michigan State University

RESEARCH

I lead a team of research scientists studying aquatic invasive species biology. Much of my focus has been on integrating technologies developed in the medical sciences and applying them to the physiology and ecology of an organism. I integrate the use of molecular biology, genomics and metabolomics to develop tools that resource managers can use to efficiently and effectively monitor and control populations of aquatic invasive species.

SELECTED PUBLICATIONS

- Erickson, RA, Rees, CB, Coulter, AA, Merkes, CM, McCalla, SG, Touzinsky, KF, Walleser, L, Goforth, RR, and Amberg, JJ. 2016. Detecting the Movement and Spawning Activity of Bigheaded Carps with Environmental DNA. *Molecular Ecology Resources* 16(4): 957-965.
- Amberg, JJ, McCalla, SG, Monroe, E, Lance, R, Baerwaldt, K, Gaikowski, MP. 2015. Improving efficiency and reliability of environmental DNA analysis for silver carp. *Journal of Great Lakes Research* 41(2): 367-373.
- Merkes CM, McCalla SG, Jensen NR, Gaikowski MP, Amberg JJ. 2014. Persistence of DNA in Carcasses, Slime and Avian Feces May Affect Interpretation of Environmental DNA Data. *PLoS ONE* 9(11): e113346. doi:10.1371/journal.pone.0113346
- Lance, R, Perkins, E, Russo, E, Schultz, M, Smith, D, Baerwaldt, K, Hancock, R, Chapman, D, Amberg, J, Gaikowski, M, Klymus, K, Richter, C, Barton, M, Schilling, K. 2014. Environmental DNA Calibration Study: Interim Technical Review Report. Interim report submitted to Asian Carp Regional Coordinating Committee. 163 pages.
- Ye, L, Amberg, JJ, Chapman, D, Gaikowski, MP, Liu, WT. 2013. Fish gut microbiota analysis differentiates physiology and behavior of invasive Asian carp and indigenous American fish. *The ISME Journal* (2013), 1–11
- Amberg, JJ, Goforth, RR, Sepulveda, MS. 2013. Antagonists to the Wnt cascade exhibit sex-specific expression in gonads of sexually mature shovelnose sturgeon. *Sexual Development* 7, 308-315.
- Amberg, JJ, McCalla, SG, Miller, L, Sorensen, P, Gaikowski, MP. 2013. Detection of environmental DNA of bigheaded carps in samples collected from selected locations in the St. Croix River and in the Mississippi River 44.
- Coulter, AA, Keller, D, Amberg, JJ, Bailey, EJ, Goforth, RR. 2013. Phenotypic plasticity in the spawning traits of bigheaded carp (*Hypophthalmichthys* spp.) in novel ecosystems. *Freshwater Biology* 58, 1029-1037.
- Nutile, S, Amberg, JJ, Goforth, RR. 2013. Evaluating the effects of electricity on fish embryos as a potential strategy for controlling invasive cyprinids. *Transactions of the American Fisheries Society* 142, 1-9.
- Amberg, JJ, Schreier, TM, Gaikowski, MP. 2012. Molecular responses differ between sensitive silver carp and tolerant bighead carp and bigmouth buffalo exposed to rotenone. *Fish Physiology and Biochemistry* 38, 1379-1391.

Upper Midwest Environmental Sciences Center Overview

Welcome to the Upper Midwest Environmental Sciences Center (UMESC). We are proud to be one of the leading research centers conducting ecological research to support the Department of the Interior's and other local, state and federal resource agencies management of natural resources, fish, and wildlife. For more than a half century we've served the public and our partners by generating quality relevant scientific products and information for the improved management of our natural resources, including water, wildlife and land. We help protect these invaluable resources to improve our health and recreational opportunities for both today's and tomorrow's generations.

We are located on an island in the Mississippi River near the city of La Crosse, Wisconsin. It is a U.S. Geological Survey (USGS) Science Center, located within USGS's Midwest administrative area. The USGS Midwest Region promotes coordination between the Midwest Region Science Centers. UMESC's emphasis is on the Upper Midwest, however, our research, monitoring, and technical assistance efforts extend across the nation and world.

The Center's first mission was the control of aquatic invasive species such as sea lamprey, and has since expanded into the study of river ecology, wildlife ecology, the effects of contaminants on fish and wildlife, and geospatial technology (see UMESC's history page). Over the years UMESC has developed partnerships with a variety of other federal departments/agencies, states, educational institutions, and organizations. These partnerships are important in ensuring the relevance of our activities and the utility of our products.

UMESC Research Focus

Our research, monitoring and technical support focuses on the:

- control of aquatic invasive species
- well-being and functioning of the large rivers, especially the Upper Mississippi River
- preservation of threatened and endangered species
- effects of contaminants on amphibians, fish and wildlife
- developing maps, computer models, and other decision support tools for improved management of our resources

We work on the control of aquatic invasive species such as Asian carp, zebra mussels, and sea lamprey. Other research is conducted on the effects of contaminants (both industrial compounds such as PCBs and dioxins, and emerging contaminants such as pharmaceuticals) on fish and wildlife. We are concerned about the wildlife, and how these contaminants move through the environment to potentially affect human health. We also study threatened and endangered species such as amphibians and native freshwater mussels. Again we are not only interested in preserving these species for future generations, but also in determining what the potential ramifications are for human well-being. The Mississippi River is an invaluable resource providing drinking water, recreation, transportation, and aesthetics to millions of Americans. Our research and monitoring assesses the health, status and trends of the Upper River and helps determine how large complex river systems function. This work provides critical information needed by river managers to improve this magnificent resource while maintaining its multiple uses. Because the soundness of its methodology and the quality of the information provided by UMESC and its partners through the Long Term Resource Monitoring Program (LTRMP), the approach used in the LTRMP is now being expanded to address great rivers worldwide. Finally, we work on developing maps, computer models, and other decision support tools, often in geospatial formats, to help inventory and manage our resources. Major products include vegetation inventories of National Parks, such as Glacier, the Apostle Islands, and the Appalachian Trail, and also numerous national wildlife refuges.

UMESC uses Science Teams to conduct its research and related activities. A listing of the Science Teams and their programs/projects is available on the Science Program's Web page.

Relationship to the USGS Science Strategy

In 2007, the USGS developed a science strategy plan outlining major natural-science issues facing the United States, focusing on mission areas where natural science can make a substantial contribution to the well-being of the Nation and the world. The agency continues to implement this plan. UMESC's research, monitoring, and technical assistance activities support many of the mission focus areas.