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

Project Title: **ENRTF ID: 148-D**

Integrating Control of Zebra Mussels and Aquatic Vegetation

Category: D. Aquatic and Terrestrial Invasive Species

Total Project Budget: $ 251,310

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

Summary:

The project investigates the use of aquatic pesticides for combined control of zebra mussels and nuisance aquatic vegetation by identifying efficacious pesticides to mussels and sites of nuisance species co-occurrence.

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Sponsoring Organization: U. S. Geological Survey

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Location

Region: Central

County Name: Statewide

City / Township:

Alternate Text for Visual:

The application of aquatic herbicides to control both nuisance vegetation and invasive zebra mussels

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

PROJECT TITLE: Integrating control of zebra mussels and aquatic vegetation

I. PROJECT STATEMENT

The project will determine whether herbicides and algaecides that are applied to manage nuisance aquatic vegetation can simultaneously control zebra mussels (*Dreissena polymorpha*), thereby maximizing the benefit of a pesticide treatment and eliminating the need for application of a specific molluscicide. A range of registered chemicals are applied to Minnesota waters every year for management of algae and nuisance plants (e.g., Eurasian water milfoil and curly pondweed). Resource managers and lakeshore owners could effectively reduce both nuisance vegetation and zebra mussels with one pesticide treatment by planning applications to coincide with a vulnerable period in the life cycle of mussels. However, integration of vegetation and mussel management requires information on the sensitivity of different life stages of zebra mussels to herbicides at expected field conditions and application rates for plant and algae control. The Minnesota Aquatic Invasive Research Center is currently testing the effectiveness of low dose copper (an algaecide) on the early larval (veliger) stage of zebra mussels. This study would greatly expand the database on aquatic pesticide toxicity to zebra mussels and determine the utility of integrating control efforts for zebra mussels with aquatic vegetation management.

We propose that management of aquatic vegetation could reduce zebra mussel populations where these nuisance species co-occur. Our objectives in this study are:

1) Expand the database on aquatic pesticide toxicity to zebra mussels. A suite of commonly used pesticides with varying modes of action and targets will be tested on zebra mussels (Table 1).
2) Determine sensitivity to pesticides based on life stage of the mussel. Toxicity tests will be conducted on three life stages of zebra mussels, including the veliger, newly settled juvenile, and reproducing adult.
3) Identify candidate sites in Minnesota waters for integrating nuisance aquatic vegetation and mussel management. Data on aquatic pesticide use and zebra mussel distribution in Minnesota lakes will be compiled to identify co-occurrence of vegetation management activities and zebra mussel populations.

Table 1. Pesticides, and their uses, to be tested on zebra mussels

Compound	Use
Copper chelates	Controls algae, chara
2,4-D amine	Systemic herbicide; selective; broadleaf control (e.g., watermilfoil)
2,4-D ester	Systemic herbicide; selective broadleaf control (e.g., coontail, watermilfoil)
Diquat dibromide	Contact herbicide; broad spectrum; effective against various submersed vegetation (e.g., pondweeds, coontail, milfoil)
Endothall amine	Contact herbicide; broad spectrum; (e.g., pondweeds, coontail, milfoil)
Triclopyr	Systemic herbicide; selective; effective against milfoil and other emergent species.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Determine the sensitivity of veliger, juvenile, and reproducing adult zebra mussels to aquatic herbicides at expected field conditions and application rates. **Budget: $ 173,932**

Six commonly used pesticides with varying modes of action and management targets will be tested (Table 1). Tests will be conducted in a mobile bioassay trailer supplied with lake water in order to simulate environmental conditions during pesticide application. Test treatments will include a control and three pesticide concentrations, up to the maximum allowed by the label. Three life stages of zebra mussels will be exposed to each chemical, including 3-d old veliger, newly settled juvenile, and reproductive adult. The predicted mortality of each zebra mussel life stage at expected application rates for each pesticide will be determined.

Outcome	Completion Date
1. Determine the toxicity of six pesticides to three life stages of zebra mussels at expected environmental conditions and application rates.	September 2019
2. Identify efficacious pesticide treatments for control of both zebra mussels and aquatic vegetation.	February 2020
3. Disseminate results through a report and publication.	June 2020

Activity 2: Identify candidate sites in Minnesota waters for integrating management of aquatic vegetation and zebra mussels **Budget: $ 77,378**

The use of registered pesticides for management of aquatic plants in central region lakes will be compiled from state agency reports (Minnesota Department of Natural Resources and Department of Agriculture) and compared to monitoring data on zebra mussel populations over the same time period. Data will be analyzed to determine co-occurrence of nuisance vegetation and zebra mussels and to decipher patterns in pesticide use and the establishment of zebra mussels within lakes.

Outcome	Completion Date
1. Compile data on aquatic pesticide use in central region lakes since 2010.	April 2019
2. Compile monitoring data on zebra mussel occurrence and population in central region lakes since 2010.	August 2019
3. Identify patterns in pesticide use and mussel distribution and sites for future integrated control efforts.	December 2019
4. Disseminate results through a report and/or publication.	June 2020

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 (UMESC) in La Crosse, Wisconsin, the Minnesota Aquatic Invasive Species Research Center (MAISRC) in St. Paul, Minnesota and the Minnesota Department of Natural Resources. UMESC staff (Waller, Luoma, support staff biologists and chemist) will conduct Activity 1. Keegan Lund (MNDNR) will assist with selection of pesticide testing regimes and the study lake (Activity 1) and in compilation of pesticide and zebra mussel data (Activity 2). Michael McCartney (MAISRC) will oversee a graduate student for completion of Activity 2.

B. Project Impact and Long-Term Strategy

The project outcomes will provide information on if, what, and when the application of aquatic pesticides can be planned to reduce both nuisance vegetation and zebra mussels in lakes where they co-occur. Additionally, the project will identify lake locations that could be monitored in future years to determine the effectiveness of integrating aquatic vegetation management and mussel control. The indirect effect of removing vegetation on zebra mussel settlement would also be evaluated in future years. The long term goal of the project is to develop an integrated management plan for nuisance aquatic vegetation and zebra mussels in Minnesota waters.

C. Timeline Requirements: 2 years

Year 1 (July 2018 –June 2019): Data on pesticide use and zebra mussel populations will be compiled. Toxicity tests will be conducted in lakeside trials at the start of zebra mussel spawning period. Year 2 (July 2019 –June 2020): Additional toxicity trials will be completed, as needed, by September 2019 and efficacious treatments will be identified. Data on pesticide use and zebra mussel monitoring will be combined with data on pesticide efficacy and life stage sensitivity of zebra mussels to identify potential sites for future integrated control efforts. A final report will be completed by June 2020.

2018 Detailed Project Budget

Project Title: Integrating control of zebra mussels and aquatic vegetation

IV. TOTAL ENRTF REQUEST BUDGET: 2 years

BUDGET ITEM	AMOUNT
Personnel:	
Research fisheries biologist, (UMESC) (71% salary, 29% benefits); 31% FTE Year 1, 4% FTE Year 2	$ 73,424
Research fisheries biologist, (UMESC) (71% salary, 29% benefits); 19% FTE Year 1	$ 34,280
Biologist research assistant (UMESC)/project implementation, (80% salary, 20% benefits); 31% FTE Year 1, 4% FTE Year 2	$ 34,164
Biologist research assistant (UMESC)/project implementation, (75% salary, 25% benefits); 19% FTE Year 1	$ 20,465
Biologist research assistant (UMESC)/project implementation, (75% salary, 25% benefits); 19% FTE Year 1, 4% FTE Year 2	$ 30,064
Student (UMESC) project implementation, (75% salary, 25% benefits); 15% FTE Year 1	$ 9,691
Chemist (UMESC), (75% salary, 25% benefits); 8% FTE Year 1	$ 9,222
Professional/Technical/Service Contracts:	
Minnesota Aquatic Invasive Species Research Center, University of Minnesota to support a graduate student of M. McCartney for completion of Activity 1	$ 40,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 251,310

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: USGS appropriated funds.	$ 153,000	Secured
Other State $ To Be Applied To Project During Project Period:	n/a	n/a
In-kind Services To Be Applied To Project During Project Period: USGS will provide funds for all expenses related to travel, supplies, and equipment related to the project.	n/a	n/a
USGS: Bioassay trailer and test system	$ 15,000	Secured
Analytical instruments (HPLC, spectophotometers)	$ 8,500	Secured
Water chemistry meters/probes	$ 1,500	Secured
Travel	$ 9,500	Secured
Microsopes and microscopy supplies	$ 10,000	Secured
USGS overhead expenses (55%)	$ 138,221	Secured
Past and Current ENRTF Appropriation:	$ -	n/a
LCCMR: Minn Laws 2013, Regular Session, Chapter 52, Section 2, Subd 6(f) Zebra Mussel Control Research and Evaluation in Minnesota Waters	$ 600,000	completed
MAISRC: Subaward H033219601, Temperature-dependent toxicity of molluscicies to zebra mussels	$ 182,546	completed
Other Funding History: None	$ -	n/a

Integrated control of nuisance vegetation and zebra mussels

Project manager qualifications and organization description.

Project title: Integrating control of zebra mussels and aquatic vegetation
Project manager: Diane L. Waller
Project manager qualifications: Diane Waller is a research fisheries biologist in the Aquatic Ecosystems Health branch of the USGS' Upper Midwest Environmental Sciences Center. Dr. Waller has conducted research on dreissenid mussels since 1991, with a focus on control tools and laboratory culture methods. Recent studies include evaluation of non-target and target animal effects of the molluscicide, Zequanox, and carbon dioxide for invasive species control and development of alternative delivery methods for molluscicides. Dr. Waller is a member of the steering committee for the Invasive Mussel Collaborative (http://www.invasivemusselcollaborative.net). She will be responsible for development of the study plan and implementation of all research tasks, including preparation and submission of the final report and related publications, and budget oversight. Relevant publications include:

Waller, D.L., and J.A. Luoma 2017. Effects of the biopesticide Zequanox® on reproduction and early development of the fathead minnow (*Pimephales promelas*)**.** Mgmt Biol Inv 1:125-135.

Waller, D., M. Bartsch, K. Fredricks, S. Schleis, L. Bartsch and S. Lee. 2016**.** Effects of carbon dioxide on juveniles of the freshwater mussel *Lampsilis siliquoidea*. Environ Toxicol Chem 36: 671-681.

Waller, D.L., J.A. Luoma and Erickson, R. 2016. Safety of the molluscicide Zequanox® to nontarget macroinvertebrates *Gammarus lacustris* (Amphipoda: Gammaridae) and *Hexagenia* spp. (Ephemeroptera: Ephemeridae)**.** Mgmt Biol Inv 7:269-280.

Luoma J.A., K.L. Weber, **D.L. Waller**, J.K. Wise, D.A. Mayer, D.B. Aloisi. 2015. Safety of spray-dried powder formulated *Pseudomonas fluorescens* strain CL145A exposure to subadult/adult unionid mussels during simulated open-water treatments. U.S. Geological Survey Open-File Report 2015–1064, 248 pp.

Waller, D. L., and Fisher, S. W. 1998. Evaluation of several chemical disinfectants for removing zebra mussels from unionid mussels. Prog Fish-Cult 60(4):307-10.

Waller, D.L., Fisher, S.W., Dabrowska, H. 1996. Prevention of zebra mussel infestation and dispersal during aquaculture operations. Prog Fish-Cult 58:77 – 84

Fisher, S.W., Dabrowska, H., **Waller, D.L**. Babcock-Jackson, L., and Zhang., X. 1994. Sensitivity of several zebra mussel (*Dreissena polymorpha*) life stages to candidate molluscicides. J Shellfish Res 12:175-182.

Waller, D.L., Fisher, S.W., Dabrowska, H. Rach, J.J., Cope, W.G. and Marking, L.L. 1993. Toxicity of candidate molluscicides to zebra mussels and selected non-target organisms. J Great Lakes Res 19:695-702.

Organization description: The Upper Midwest Environmental Sciences Center (UMESC) is one of the leading USGS 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 (http://www.umesc.usgs.gov/umesc_home.html). The Center's mission is to provide the scientific information needed by resource managers, researchers, decision makers, and the public; to protect, enhance, and restore the ecosystems in the Upper Mississippi River Basin, the Midwest, and the world. Current research and monitoring programs include: (1) Understanding large rivers and how they support humans, ecosystems, and economies, (2) Developing maps (Mississippi River, National Parks), visualization tools and decision aides for resource managers, (3) **Controlling aquatic invasive species**, (4) Developing chemicals and drugs to maintain healthy fish, (5) Restoring threatened and endangered species (amphibians, fish, mussels and birds), and (6) Determining contaminant effects on wildlife, as sentinels for human health (terrestrial, aquatic)