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

Project Title: **ENRTF ID: 155-D**

Controlling Densities of Zebra Mussels in Infested Lakes

Category: D. Aquatic and Terrestrial Invasive Species

Total Project Budget: $ 428,864

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

We will determine the metapopulation structure of zebra mussels within lakes, figure out source populations, and chemically treat those to reduce densities and overall impacts in whole lakes.

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Location

Region: Central

County Name: Douglas

City / Township:

Alternate Text for Visual:

Metapopulation approach for controlling zebra mussels in established lakes

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

PROJECT TITLE: Controlling densities of zebra mussels in infested lakes

I. PROJECT STATEMENT

Unfortunately, zebra mussel infestations continue to rise each year and despite creative efforts to slow down the spread, they will likely get into most lakes that get even moderate usage if the lakes are suitable habitats. The general response to zebra mussels once they get into a lake is to give up on paying them attention and focus efforts instead on keeping them out of the next uninfested lake. Virtually nobody is developing methods to control zebra mussels once they get into lakes. So far, quick eradication efforts have been unsuccessful and even if temporarily getting rid of the infestation, it is likely only a matter of time until the next infestation event. Somebody needs to begin thinking about how to manage zebra mussels once they get into a lake to lessen their negative impacts to ecosystems. Given the impact on property values, county tax revenues, fisheries and overall ecosystem health a discussion on how to manage zebra mussels is critical. As a new lake management consulting company with a former university biology teacher and active, published researcher, we are proposing a study to begin the process of figuring out how to reduce densities of zebra mussels and their impacts in lakes where they have been established. In addition to our qualifications, funding our group will diversify awardees of these funds, which in year's past have rewarded strictly government, nonprofits, and academic institutions. Funding private companies will provide support for innovative and cost-effective solutions to combat invasive species, supporting not only science but Minnesota business startups.

Our study will determine the spatial structure and habitat usage of zebra mussel metapopulations within lakes, determine the overall reproductive value of metapopulation patches, determine a treatment target, treat patches with high reproductive value, and determine whether this helps to reduce densities in the next the year. We propose to generally treat zebra mussel management in much the same way nuisance plant management is conducted. The difficulty in doing such a thing is that while plants are relatively easy to observe and sample, zebra mussels, by being on the bottom of the lake or attached to substrates, are difficult to visually detect and thus to direct chemical or other treatments. In order to circumvent this, we will couple our field study with kriging methods using GIS. We will visit six zebra mussel infested lakes and collect samples randomly chosen over the area of the lake.

The overall goal of the project would be to develop a method that could be used to minimize the impact of zebra mussels on Minnesota lakes once they invade. The direct outcome we aim to achieve is to reduce the densities of zebra mussels in infested lakes, which will indirectly have positive effects on fish, restore the integrity of the food web, and to decrease fouling on both natural and artificial hard surfaces. A reduction in densities would also indirectly reduce the number of transport events from managed lakes and slow spread to newly currently uninfested lakes. The project will achieve these goals by identifying source patches (i.e., patches of zebra mussel populations within lakes that have a high reproductive potential) and treat those to reduce densities and decrease reproductive potentials throughout the entire lake. We will determine the management strategy successful if (a) there is a reduction the area of a lake covered by zebra mussels and (b) there is a reduction in the net reproductive rate of zebra mussels in the area they do exist.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Zebra mussel population survey and mapping* **Budget: $107,216**

The six smallest lakes infested with zebra mussels for at least five years will be selected as study lakes. These will include Cowdry, Brophy, Victoria, Geneva, Irene, and Darling lakes. Each lake will be visited by boat where 100 random spatial locations will be selected and samples will be collected where we will determine the density and age-structure of populations together with the depth, sediment hardness, and plant coverage at each site.

Outcome	Completion Date

1. Maps of randomly spaced points of each of six lakes	*July 2018*
2. Go to lakes and collect environmental grabs of mud, plant samples, and hard substrates to determine zebra mussel presence, densities, and size structure.	*October 2018*

Activity 2: *Use a Geographic Information System to Define Metapopulations* **Budget: $321,648**

Field data will be entered into a Geographic Information System and the relationship between zebra mussel density and reproductive rates will be estimated over the entire lake by using a kriging method. These will lead to the assignments of patches in each lake as either source or sink metapopulations based on modeling simulations so that patches can be identified for treatment. Half of the lakes (*n*=3) will have their source patches treated chemically with Zequanox and half of the lakes (*n*=3) will serve as controls. We will consider the efforts successful if, in the next year, densities and reproductive rates are minimized in the treatment lakes relative to the control lakes.

Outcome	Completion Date
1. Probability maps showing where zebra mussels are most likely to occur in a lake.	*May 2019*
2. Patches delineating populations within lakes of zebra mussels being assigned as sources or sinks.	*May 2019*
3. Treatment of source populations within three of the lakes	*October 2019*
4. Statistical analysis and report showing whether the reduction worked	*June 2021*

III. PROJECT STRATEGY

A. Project Team/Partners

The project manager will be Dr. Daniel McEwen owner and operator of Limnopro Aquatic Science, Inc. as well as a company with proper certification to do removal treatments, either chemical or mechanical, for zebra mussels. There are no project partners not receiving funds.

- Dr. Daniel McEwen [$74,256]: Providing experimental design, data analysis, reporting, and overall project and personnel oversight.
- Limnopro Aquatic Science, Inc. [$270,000]: Field & lab processing infrastructure, tools, & support personnel
- Chemical/Mechanical Zebra Mussel Control Co. TBD [$75,000]: To provide treatment to zebra mussels for purpose of control.

B. Project Impact and Long-Term Strategy

The long-term, hoped for impact of this study, is to begin looking at zebra mussel infestation as a manageable problem, much like is done with invasive plants. As more and more lakes get infested, and there does not appear to be a slowdown in the spread despite measures taken in prevention and rapid response eradication efforts, moneys and efforts will need to move toward reducing their impact as much as possible. This is the first study we are aware of that would take such approach and there is certain to be useful, applied information obtained from the study for long-term management.

C. Timeline Requirements

We are proposing the project to run for three consecutive years. Not only will this allow adequate time to complete all the tasks, the timeframe is necessary to maintain integrity of the research design. The best results can only be obtained when samples are collected during the same time every year to rule out confounding factors potentially associated with seasonality.

2018 Detailed Project Budget

Project Title: *Controlling densities of zebra mussels in infested lakes*

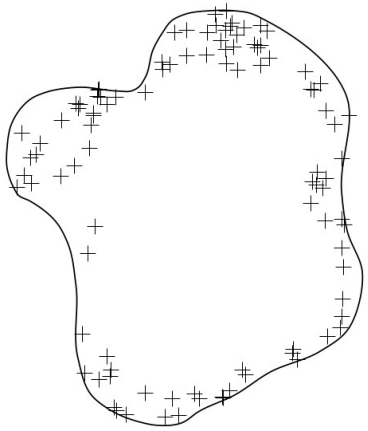
IV. TOTAL ENRTF REQUEST BUDGET 3 **years**

BUDGET ITEM	AMOUNT
Personnel:	
Daniel McEwen, Project Manager (70% salary, 30% benefits); Four months salary is requested for three years (12 months total across the proposal) for participation and supervision of on lake sampling, sample preservation and laboratory testing, data interpretation, publication preparation, and the disemmination of results.	$ 74,256
Professional/Technical/Service Contracts:	
Limnopro Aquatic Science, Inc.: Funds requested to pay for staff ($30,000 per year * 3 years = $90,000) for processing samples, entering data, acquiring permits, and etc.; contractor will also carry insurance provide facilities, equipment, boat, and storage space at a cost of 2X staff costs ($90,000 * 2 = $180,000 for 3 years)	$ 270,000
Chemical or Mechanical Zebra Mussel Treatment Co.: TBD; Chemical treatment with Zequinox of three lakes at $25,000 per lake.	$ 75,000
Equipment/Tools/Supplies:	N/A
Grab sampler	$ 700
Field supplies: bottles, preservation jars, data recorders	$ 2,000
Lab supplies: chemicals, forceps, rulers	$ 2,000
Dissecting microscope	$ 4,000
Acquisition (Fee Title or Permanent Easements):	N/A
Travel:	
Mileage (~1680 miles). Travel to and from lakes at $0.54 per mile	$ 908
Additional Budget Items:	N/A
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 428,864

V. OTHER FUNDS

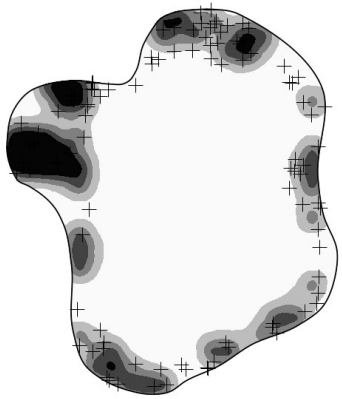
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	$ -	N/A
Other State $ To Be Applied To Project During Project Period:	$ -	N/A
In-kind Services To Be Applied To Project During Project Period:	$ -	N/A
Past and Current ENRTF Appropriation:	$ -	N/A
Other Funding History:	$ -	N/A

Metapopulation approach to controlling zebra mussel density

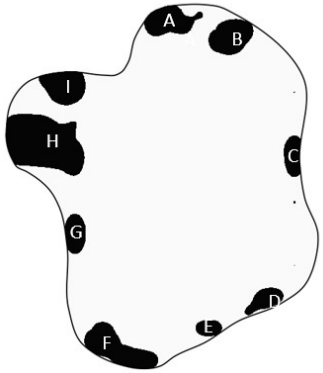


Step 1: Randomly select 100 sampling sites on each lake

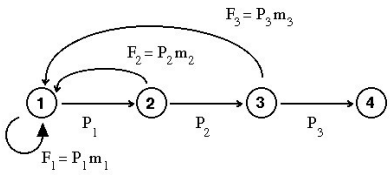
Step 2: Visit each site and collect zebra mussels, depth, sediment hardness, and plant coverage.



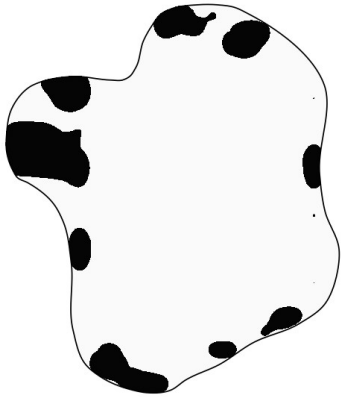
Step 3: Generate probability map in GIS to determine zebra mussel coverage based on depth, sediment hardness, plant coverage, and spatial autocorrelation.



Step 6: Each patch lettered A – I has a distinct density (#/m^2), reproductive rate, and genetic affiliation with other patches based on dispersal. Patches are assigned as sources (births>deaths) or sinks (deaths>births) and chemical treatment focuses on most highly related sources.



Step 5: For each patch, determine age structure of zebra population and use that in a age-structured population model to determine net reproductive rate



Step 4: Convert probability map to likely patches of zebra mussel populations.

Project Manager Qualifications & Organizational Description

The project manager overseeing the work will be Dr. Daniel McEwen, who is an aquatic ecologist by training and owner of Limnopro Aquatic Science, Inc., a new lake management and consulting company operating out of St. Cloud, Minnesota. Dr. McEwen is well qualified to take on a research project and has managed many grants in his past. He has used many of the same methods proposed here in past research projects. He has extensive experience sampling on lakes, processing samples, analyzing data using statistics and mathematical modeling procedures, and has successfully published in peer reviewed journals doing the same. He taught biology, ecology, environmental science, research, and quantitative methods for eight years as a professor at Minnesota State University Moorhead where he was a favorite of students and faculty colleagues alike. He was offered and accepted a position working in private industry as the Director of Environmental Services at RMB Environmental Laboratories, Inc. in Detroit Lakes, Minnesota where he gained more experience particularly working with invasive species. The project most closely allied with the present submission was done for the Otter Tail County AIS Task Force on zebra mussel infestation, which performed a comprehensive analysis of risk factors associated with currently uninfected lakes, a literature review on zebra mussel ecology and management techniques, and a study plan for their consideration for future work. This project gave rise to a 100 + page document that extensively covered zebra mussel ecology in north central Minnesota. Dr. McEwen has now launched his own business to serve central Minnesota lakes region. He has approximately 15 years of experience working on lakes and wetlands in both Minnesota and arctic Alaska. Over his near 15-year career as a lake scientist he has managed projects from cradle-to-grave, including participating as a PI, co-PI or in support of over $1,000,000 of awarded funding. He also recently completed the Minnesota Aquatic Invasive Species Research Center (MAISRC) AIS Detector Certification program.

Limnopro Aquatic Science, Inc. will provide the following services under the oversight of Dr. McEwen, indicative of the broad ecological grounding the company would have to address this AIS issue:

- *Lake Management Plans (Brief or Comprehensive)*
- *AIS Detection (Scans and/or Identification)*
- *AIS Risk Assessment (Colonization and Suitability Analysis)*
- *AIS Mapping (Observed and/or Predicted Lake Coverage)*
- *Lake Mapping (Depth, Substrate Composition, & Plant Coverage)*
- *Water Quality Assessment (Nutrients and Water Clarity)*
- *Algae (General Community Survey & Taxonomy)*
- *Algae (Identification of Toxic Algae)*
- *Aquatic Plants (General Community Survey & Identification)*
- *Aquatic Plants (Nuisance Aquatic Plant Delineation & Treatment)*
- *Zooplankton Assessment (General Community Survey & Identification)*
- *Macroinvertebrates (General Community Survey & Identification)*
- *Fisheries Assessment (General Community Survey & Identification)*
- *People Assessment (Property Values & Lake User Surveys)*
- *Watershed Modeling (Inflow/Outflow including TMDL, BASIN, BATHTUB, FLUX, MNLEAP & TMDL)*
- *Ecological Modeling (Treatment Simulation & Outcomes)*
- *Contract Employment (Administration for Lake Groups)*
- *Grant Monitoring & Writing (Assistance Applying for Funding Projects)*
- *Educational Presentations (Lake Presentations & Workshops)*
- *Research Design (Determination of How to Collect & Analyze Data from Projects)*