Environment and Natural Resources Trust Fund
2016 Request for Proposals (RFP)

Project Title: **ENRTF ID: 125-D**

Modeling AIS Spread to Evaluate Management Options

Category: D. Aquatic and Terrestrial Invasive Species

Total Project Budget: $ 264,141

Proposed Project Time Period for the Funding Requested: 2 years, July 2016 to June 2018

Summary:

This project will describe and mathematically model the spatial distribution and pathways of AIS in Minnesota to predict future spread, estimate risk and evaluate the impact of control interventions.

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Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Images to represent how mathematical modeling will be used to understand how pathways and risk factors have contributed to AIS spread.

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

PROJECT TITLE: Understanding the historical spread of aquatic invasive species to predict future invasion risk and management options in Minnesota

I. PROJECT STATEMENT

Aquatic invasive species (AIS), including emerging pathogens (EP), negatively affect the ecology and enjoyment of Minnesota's precious natural resources. As a result, millions of dollars are spent and countless hours of effort are dedicated each year for prevention, management and control. Allocating our limited funds and effort to areas of greater risk or approaches that yield maximum benefit is essential.

A scientifically justified and integrated analysis to identify factors and areas of greatest risk for future invasion has been identified as an urgent need by managers, researchers, and the public alike. Understanding the historical spread of AIS and EP to predict future invasions is no trivial task, considering the complex interaction of human and natural pathways. However, we hypothesize that by mathematically modeling various pathway networks and risk factors, the historical spread of AIS and EP can be explained. We further hypothesize that parameters derived from these network models can be used to predict the spread of future invasions. These tools will allow managers to better allocate limited resources based on areas of risk and evaluate management strategies for maximum benefit.

Our ultimate goal is to protect the long-term health and sustainability of Minnesota's fish populations by limiting the impact and spread of AIS and EP. This goal will be achieved in part by describing and mathematically modeling the spatial distribution and pathways of AIS and EP in Minnesota to predict future spread, estimate risk and evaluate the impact of control interventions. More specifically, we will:

1. Describe the movement of AIS and EP through human-influenced and natural networks in Minnesota
2. Simulate and predict the spread of AIS and EP based on a mathematical model
3. Evaluate various hypothetical management strategies to reduce the spread of AIS and EP

Preliminary research as part of an ongoing project has focused on statistically describing the distribution of zebra mussels, Eurasian water milfoil, and viral hemorrhagic septicemia virus in Minnesota. In addition, high-risk pathways for these species have begun to be analyzed, including water connectivity (data source: US Geological Survey), watercraft movement (data source: MN DNR watercraft inspection program), and baitfish harvest (data source: recent industry survey). An integrated analysis and organization of these data has not previously been done and will greatly inform the proposed model development in this project. As an example, five significant clusters of zebra mussel-infested waters have been identified in Minnesota. Understanding how these clusters are linked through direct connectivity, watercraft, and baitfish will allow us to estimate the role each pathway has played in the historical spread. **Once the historical spread has been explained, future invasion potential can be predicted based on an intensive evaluation and validation process. We can then mathematically interject various "what if?" management scenarios in the model to estimate the affect, if any, on the spread.**

Activity 1: *Describe the movement of AIS and EP through human-influenced and natural networks in Minnesota* **Budget: $91,780**

Preliminary research to characterize the connections between bodies of water from watercraft movement (MN DNR watercraft inspection surveys) and direct water connectivity (USGS) has been completed. These organized data sets will be described using network analysis. The networks will be fit to historical data to determine how well each pathway explains the spread to date of zebra mussels and Eurasian water milfoil.

A hypothetical introduction event will be simulated to forecast the spread of AIS and EP through individual networks. Individual network models will be important to evaluate the interaction of pathways (Activity 2) and management intervention (Activity 3). The structure of the network analyses will be presented to stakeholders at a half-day workshop, in which critical parameterization will be assessed and reviewed until reaching consensus.

Outcome	Completion Date
1. Descriptive summary and simulation of AIS movements through human-influenced (watercraft) and natural (water connectivity) networks	*March 2017*
2. Workshop with AIS stakeholders to finalize network analyses	*March 2017*

Activity 2: *Simulate and predict the spread of AIS and EP based on a mathematical model.* **Budget: $87,680**

Significant parameters from the networks (Activity 1) will be combined to develop a mathematical model. Additional risk factors, such as climate and habitat suitability, will also be evaluated to strengthen the model. The final model will include the significant risk factors that best explain the distribution of AIS and EP in Minnesota. A hypothetical invasion will be simulated to predict future spread and identify areas of risk.

Outcome	Completion Date
1. A descriptive report of AIS and EP invasion in Minnesota and underlying risk factors	*December 2017*
2. Mathematical model and risk maps predicting future invasion potential for AIS and EP	*March 2018*

Activity 3: *Evaluate various hypothetical management strategies to reduce the spread of AIS and EP.* **Budget: $84,681**

The network analyses and model will be designed to explain the current distribution of AIS and EP and assume the status quo for future invasion potential. Through an iterative and collaborative process with managers and other stakeholders, an adaptive management approach to modify various factors will be done. This will allow for the evaluation of "what if?" management scenarios to test the outcome, without the time, money, or risk of doing so in real life.

Outcome	Completion Date
1. Workshop with AIS and EP stakeholders to test hypothetical prevention, management, and control strategies.	*March 2018*
2. Cost-effective and risk-based recommendations for prevention, management, and control strategies to limit the introduction and spread of AIS and EP in MN.	*June 2018*

III. PROJECT STRATEGY

A. Project Team/Partners: A highly collaborative team of researchers and mangers will work together to successfully achieve the proposed activity. The project team to be funded by ENRTF includes Principal Investigator Dr. Nick Phelps, and Co-investigators Dr. Meggan Craft, Dr. Andres Perez, Dr. Michael McCartney, Dr. Paul Venturelli, one graduate student, and one post-doctoral associate. Members of the project team not to be funded by the ENRTF consist of AIS managers from MN DNR and other researchers within the Minnesota Aquatic Invasive Species Research Center.

B. Project Impact and Long-Term Strategy: This research activity is intended to create a mathematical modeling tool for management and mitigation of threats to aquatic natural resources in Minnesota. Once developed, the tool can be easily adapted to include additional species of interest, risk factors, and management scenarios. Public and private stakeholders interested in making use of the tool, including the MN DNR and counties, will be trained on its operation and abilities. As future research is conducted, the model can be refined to more accurately reflect our understanding of AIS and EP in Minnesota.

C. Timeline Requirements: Two years (7/1/16-6/30/18) is required to complete the proposed project activities.

2016 Detailed Project Budget

Project Title: Understanding the historical spread of aquatic invasive species to predict future invasion risk and management options in Minnesota

IV. TOTAL ENRTF REQUEST BUDGET : 2 years

BUDGET ITEM	AMOUNT
Personnel:	
Nicholas Phelps (PI): Activity 1-3; 10% FTE per year (plus 33.7% fringe)	$ 26,775
Meggan Craft: Activity 1; 5% FTE per year (plus 33.7% fringe)	$ 13,676
Andres Perez: Activity 2; 5% FTE per year (plus 33.7% fringe)	$ 15,840
Michael McCartney: Activity 3; 2% FTE per year (plus 33.7% fringe)	$ 4,007
Paul Venturelli: Activity 3; 2% FTE per year (plus 33.7% fringe)	$ 5,451
Graduate student: Activity 1-3; 50% FTE per year (plus 79.43% fringe)	$ 81,975
Post doctoral associate: Activity 1-3; 100% FTE (plus 22.4% fringe)	$ 106,317
Professional/Technical/Service Contracts:	$ -
Equipment/Tools/Supplies:	$ -
Computer software : ArcGIS	$ 3,000
Computer software : Clusterseer	$ 1,600
Acquisition (Fee Title or Permanent Easements): N/A	$ -
Travel:	
Domestic travel to attend one scientific conference per year of the project	$ 5,000
In state travel to meet with project partners	$ 500
Additional Budget Items:	
One workshop with project partners and stakeholder per year of the project	$ 5,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 264,141

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: /	N/A	
Other State $ To Be Applied To Project During Project Period:	TBD	*Pending*
In-kind Services To Be Applied To Project During Project Period: /	N/A	
Funding History: The proposed project is a continuation of a 2-yr $500,000 MnDRIVE project.	$500,000	7/1/14 - 6/30/16
Remaining $ From Current ENRTF Appropriation:	N/A	

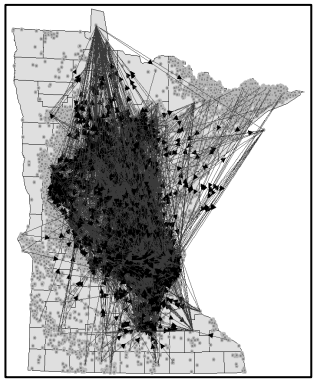
Understanding the historical spread of aquatic invasive species to predict future invasion risk and management options in Minnesota

Goal of the project:

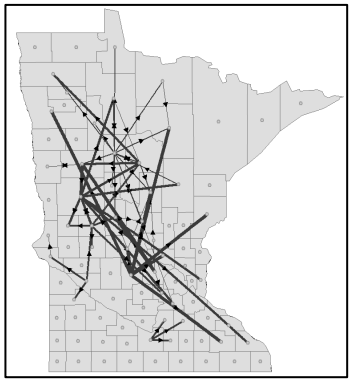
To develop a mathematical model of the spatial distribution, risk factors, and pathways of aquatic invasive species (AIS) and emerging pathogens (EP) to predict the spread and evaluate the impact of control strategies.

Pathways and risk factors

Watercraft



Baitfish

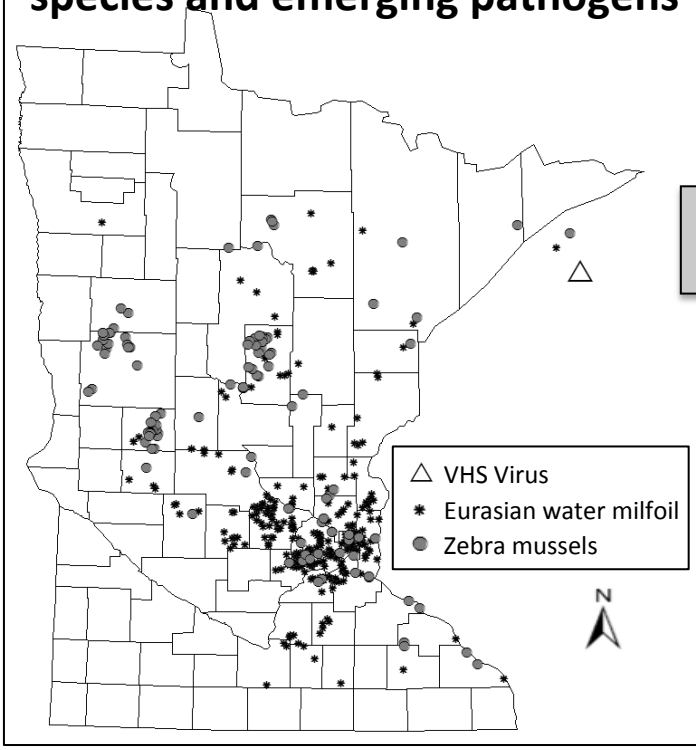


Water Connectivity

Other factors

To be determined based on ongoing research

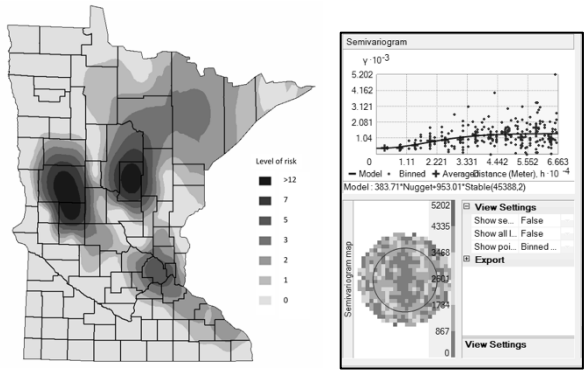
Distribution of aquatic invasive species and emerging pathogens



Model → Management!

Mathematical modeling will be used to understand how pathways and risk factors have contributed to the invasion of AIS and EP. We can use approach to:

1. Predict future invasions
2. Develop risk maps
3. Strategically target management
4. Evaluate "what if?" scenarios



Preliminary modeling of zebra mussel risk by team members

PROJECT MANAGER QUALIFICATIONS AND ORGANIZATION DESCRIPTION

Nicholas Phelps, Project Manager, is an Assistant Professor in the Department of Veterinary Population Medicine at the University of Minnesota College of Veterinary Medicine. He also has an appointment with University of Minnesota Extension as the aquaculture specialist and a faculty member of the MN ENRTF supported MN Aquatic Invasive Species Research Center. He earned a Ph.D. in Veterinary Medicine (University of Minnesota), an M.S. in Aquaculture/Fisheries with an emphasis on fish health (University of Arkansas–Pine Bluff), and a B.S. in Aquatic Biology (Bemidji State University). His research focuses on emerging threats to fisheries sustainability and production, which lie at the intersection of animals, humans, and environmental health. Dr. Phelps has ongoing research in aquatic invasive species control, risk management, emerging virus discovery, diagnostic development, and significant efforts focused on detection, control, and management of the viral hemorrhagic septicemia virus of fish. Dr. Phelps has also led several aquatic invasive species prevention workshops in recent years.

The collective experience and organizational support of the project team members will ensure successful completion of the proposed project goals.

ORGANIZATIONAL DESCRIPTION

The diverse and multidisciplinary team assembled to understand AIS and EP spread, predict future invasions, and evaluate management strategies is comprised of two colleges at the University of Minnesota and the Minnesota Department of Natural Resources. All individuals are conveniently located in St. Paul to facilitate close collaboration and communication. Drs. Nicholas Phelps, Meggan Craft, and Andres Perez are faculty members of the Department of Veterinary Population Medicine in the College of Veterinary Medicine. The Department of VPM merges clinical and population sciences with veterinary diagnostic medicine to create opportunities to address today's most pressing issues in animal health and sustainability. Drs. Paul Venturelli and Michael McCartney are faculty members of the Department of Fisheries, Wildlife and Conservation Biology in the College of Food, Agriculture, and Natural Resources Sciences. The Department of FWCB studies the biology and ecology of some of the most interesting and diverse organisms and ecosystems in the world. Their goal is to respond to societal needs for information and education pertaining to the conservation of our natural resources and to ensure excellent teaching, research, and outreach programs. Drs. Nick Phelps, Paul Venturelli, and Michael McCartney are also collaborators with the Minnesota Aquatic Invasive Species Research Center, who's mission is to develop biologically and economically sound solutions to control key aquatic invasive species affecting Minnesota's waters. Lastly, the Minnesota Department of Natural Resources Division of Ecological and Water Resources, among other things, is responsible for protecting ecological health by restoring ecosystems and addressing threats such as invasive species.