Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)

Project Title: **ENRTF ID: 156-F**

Prioritizing Shoreline Habitat Restoration in Minnesota Lakes

Category: F. Methods to Protect, Restore, and Enhance Land, Water, and Habitat

Total Project Budget: $ 294,913

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 - June 2020

Summary:

This project will enhance efforts to increase natural reproduction of fish in Minnesota lakes by assembling easily accessible information on wave energy and near-shore spawning habitat.

Name: William Herb

Sponsoring Organization: U of MN - St. Anthony Falls Laboratory

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Web Address www.safl.umn.edu

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Diagram of wind creating waves on a lake, map of wave energy on a lake.

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

I. PROJECT STATEMENT

Fishing is big business in Minnesota, with over 1.5 million anglers spending more than 1.4 billion dollars each year. A key to maintaining healthy fish populations in Minnesota lakes is to maintain quality near-shore and shoreline habitat. Natural fish reproduction in MN lakes is threatened by watershed and lakeshore development activities, which increase erosion, sediment loading, and nutrient loading to lakes. For walleye, successful reproduction in a lake requires gravel to cobble substrates for egg incubation in near-shore waters. Development activities in a watershed or on a lakeshore can impact fish spawning habitat by increasing fine sediment and nutrient loading to a lake, filling in the substrates with fine sediment and decaying organic matter.

There are a number of ways in which healthy near-shore habitat in lakes is strongly linked to wind and wave energy. Examples include:

- Walleye spawning gravel substrates can be kept clean of fine sediment by wave energy.
- Wave energy affects the distribution of submersed aquatic plants that provide juvenile habitat for some fish species.
- Shoreline erosion is driven mainly by wind-generated wave energy.

As a result, successful lake habitat restoration requires good information on wind and wave energy, and this information is currently not available. The Minnesota DNR has approached the University of Minnesota to develop tools to provide better predictions of wave energy and near-shore habitat in Minnesota lakes.

The main goal of this project is to create easily accessible information on wave energy and near-shore habitat, to enable successful habitat restoration projects and increase natural fish reproduction in Minnesota lakes. The deliverable product will be a map (GIS layer) that can be used by lake managers to map different classes of near-shore habitat in a lake. The project will focus on walleye habitat, but the information created in this study will be applicable to many other fish species and to more general shoreline wildlife habitat restoration and erosion reduction efforts.

This project will take advantage of the experience of the Minnesota DNR in assessing and managing lake habitat, of the U of M St. Anthony Falls Lab (SAFL) in waves, sediment transport, and lake modeling, and of the UMD Natural Resources Research Institute in habitat assessment, spatial analysis, and management tools. Although wave energy models already exist for ocean coastline and large lakes, a key piece of the project will be to determine how wind-sheltering from surrounding hills and trees reduce wind speeds and wave energy on lakes of different sizes and shapes in Minnesota. Wind sheltering models previously developed at SAFL can use ENRTF-funded LiDAR data to accurately determine wind-sheltering and the corresponding reduction in wave energy. This study will take advantage of, and add to, the extensive lake data set generated by the ENRTF-funded SLICE (Sustaining Lakes In A Changing Environment) program, and will use Sentinel lakes as case study lakes.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Wave energy predictions for Minnesota Lakes* **Budget: $116,969**

Adapt previously developed wave models to small lakes and large lakes with complex shorelines, taking into account wind sheltering effects from local terrain and trees. Add models for sediment resuspension and transport to the wave model.

Outcome	Completion Date
1. Assemble preliminary models for predicting nearshore wave height and energy.	*3/2018*
2. Apply wave models to a set of four representative MN lakes.	*9/2018*
3. Add sediment resuspension models to wave model to predict lake substrate types.	*3/2019*

Activity 2: *Wave and sediment response measurements* **Budget: $84,677**

Collect wave height and water velocity data at four lakes for model verification. Conduct laboratory wave tank tests of *sediment resuspension and transport.*

Outcome	Completion Date
1. Experimental wave tank data for nearshore sediment resuspension and transport.	*6/2018*
2. Collect field data set for wind, waves, and nearshore water velocities.	*12/2018*

Activity 3: *Wave energy effects on near-shore lake habitat* **Budget: $33,127**

Relate predicted wave energy and sediment grain size distribution to available field surveys of near-shore substrate composition and plant communities.

Outcome	Completion Date
1. Acquire inshore substrate, aquatic plant, and other ancillary data for selected lakes to use in developing in shore habitat models based on wave energy.	*6/2019*
2. Characterize substrate composition, periphyton, and macrophyte growth in relation to wave power and lake trophic status.	*12/2019*

Activity 4: *State-wide shoreline habitat mapping* **Budget: $60,141**

The fetch, wave energy, and substrate models will be applied to a set of lakes across Minnesota. GIS-based maps of shoreline wave energy and habitat classes will be generated for a set of 500+ lakes in the state.

Outcome	Completion Date
1. Implement fetch, wave energy, and sediment sizing models into GIS environment.	*9/2019*
2. State-wide wave energy map for 500+ lakes; hold information sessions for lake managers.	*6/2020*

III. PROJECT STRATEGY

A. Project Team/Partners

Drs. William Herb and Heinz Stefan (*UMN-SAFL)* will be the overall lead in the project, develop wave energy and lake sediment models, relate wave energy to shoreline habitat features, and assist in the development of the habitat assessment tool. UMD-NRRI staff will assist in evaluating shoreline habitat features and in producing the deliverable maps. Herb, SAFL support staff, and NRRI staff will be funded by the ENRTF, while Stefan will contribute time to the project. All personnel funded by the ENRTF are soft-funded research staff and students.

The MN DNR will contribute in-kind staff time, equipment, and data for characterization of near-shore substrate composition and aquatic plant communities, coordinated by Tim Cross (Fisheries Research Scientist) and John Hiebert (Shoreland Habitat Manager).

B. Project Impact and Long-Term Strategy

Information on wave energy affecting shoreline habitats of Minnesota lakes is critical for lake managers using limited resources to improve sustainable lake habitat conditions. Using the study results to bolster critical natural reproduction processes for fish in lakes where shoreline habitats have been compromised is a likely outcome. The wave energy maps will have a number of applications, including, for example, mitigation of shoreline erosion for lake cabin owners and for reestablishing macrophytes in lakes.

C. Timeline Requirements

The proposed project is planned for three years, starting July 1, 2017 and ending June 30, 2020

2017 Detailed Project Budget

Project Title: Prioritizing shoreline habitat restoration in Minnesota Lakes

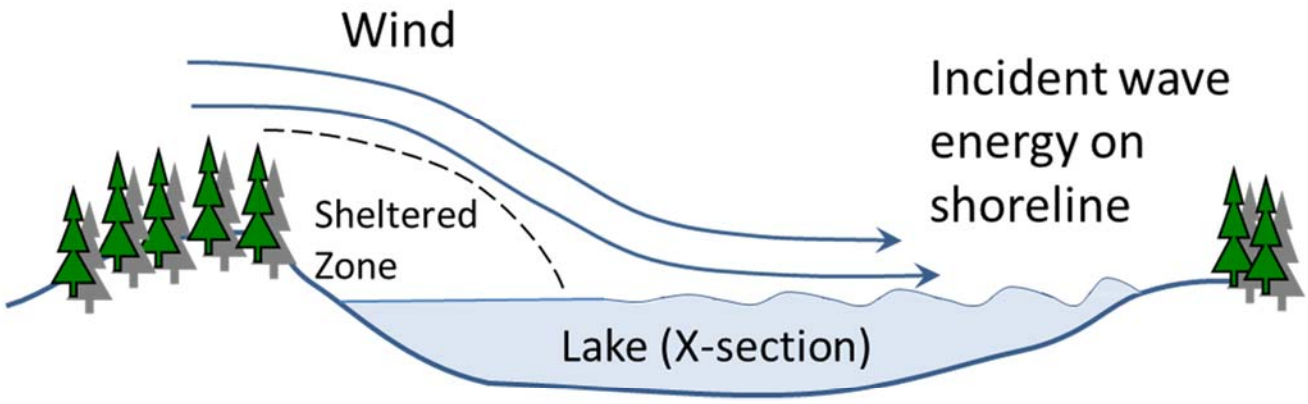
IV. TOTAL ENRTF REQUEST BUDGET, 3 years

BUDGET ITEM	AMOUNT
Personnel:	$ 278,010
Herb (PI): Project management, wave modeling, 28% fte, 66% Salary, 34% Fringe, 36 months ($84,926)	
NRRI Res. Assoc.: Map development, 15% fte, 66% Salary, 34% Fringe, 36 months ($42,513)	
Meijun Cai, Res. Assoc., Habitat model, 5% fte, 66% Salary, 34% Fringe, 36 months ($14,086)	
Erickson, B., Assist. Scient.: Field measurements,6% fte, 74% Salary, 26% Fringe, 36 months ($15,210)	
Res. Assoc.: Wave modeling, 39% fte, 66% Salary, 34% Fringe, 36 months ($94,021)	
Mielke, S., Jun. Scient.: Lab measurements, 6% fte, 74% Salary, 26% Fringe, 36 months ($12,178)	
Undergrad: Lab and field measurements, 22% fte, 100% Salary, 0% Fringe, 36 months ($15,075)	
Equipment/Tools/Supplies:	$ 12,825
6 distance sensors $400 each ($2,400)	
6 anemometers $375 each ($2,250)	
3 Data Loggers $1625 each ($4875)	
Tripods, Misc. field supplies ($2700)	
Misc. Lab Supplies ($600)	
Travel:	$ 3,368
Project personnel travel to field sites ($648)	
Duluth personnel travel to Twin Cities for meetings ($972)	
In-state conferences ($924)	
Informational seminars ($824)	
Other Expenses: Printing materials for informational seminars ($300), NRRI GIS Lab fees ($410)	$ 710
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	**$ 294,913**

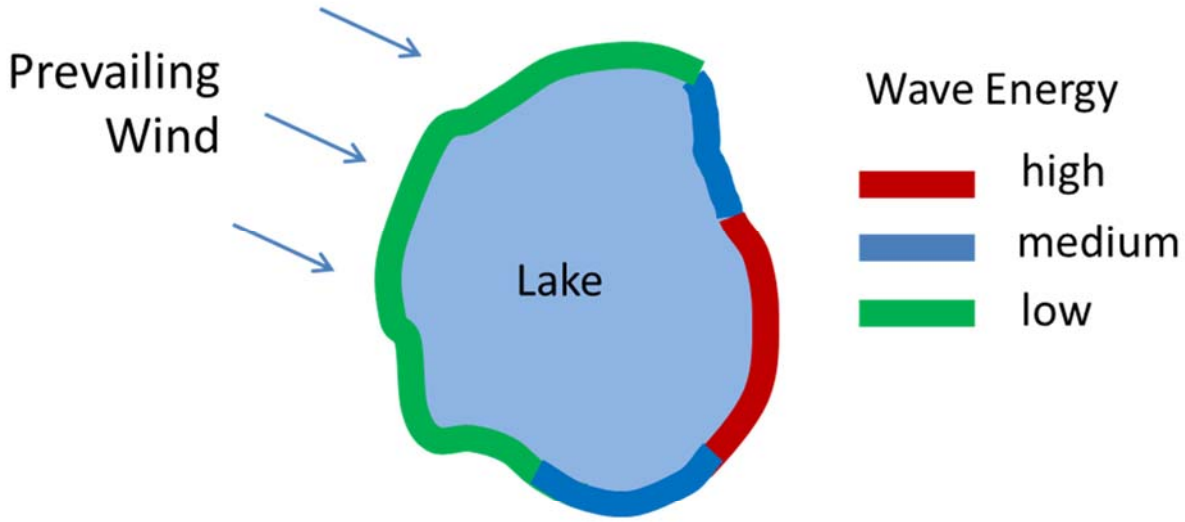
V. OTHER FUNDS

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: *In-kind services will be provided by the Minnesota DNR, including personnel and equipment, estimated $22,000 per year.*	$ 15,000	*estimated*
Unrecovered UMN Indirect costs (52% MTDC)	$ 153,355	*Secured*
Funding History: N/A	$ -	
Remaining $ From Current ENRTF Appropriation: N/A	$ -	

I. Create wave energy model



II. Map wave energy on each lake shoreline



III. MN DNR uses wave energy maps to manage fish habitat and shoreline restoration projects

2017 LCCMR Project Manager Qualifications and Organization Description

William Herb, St. Anthony Falls Laboratory, University of Minnesota

Key Qualifications

William Herb has conducted research on lake and stream water quality and hydrology for the past thirteen years. His past projects have included modeling studies aquatic plant growth in lakes, wind and wave measurements for assessing shoreline erosion on Lake of the Woods, and several projects assessing the effects of land use change and climate change on fish habitat in Minnesota lakes and streams. He also led the development of a software tool for the MPCA, used to assess the impact of land development on thermal pollution to trout streams. He is currently PI on a MnDOT funded project ($160k) to study the transport of road salt through watersheds in Minnesota, and was project manager for DNR Coastal Program project ($60k) to create high resolution hydrology models for North Shore streams.

Education

M.S., Water Resources Science, University of Minnesota 2003
Ph.D., Mechanical Engineering, University of Minnesota 1996
M.S., Mechanical Engineering, University of Minnesota 1991
B.S., Mechanical Engineering, University of Wisconsin 1985

The **St. Anthony Falls Laboratory** (SAFL) is an interdisciplinary fluid mechanics research and educational facility of the College of Science and Engineering at the University of Minnesota. The mission of SAFL is 1) to advance fundamental knowledge in engineering, environmental, geophysical, and biological fluid mechanics, 2) to benefit society by implementing this knowledge to develop engineering solutions to major environmental, water, ecosystem, health, and energy-related problems, and 3) to disseminate new knowledge to University of Minnesota students, the engineering and scientific community, and the public.