Environment and Natural Resources Trust Fund

2025 Request for Proposal

General Information

Proposal ID: 2025-199

Proposal Title: Protecting Shorelines and Preserving Habitat in Minnesota Lakes

Project Manager Information

Name: Jessica Kozarek

Organization: U of MN - St. Anthony Falls Laboratory

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Project Basic Information

Project Summary: The effectiveness of lakeshore protection and restoration approaches will be tested in a novel lakeshore laboratory designed to test the interactions between wind and boat waves and various shoreline vegetation.

ENRTF Funds Requested: $683,000

Proposed Project Completion: June 30, 2028

LCCMR Funding Category: Water Resources (B)

Project Location

What is the best scale for describing where your work will take place?

Region(s): Metro

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Minnesota has over 30,000 miles of inland lakeshore, many of which have been developed or are undergoing development. These lakeshores are subject to erosive forces due to wave action from both wind driven waves and human disturbances (boat wakes). However, hard armoring techniques often used to protect against erosion, such as seawalls or riprap, can alter sediment transport and remove critical riparian and near-shore habitat. Soft armoring techniques incorporate or mimic natural shorelines by using, for example, vegetation or natural materials to 1) dissipate or attenuate wave energy and 2) help hold soil in place via root structure. Under the appropriate conditions, these nature-based techniques may be more cost efficient, provide ecological and aesthetic benefits, and be more resilient to changing lake levels (e.g., responsive to natural shoreline migration). However, these approaches may not be sufficient or relevant in all situations, particularly for sites with very high wave energy and may need to be modified. While significant information is available for shoreline protection for estuarine, marine and Great Lakes coastal systems, there is a need to quantify the benefits and support the design of natural and nature-based shorelines for typical inland lakes in Minnesota.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

The goal of this project is to inform best practices for shoreline management by linking wave characteristics (wave height, frequency, etc.) to shoreline protection effectiveness (wave attenuation, reduced fluid stresses, reduced shoreline erosion). We plan to address shoreline stabilization across a range of wave types/shorelines such that the results are broadly applicable to inland lakes to target effective solutions to protect shorelines and preserve habitat.

The major tasks will include:

1. Review of soft armoring methodology (Activity 3). In conjunction with project partners and stakeholders, we will compile a review of soft armoring and nature-based methods for shoreline protection. This review will include a survey of current lakeshore stabilization practices in Minnesota.

2. Outdoor laboratory experiments (Activities 1 and 2). We will create an outdoor experimental facility to evaluate the effectiveness of nature-based solutions in stabilizing shorelines and attenuating water waves. Wave characteristics will be assembled from existing monitoring data and used to set the experimental wave conditions. Experimental lakeshores will be constructed based on data from rocky, sandy, and clay-y lakeshore materials.

3. Outreach and education (Activity 3). The research team will coordinate with shoreline practitioners and will work in conjunction with SAFL communications staff to share results.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

The major outcome from this project is the systematic evaluation of shoreline protection methods to reduce the impact of wind-driven and boat waves on shoreline erosion. Motivated by the high degree of natural variability in wave characteristics (height, wavelength, etc.), vegetation (species, submerged and emergent, etc.), and shoreline materials (rock, cohesive clay, etc.), we plan to use experiments to investigate the effect of soft armoring (vegetation) while controlling other variables (e.g., shoreline material and wave characteristics). A key target will be to determine the wave characteristics under which soft armoring methods are effective.

Activities and Milestones

Activity 1: Design, setup, and preliminary experiments in Outdoor LakeshoreLab

Activity Budget: $300,000

Activity Description:
The first activity is the design and setup of the Outdoor LakeshoreLab in the outdoor research space adjacent to the Outdoor StreamLab (OSL) at SAFL. Similar to the goals of the OSL for streams, this experimental set up will allow for experiments on the interactions between physical (erosion), and biological (plant establishment and growth) processes in a controlled environment designed to mimic a lakeshore. Focused on lakeshore processes, this experimental area will consist of a long pool (10 m x 2 m x 1 m deep) with a controllable wave maker capable of creating repeatable waves with characteristics similar to wind and boat waves on Minnesota's inland lakes. Because many soft armoring approaches on lakeshores involve vegetation, the outdoor location and full-scale setup is key to incorporating vegetation processes including root growth into the strategic evaluation of lakeshore protection approaches. We propose an experimental approach over field data collection because of several key advantages: 1. It will not be subject to the uncertainties involved in the timing of wave events and in water levels 2. Experiments enable the testing of individual management activities while controlling for variability in shoreline material (soil properties).

Activity Milestones:

Description	Approximate Completion Date
Design kickoff meeting	December 31, 2025
Design and setup of lakeshore experiments	June 30, 2026
Testing and preliminary experiments	December 31, 2026

Activity 2: Lakeshore protection experiments

Activity Budget: $290,000

Activity Description:
We will utilize the Outdoor LakeshoreLab to conduct experiments to demonstrate and evaluate the impact of soft armoring approaches to shoreline protection. Soft armoring approaches rely on natural materials to 1) attenuate wave energy, 2) reduce near shore hydrodynamic forces, and 3) prevent geotechnical failure. To demonstrate and evaluate the benefits various soft armoring approaches, we propose experiments that incorporate real vegetation to include the stabilizing aspects of terrestrial vegetation and rooting structures. We will collect data on wave heights / frequency vs. erosion under various conditions for specific soils representative of lakeshores. We will measure absolute erosion and erosion rates on the shoreline and lakebed. In addition to experimental data, we will focus on video and image collection to document and visualize processes involved in shoreline erosion and protection that are difficult to capture in the field. This will provide unique materials for our education and outreach efforts. The final experimental matrix of shoreline protection methods will be determined in conjunction with our advisory group (Activity 3), but will include fully vegetated shorelines with native vegetation and root structure, partially armored (with riprap) shorelines with vegetation, and fully armored (retaining wall) shorelines.

Activity Milestones:

Description	Approximate Completion Date
Experimental matrix with input from stakeholders	January 31, 2027
Complete shoreline experiments	November 30, 2027
Complete followup shoreline experiments	May 31, 2028
Final report and publication of data	June 30, 2028

Activity 3: Meeting with Minnesota Lake Shore Stakeholders

Activity Budget: $93,000

Activity Description:
Minnesota's lakes are one of its greatest assets, valued by many different stakeholders for many different uses. Heavily developed shorelines have implications for water quality through increased nutrient and sediment inputs and loss of aquatic and terrestrial shoreline habitat. Faced with the impacts of shoreline erosion due to wind and boat waves, many landowners turn to retaining walls or riprap, expensive options that often have negative consequences for habitat. These tradeoffs are well recognized by many shoreline natural resource professionals and stakeholder groups including: various SWCDs and watershed districts, MN DNR, Minnesota Lakes and Rivers Advocates, MN COLA, Freshwater Society, and others. This project is designed to support the efforts of these stakeholders to protect shoreline habitat through the testing and evaluation of shoreline approaches designed to reduce erosion while retaining shoreline habitat. It is expected that this project will provide quantitative data and qualitative visuals of the tradeoffs between vegetation benefits in shoreline protection and hard armoring consequences. We will develop an advisory team early in the project, survey current lake shoreline management practices, and meet with this team throughout to ensure that the project is informed by practice and that there is direct transfer of information to practice.

Activity Milestones:

Description	Approximate Completion Date
Build advisory team	September 30, 2025
Kickoff meeting	December 31, 2025
Field site visits by reserach team	August 31, 2026
Site visit - SAFL Outdoor LakeshoreLab	October 31, 2026
Identify key practices with stakeholder input	January 31, 2027
Site visit - SAFL LakeshoreLab and shoreline workshop	June 30, 2028

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Jeffrey Marr	University of Minnesota - ,St. Anthony Falls Lab	co-PI, experimental setup and linkage with ongoing lake work	Yes
Kimberly Hill	University of Minnesota, St. Anthony Falls Lab	co-PI, mentor graduate student, sediment transport expertise	Yes
William Herb	University of Minnesota- St. Anthony Falls Lab	co-PI, wave analysis expertise	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

The research products will be technical reports and video documentation from the outdoor experiments. All data and reports will be made publicly available through the UMN Digital Conservancy and Data Repository. These data will be shared directly with state and local lakeshore stakeholders through meetings and a lakeshore workshop hosted at SAFL. The design and creation of a lakeshore test basin at SAFL will allow for a wide range of future research questions related to lakeshore areas in Minnesota including fish habitat, vegetation dynamics for submerged, emergent and shoreline plants and evaluation of future protection methods.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Wind Wave and Boating Impacts on Inland Lakes	M.L. 2023, , Chp. 60, Art. 2, Sec. 2, Subd. 04c	$415,000

Project Manager and Organization Qualifications

Project Manager Name: Jessica Kozarek

Job Title: Researcher

Provide description of the project manager's qualifications to manage the proposed project.

Jessica Kozarek has been a research associate and manager of the Outdoor StreamLab at the University of Minnesota at St. Anthony Falls Laboratory since 2010. She received a BS in chemical engineering from Penn State, and MS and PhD degrees in biological systems engineering from Virginia Tech. Dr. Kozarek's primary research interests are in the areas of stream restoration and management; ecohydraulics; interactions between flow, sediment, and aquatic biota and vegetation; use of hydraulic models to develop restoration guidance; and water quality and nutrient dynamics. She designs and leads experiments linking physical (flow and sediment movement), and biological processes (fish, mussels and vegetation) in aquatic environments in the lab, the field, and in the Outdoor StreamLab, a field-scale stream and floodplain experimental facility. Dr. Kozarek is an experienced project manager having led multi-investigator projects for state and federal agencies and will work in conjunction with co-PI Jeff Marr to manage the design and setup of experimental facilities at SAFL. Marr manages SAFL's Applied Research and Engineering team, a 13 member team that

supports research through custom experimental facility and instrumentation construction and carries out applied research with public and private sponsors.

Organization: U of MN - St. Anthony Falls Laboratory

Organization Description:
The St. Anthony Falls Laboratory (SAFL) is an interdisciplinary fluid mechanics research lab and educational facility under the College of Science and Engineering at the University of Minnesota.

SAFL is comprised of engineers and scientists who collaborate across disciplines to solve fluids-related problems in the Earth-surface environment. Our vision encompasses both science and practice, beginning with basic research and moving through application, decision-making, and management.

Located on Hennepin Island in the Mississippi River in the heart of Minneapolis, SAFL serves as a resource for departments across the Twin Cities campus, the statewide University system, and the broader research community. SAFL partners with local, state and federal agencies; private consulting firms; businesses of many kinds; technical associations; and other educational institutions to expand knowledge and solve problems.

Located adjacent to SAFL, the Outdoor StreamLab (OSL) and affiliated outdoor research space offers laboratory-quality measurements and control in a field-scale setting with access to natural sunlight and climatic conditions. This facility can be used for a variety of hydrological, ecological, and biological research opportunities. Equipment in the OSL includes flow sensors, water chemistry sensors, and a data collection carriage.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Jessica Kozarek		PI/Project Manager			37.1%	0.51		$105,656
Kimberly Hill		Co-PI, Graduate Student Mentor			37.1%	0.06		$15,266
Jeffrey Marr		Co-PI, Experimental Setup			37.1%	11.55		$20,836
William Herb		Co-PI, Experimental Design			37.1%	51.9		$36,496
Richard Christopher		EngineerExperimental Setup/Plumbing and Construction			37.1%	0.24		$30,210
Matthew Hernick		Experimental Setup/Plumbing and Construction			37.1%	0.24		$30,322
Christopher Milliren		Experimental Setup/Data Collection			37.1%	0.24		$25,458
Matthew Lueker		Experimental Setup/Wave Maker Design			33.5%	30		$29,447
Andrew Riesgraf		Experimental Setup/Plumbing and Construction			33.5%	30		$28,607
Benjamin Erickson		Experimental Setup/Facilities Coordination			33.5%	30		$30,036
Erik Noren		Experimental Setup/Machinist			33.5%	0.33		$13,158
Cheryl Miller		Experimental Setup/Safety and Coordination			37.1%	0.15		$17,839
Civil Engineering Graduate Student (TBD)		Graduate Researcher, Experiments			55%	1		$115,057
2 Undergraduate Students		Undergraduate Researchers			0%	1.5		$22,922
							Sub Total	**$521,310**
Contracts and Services								
TBD	Professional or Technical Service Contract	Concrete Contractor				0		$30,000

University of Minnesota, Facilities Management	Professional or Technical Service Contract	Electrical work completed by UMN Facilities Management for electrical needs to run wave maker.				0		$35,000
							Sub Total	**$65,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	Supplies including lumber, plumbing, water pumps	Supplies to set up lakeshore facility					$16,000
	Tools and Supplies	Experimental supplies including sediment and vegetation	Supplies to set up lakeshore facility					$15,000
	Tools and Supplies	Experimental supplies including sediment and vegetation	Supplies to set up lakeshore facility					$2,000
	Equipment	Equipment Rental	Rental of earth moving equipment to construct experimental lake shore					$10,000
							Sub Total	**$43,000**
Capital Expenditures								
		Equipment to construct outdoor wave maker including actuators, metal panels, etc. Cost reflects constructed equipment.	Equipment used to create repeatable waves in outdoor facility.	X				$50,000
							Sub Total	**$50,000**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Conference Registration Miles/ Meals/ Lodging	Yr 2, travel (mileage) for 2 people for 2000 miles (5 trips x 100 miles each way) at $0.63/mile for travel to site visits (lakeshore projects); Yr 3- conference registration for 2 presentors at MN Water resources conference (2 X $220)	Yr 2- travel to site visits (lakeshore projects); Yr 3 - converence registration for 2 people to present and attend at Minnesota Water Resources Conference					$1,690
							Sub Total	**$1,690**
Travel Outside Minnesota								

							Sub Total	**-**
Printing and Publication								
	Publication	cost for publication fees for peer reviewed journal article (average cost $2,000)	publication fees for peer reviewed journal article					$2,000
							Sub Total	**$2,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$683,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Capital Expenditures		Equipment to construct outdoor wave maker including actuators, metal panels, etc. Cost reflects constructed equipment.	This equipment, to be manufactured at SAFL, is a unique and required piece of equipment to study wave interactions in this outdoor space. It will be used to study lake waves and shorelines (research proposed in this project and any followup research) for the duration of its useful life. Individual costs include actuators ($20,000), machined metal parts ($20,000), and machined connections ($5,000), and energy dissipators ($5,000). **Additional Explanation :** This equipment, to be manufactured at SAFL, is a unique and required piece of equipment to study wave interactions in this outdoor space. It will be used to study lake waves and shorelines (research proposed in this project and any followup research) for the duration of its useful life.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $683,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: f330eeef-b1d.pdf

Alternate Text for Visual Component

The SAFL OSL is a highly visible experimental facility with a viewing platform and signage describing research in the public park. The Outdoor LakeshoreLab will be set up in the space adjacent to the Outdoor StreamLab, consisting of a large tank and wave making device....

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
PRF_1129223 LCCMR Kozarek Letter of Support.pdf	e185634e-af2.pdf
Letter- MN Lakes and Rivers	a234eba1-192.pdf
Letter - MN COLA	a596a119-257.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

No

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing $10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Angela Boutch, UMN St. Anthony Falls Laboratory