Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-470

Proposal Title: Continuously Monitored Mesotrophic Lakes: Healthy Waters, Thriving Fisheries

Project Manager Information

Name: Craig Hill

Organization: U of MN - Duluth

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Project Basic Information

Project Summary: Continuous long-term temperature and water quality monitoring in adjacent mesotrophic lakes under similar environmental forcing helps understand response to climate and human impacts and the implications on fisheries and recreation.

ENRTF Funds Requested: $299,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Small Projects (G)
Secondary Category: Water (B)

Project Location

What is the best scale for describing where your work will take place?
Region(s): Central, NW,

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's economy is closely tied to its lakes. To protect these ecosystems, many state, university, non-profit, and community organizations engage in monitoring programs across the state. These observations provide a wealth of data to understand climate and human-induced impacts on fisheries, water quality, and recreation. Most monitoring occurs scattered throughout the state, and an opportunity exists to enhance our understanding of lake ecosystem response using two adjacent mesotrophic lake environments with very different depths, littoral zones, and surrounding development. Availability of new lower-cost observation systems provides opportunities to expand continuous monitoring programs throughout the state to augment existing manual sampling and other long-term monitoring programs. Oftentimes, appropriate sensors are only available for short periods of time, occasionally being reallocated to other research programs, leaving critical gaps in observational data. To appropriately manage systems, we need to accumulate detailed continuous annual observations highlighting seasonal turnover, lake warming, water quality changes, and correlations to external meteorological forcing. The adjacent location between the proposed lakes allows a unique test bed for monitoring and assessing the conditions of surface water on a regular cycle to enhance existing observation programs and develop new long-term data comparing previously undocumented changes in two mesotrophic lakes.

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.

Two north-central Minnesota lakes have been identified as test beds for establishing year-round environmental long-term monitoring stations to understand annual variations in warming and water quality and its potential impacts on fishing and recreation. Located near a popular summer destination, Hinds Lake is a small, relatively shallow, minimally developed lake with a large littoral zone. Long Lake, located just 1.5 miles away, is a heavily developed, larger and deep lake with a small littoral zone. The close proximity ensures that external meteorological forcing is similar for both lakes, yet their ecosystems and human influence are very different, providing a unique location to make high resolution continuous year-round measurements. In the deepest portion of each lake, a vertical thermistor chain with 10-20 nodes will monitor temperature fluctuations. Two key locations at various depths in each lake will use 12 parameter sondes to identify changes in water quality parameters, and the rate of change across depths in these surface water systems. When conditions permit, monthly vertical multiparameter sonde profiles will be collected. Shoreside water level and basic water quality stations will augment the data from deep water column observations, providing a holistic seasonal view on system response.

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?

Monitor, analyze, compare, and visualize ecosystem response variations in two adjacent yet different mesotrophic lake systems, enhancing our understanding on how to protect these important fisheries and recreation ecosystems. Data supports decision-making and evaluation efforts for lake associations and state agencies, augments established volunteer and state-run manual sampling programs, informs local residents and schools through outreach, and provides a system to accept additional sensors for AIS monitoring or other parameters. This project aims to also demonstrate the capabilities of lower-cost environmental lake monitoring systems to emphasize the potential for expanding similar networks across the region and state.

Activities and Milestones

Activity 1: Laboratory validation - Data Acquisition (DAQ) system assembly and operations

Activity Budget: $107,887

Activity Description:
Leveraging experience building real-time marine observation systems, the research group will purchase all necessary sensors, data acquisition, and field deployment equipment. The project PI (Dr. Hill) will work closely with a graduate and undergraduate student to assemble the two deep-lake temperature and water quality monitoring stations, including the anchor and mooring system and the submerged data acquisition and power enclosure. These systems include the anchor and release system, electronics enclosures (data logger and converters) with connections for temperature monitoring cables, connection and routing of multiparameter water quality sondes, and power systems. Due to the timing of the project start date, we aim to move quickly through this activity to allow for pre-winter system deployments. Five shoreside monitoring stations will initially be built to deploy at Hinds Lake (2) and Long Lake (3) during the first year. These shoreside stations will be assembled and tested during this activity, including setup of the data acquisition (DAQ) system and the user dashboard where real-time data is visible. To ensure reliable and repeatable methods across each year of the project, the team will develop a documented Standard Operating Procedure (SOP) for field activities and system assembly and operations.

Activity Milestones:

Description	Approximate Completion Date
Purchase all necessary monitoring equipment	August 31, 2026
Fabricated field monitoring stations and validate continuous data acquisition system operations in the laboratory	October 31, 2026
Develop field deployment and recovery SOP	October 31, 2026

Activity 2: Field Deployments

Activity Budget: $157,091

Activity Description:
The project team targets initial system deployment prior to the 2026-2027 winter season, aiming to get lake temperature and water quality monitoring stations in deep-lake locations before ice coverage sets in. Each year the team will visit the primary system deployment locations in the deep part of Hinds and Long Lake to recover/deploy the monitoring stations. This will happen shortly after ice out (~May) and in late Fall (~November) to download new data, replace batteries, maintain system components, etc. Additionally, the project team will use a multiparameter sonde to collect monthly vertical profiling casts, providing additional data verification and system response information. Recovery of deep-lake continuous monitoring platforms is done via an acoustic release system, allowing the team to deploy a vertical profile of sensors while maintaining clearance below all watercraft, yet still be able to easily locate, recover, and redeploy from the surface. All field activities will use already available watercraft and closely follow AIS prevention protocols. Deploying, maintaining, and servicing shoreside observation stations also is included in this activity, which includes visiting each of the deployed real-time shore stations and performing any necessary maintenance on the deployed components.

Activity Milestones:

Description	Approximate Completion Date
Year 1 (2026-2027) Data Collection	April 30, 2027
Year 2 (2027-2028) Data Collection	April 30, 2028

Year 3 (2028-2029) Data Collection	April 30, 2029

Activity 3: Outreach and Data Dissemination

Activity Budget: $10,917

Activity Description:
Data from the deep-lake monitoring stations documenting continuous water temperatures and water quality parameters at two key depths will be processed and visualized in an annual report and presentation for Hinds Lake and Long Lake. These reports will include key findings, visualizations of water temperature changes and trends, water quality metrics, identification of concerning trends related to fisheries and/or recreation (e.g. temperature thresholds, dissolved oxygen thresholds for fisheries, etc.). Reports will be archived with the UMN system, and also distributed to area agencies as part of Activity 4. As part of these reports, analysis will focus on the distinct characteristics of the two mesotrophic lakes, and highlight the comparison in temperature, water quality, water level, and other key metrics changing throughout the year.

Activity Milestones:

Description	Approximate Completion Date
Year 1 (2026-2027) Lake Observation Reports	June 30, 2027
Year 2 (2027-2028) Lake Observation Reports	June 30, 2028
Year 3 (2028-2029) Lake Observation Reports	June 30, 2029

Activity 4: Data Processing and Reporting

Activity Budget: $23,105

Activity Description:
Each year, the project team will provide annual updates on project accomplishments, data collected, and results to the Board of Directors for the Hinds Lake Association and Long Lake Association. This information will be passed on to association members. A key component of this will include providing visualization of the data observations, allowing association members and local residents to see how two adjacent lakes respond each year. Additionally, the project team will provide annual project reports and summaries to local organizations (Activity 3) (e.g. Park Rapids local DNR Fisheries office), and discuss how the team can provide outreach opportunities with local schools (e.g. Park Rapids school district).

Activity Milestones:

Description	Approximate Completion Date
Year 1 (2026-2027) Outreach Activities	June 30, 2027
Year 2 (2027-2028) Outreach Activities	June 30, 2028
Year 3 (2028-2029) Outreach Activities	June 30, 2029

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?

Results from monitoring will be shared with lake associations and residents at both lake locations, as well as with county agencies (e.g. DNR) and local schools. Ongoing funding will be pursued through future LCCMR opportunities, MN DNR, or other statewide environmental monitoring programs. A key component for outreach during this project is to demonstrate the benefit to lake associations, communicate associated costs for implementing observation systems, and potentially move towards developing systems affordable by local lake associations. With continued near-term funding, there is the potential to train local communities and residents to move towards longer-term, establish community-driven monitoring programs.

Project Manager and Organization Qualifications

Project Manager Name: Craig Hill

Job Title: Assistant Professor

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

Dr. Craig Hill brings extensive experience in developing observation systems for challenging marine environments, including both inland lakes for NE Minnesota as well as nearshore Lake Superior. He collaborates with the UMN Large Lakes Observatory and Minnesota Sea Grant to explore the capabilities of new, lower-cost multi-sensor observation systems for marine ecosystems, blending disciplines from mechanical engineering, water resources, computer science, and environmental science. With a background in geology and earth surface processes, civil engineering water resources, and mechanical engineering, for nearly two decades he has worked on collaborative research projects spanning marine renewable energy and multi-sensor observation systems. Prior to his faculty position at UMN Duluth, Dr. Hill worked as a marine research engineer where he designed and deployed large multi-sensor moorings for deep-water Lake Superior environments, designed and built small and large multi-sensor surface observation buoys for the Great Lakes, and worked in other environmental science and water resources related research at UMN St. Anthony Falls Laboratory. Dr. Hill manages multiple graduate and undergraduate student researchers and leads multi-institutional research projects between UMN Duluth, Oak Ridge National Labs, and private industry. Recent projects from Dr. Hill's research team have focused on characterizing wave energy resource availability across the Great Lakes, deploying wave observation buoys to monitor nearshore risks for rip currents and coastal erosion, and exploring the feasibility of an expanded real-time lake monitoring network for NE Minnesota. Additionally, he leads a research team developing new, low-cost wave and water quality monitoring buoys for coastal and inland lake monitoring applications. Dr. Hill teaches courses in fluid mechanics, sustainable energy, and data acquisition systems, and is guiding the development of new marine engineering curriculum at UMN Duluth. He is affiliated with the UMN Duluth Large Lakes Observatory, UMN Institute on the Environment, and the UMN Water Resources Science Program.

Organization: U of MN - Duluth

Organization Description:

The University of Minnesota Duluth (UMD) is a comprehensive regional university. Undergraduate students can choose from 17 bachelor degrees in 89 majors and 76 minors as well as five certificates. UMD also offers graduate programs in 24 fields, 12 minors, and six certificates. The Mechanical and Industrial Engineering (MIE) Department at UMD is the largest engineering department within the Swenson College of Science and Engineering at UMD and is developing a new specialized track in marine sensors and technology. With over 20 faculty members and an active student body of more than 500 students, the department excels in integrating research into undergraduate MIE curriculum and collaborating with regional companies on multidisciplinary senior design projects. Faculty in the department share affiliations with the

Advanced Materials Center, Large Lakes Observatory, among other campus-affiliated and community-based organizations. The MIE Department also houses two graduate degree programs, including the MS in Mechanical Engineering and MS in Environmental Health and Safety. Within the MIE Department and across the UMD campus, faculty are dedicated to providing applied teaching and research experiences sharing a common thread of sustainability while developing life-long learners from our graduates.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Craig Hill, PI		0.9 summer months and one course buyout Y1-3; PI Hill will lead all activities in this project and guide GRA and UG researcher through Activities 1 and 2			27%	0.27		$106,836
GRA		50% appt academic year and summer; GRA will take primary responsibility under PI Hill's direction to build and validate DAQ systems, mentor UG researcher, assist with all Field Deployments, and contribute to data analysis/reporting			45%	1		$110,870
Undergrad researcher		566 hours/year, Y1-3; Undergraduate Researcher will assist PI and GRA with systems assembly and lab validation, assist with field deployments, and assist with data analysis.			0%	0.81		$26,679
							Sub Total	**$244,385**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	Lab consumable $1,000/year; Shore station water quality data logger systems 5 @ $500/year; Field Deployment Supplies $1,000/year; anchor platforms 2 @ $150 in Y1	Consumables include validation solutions for sondes, prototyping supplies and wiring, batteries for loggers, etc. Shore stations include sensors, enclosures, and antennas for each water level and quality station. Field deployment supplies include cables, ropes, shackles, etc. for mooring, posts for stations, and anchor platforms for in-water moorings.					$13,800
	Equipment	Non-capitalized equipment: Spot Data Logger, Digital Temperature Cable (DTC) - 30 feet, Digital Temperature Cable (DTC) - 120 feet, Recite SDI-12 converter, In-Situ Multiparameter Probe, Surface	All non-captilized equipment is used to continuously monitor aquatic environments, including digital temp cables for each lake, two sondes for each					$34,765

		Buoy for DAQ and sensors, Buoy DAQ system (w/ sensors), Acoustic release buoy	lakes (total of 4), buoy data logger and daq system and housing buoy for logging all data and transmitting to shore, data converters for DTC, and data loggers for logging and retrieving sonde and temp cable records. Acoustic releases ensure reliable and safe recovery of subsurface equipment.					
							Sub Total	**$48,565**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Field travel - 4 trips per year, 3 people each trip (PI, GRA, UG): 1639 miles, 12 days of per diem per year	Mileage and per diem costs for covering trips to/from/between field sites for deployment/recovery/maintenance and data download of field DAQ systems, and outreach.					$5,575
							Sub Total	**$5,575**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		Shipping	Shipping costs for the acoustic release, DTC, shore stations, and general shipping supplies					$475

							Sub Total	**$475**
							Grand Total	**$299,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 54% modified total direct costs.	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs)	Secured	$142,018
			Non State Sub Total	**$142,018**
			Funds Total	**$142,018**

Total Project Cost: $441,018

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 993ef1eb-4f4.pdf

Alternate Text for Visual Component

Satellite view maps of Hinds and Long Lakes in Hubbard County showing illustrations of deep-water monitoring systems and shoreside stations....

Supplemental Attachments

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

Title	File
Hinds Lake Advocate - Letter of Support	5e947619-5ec.pdf
UMN Authorization Letter	e635bbf8-ad7.pdf
Sharon Natzel - Water Monitor - Letter of Support	65203fd3-bd1.pdf
Hubbard County COLA - Letter of Support	b6182b63-bdf.pdf
Long Lake Area Association - Letter of Support	89b49bdb-df8.pdf
Hinds Lake Association - Letter of Support	84f2c70b-099.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

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:

This proposal was completed entirely by Lead PI Craig Hill

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A