Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-445

Proposal Title: Protecting Threatened Aquatic Insects and Coldwater Stream Systems

Project Manager Information

Name: Matthew Petersen

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Basic Information

Project Summary: We will assess threats to stream quality in coldwater systems, develop tools to more easily locate threatened aquatic insect species, and promote viable solutions for increasing resilience in these systems

ENRTF Funds Requested: $298,000

Proposed Project Completion: July 31, 2030

LCCMR Funding Category: Small Projects (G)
Secondary Category: Resiliency (A)

Project Location

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

What is the best scale to describe the area impacted by your work?
Region(s): NE

When will the work impact occur?
During the Project

Narrative

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

Minnesota's streams and rivers are threatened by climate change and watershed alteration, leading to more intense precipitation, frequent high-flow events, increased temperatures, and greater sediment and nutrient loading. These stressors reduce ecological quality across the state's stream systems and contribute to the loss of sensitive and rare species. Few naturally functioning stream systems remain; therefore, it is critical to benchmark species presence and biotic function in high-quality systems, like coldwater streams along Minnesota's North Shore, before they are lost. Aquatic insects are critically important to stream function in these systems. They process organic matter, provide prey for fish and birds, and are biological indicators responding to changing conditions based on species' environmental tolerances. Currently we cannot identify immature aquatic insects to species. Thus, full assessment of these systems is limited. Similarly, aquatic insects listed by the Minnesota DNR as threatened or endangered cannot be identified outside of their short-lived adult stage. These limitations constrain our ability to connect landscape management practices to stream health, and to locate and protect vulnerable taxa. There is also a need to coordinate state efforts for aquatic insects as they are important to water quality, assessment, and fisheries and wildlife management.

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.

Our research will demonstrate how landscape and local watershed practices can threaten coldwater river and stream habitats and the aquatic insects that inhabit these systems. By increasing the species detection potential using DNA barcoding and metabarcoding, we can precisely determine which factors lead to altered insect communities and decreased function (e.g., organic matter processing and prey availability). We will also increase the detection potential for state-listed threatened species for all insect life-stages. Specifically, we will: i) Quantify how landscape and local watershed practices correlate with stream function. We will create statistical models that can inform management on how watershed practices impact water quality and insect communities. ii) Build and curate DNA barcode reference libraries for Minnesota DNR listed endangered, threatened, and special concern species, allowing detection in their immature life-stage. We will create a cost-effective aquatic monitoring tool to reduce processing time, increase detection probability, and inform conservation practices. iii) Collaborate with partnering state and local groups to identify knowledge gaps and opportunities for future planning. By partnering with government agencies and conservation groups we will promote viable solutions for reducing the impacts of climate change, land use changes, or extreme weather events on critical areas and species.

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 outcomes of this work will support decision-making efforts related to the protection and restoration of the condition of Minnesota waters. Accurate, consistent, and timely assessment of insect composition and water quality will be enhanced. This approach will allow for benchmarking of environmental systems that face natural and anthropogenic threats. A focus will be on stream systems and species that are of current conservation concern. Together these activities will build long term monitoring capacity, create benchmarks for minimally impacted reference conditions, and produce decision ready information to prioritize riparian restoration, sediment control, and flow management strategies that sustain insect diversity

Activities and Milestones

Activity 1: Identify in-stream and watershed best management practices for safeguarding vulnerable coldwater insect communities

Activity Budget: $186,208

Activity Description:
We will build statistical models linking aquatic insect communities to watershed characteristics and in stream variables to assess coldwater stream vulnerability under current and future conditions. Our work will focus on Minnesota's North Shore which contains the highest concentration of best preserved coldwater streams as assessed by the Minnesota Pollution Control Agency. We will select sites spanning native/natural to moderate and highly degraded conditions. At each site we will provide an insect diversity benchmark by collecting all immature aquatic insects using standard benthic sampling, and all adult insects using flight intercept traps. All specimens will be identified as species using DNA metabarcoding. This approach successfully identified over 1500 arthropod species from Minnesota's threatened Black Ash forests in one year of sampling. Species attributes (feeding behavior, habitat, emergence) will be compiled to describe insect functions. We will then model relationships between insect attributes and watershed and in stream predictors to identify management actions that most effectively preserve insect diversity and function. We will identify factors that increase stream resilience. This work will predict protection strategies most likely to preserve aquatic insect diversity and function and will complement existing water quality monitoring practices used by the Minnesota Pollution Control Agency (MPCA).

Activity Milestones:

Description	Approximate Completion Date
Establish research streams and plots	December 31, 2027
Complete first year of sampling	December 31, 2028
Complete second year of sampling	December 31, 2029
Finalize analyses and submit thesis for approval	May 31, 2030
Submit manuscript for publication	June 30, 2030

Activity 2: Facilitate decision making through enhanced detection of endangered, threatened, and special concern species

Activity Budget: $100,267

Activity Description:
We will develop a rapid, DNA based detection and monitoring program to protect Minnesota's endangered, threatened, and special concern (E/T/SC) aquatic insects. Watershed and stream adjacent habitat modifications, management, and assessment are influenced by the presence of E/T/SC species; therefore, their accurate detection is critical. Because immature aquatic insects cannot be reliably identified morphologically, and adults are short lived, we will generate Minnesota specific DNA barcodes for all 32 listed species and build a curated reference library accessible through public portals. This research will allow for a species identification capacity that currently does not exist. The outcome of this work will be a standardized protocol for detection of E/T/SC aquatic species that can be used throughout the year and for all insect life stages. We will additionally examine water-based environmental DNA workflows to maximize detection probability without killing any insects. We will validate assays against voucher specimens and quantify insect detection limits for a streamlined, cost-effective monitoring toolkit. Outputs include DNA reference sequences, validated protocols, and georeferenced occurrence data to inform conservation actions. Integrating these tools with existing protocols will close critical knowledge gaps limiting aquatic insect species monitoring.

Activity Milestones:

Description	Approximate Completion Date
Gather specimens, collect samples, establish E/T/SC barcodes	December 31, 2027
Make initial barcode data publicly available	June 30, 2028
Develop advanced markers	December 31, 2028
Complete eDNA experiment	December 31, 2029
Finalize project and submit manuscript for publication	June 30, 2030

Activity 3: Engagement for education and develop partnerships to integrate results into management, bioassessment, and conservation frameworks

Activity Budget: $11,525

Activity Description:

Aquatic insects are central to water quality bioassessment and wildlife provisioning, so we will convene a workshop of state and local partners (MPCA, MN DNR, Trout Unlimited, and local groups) to address statewide initiatives related to aquatic insects and translate the outcomes of Activity 1 & 2 into actionable items and policy recommendations. We will conduct a structured Gap analysis that defines desired outcomes, assesses current knowledge and monitoring capacity (detection probability, taxonomic resolution, data flow), and identifies discrepancies that hinder effective management. We will then develop an action plan with prioritized future collaborative research initiatives, monitoring improvements, and policy recommendations. This workshop will guide efforts to increase the resiliency of Minnesota's stream and river systems and the aquatic insects that inhabit them. We will also provide outreach to broaden the public's awareness of the ecological importance of aquatic insects. We will create a public-facing website, a concise fact sheet, and give annual presentations at the UMN Department of Entomology's Great Minnesect Show, an event that draws thousands of visitors each year. These products will enable agencies and partners to integrate product outcomes into statewide planning and generally increase awareness of aquatic insects as a critical resource.

Activity Milestones:

Description	Approximate Completion Date
Conduct outreach at The Great Minnsect Show	April 30, 2028
Conduct outreach at The Great Minnsect Show	April 30, 2028
Convene workshop with local and state stakeholders	February 28, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Will Bouchard	Minnesota Pollution Control Agency	Dr. Bouchard is expert on Minnesota's aquatic insects. He will advise on research location locations, aquatic insect sampling, and related protocols. He will offer support in his role as a taxonomic expert.	No
Dr. Cristian Beza-Beza	University of Minnesota	Dr. Beza-Beza is a professor of entomology and has extensive experience with molecular laboratory techniques. He will assist with all barcoding and metabarcoding activities	No

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
All study results will be shared with the MN DNR, MPCA, and Minnesota tribes as a way of highlighting the importance of aquatic insect species in promoting conservation and management of stream environments. We will share a project summary in a written form at the conclusion of the study, publish 3 peer-reviewed publications, and will upload our data to accessible data portals and species occurrence data the Minnesota Biodiversity Atlas. We will publicly promote our research, and the importance of Minnesota's aquatic insects through presentations at the Department of Entomology's Great Minnsect Show. Our results will have a long-lasting impact through the convening of a workshop that will bring together state and local stakeholders. The Environment and Natural Resources Trust Fund will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENTRF Acknowledgment Guidelines.

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?
This study will provide critical information needed to modernize species detection and bioassessment in Minnesota. Modern DNA-based approaches like those proposed here can save time and money while increasing assessment resolution. All study results will be shared with the MN DNR, Minnesota Pollution Control Agency(MPCA), and Minnesota tribes as a way of highlighting the approaches and findings of this study. We will use the the proposed workshop to direct application of research products and to develop future activities. We will additionally use the findings of this research as a proof of concept for further research funding proposals.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Monitoring Minnesota’s Insects: Connecting Habitat to Insect Prey	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 03f	$199,000

Project Manager and Organization Qualifications

Project Manager Name: Matthew Petersen

Job Title: Teaching Associate Professor

Provide description of the project manager's qualifications to manage the proposed project.
Dr. Matthew Petersen is an insect researcher focused on determining the underlying mechanisms responsible for insect presence and abundance. As an ecologist and taxonomist, he has been involved in large-scale initiatives to survey and document insect diversity. He has led river and stream biomonitoring initiatives based on aquatic insect community composition and has published on the application of DNA-based methods for aquatic insect monitoring. The goal of his program is to highlight how understanding the ecology of individual insect species can lead to better informed habitat management practices, sustained populations of beneficial insects, and assessment of environmental habitat quality.

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

Organization Description:
College of Food, Agricultural and Natural Resources Sciences (CFANS) is comprised of Twelve academic departments and 10 research and outreach centers, along with the Minnesota Landscape Arboretum, the Bell Museum, and dozens of interdisciplinary centers. As part of a major urban university located in the heart of the Twin Cities, we also provide immersive study opportunities across the state. Our living laboratories allow students, faculty, and staff to study throughout Minnesota's diverse ecosystems.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Post Doc/Research Spec		Associate will lead DNA-barcoding and bioinformatics efforts			26.1%	1		$82,024
Project Graduate Student		Student will lead seasonal field collections, data analyses, and manuscript preparation			24.2%	2.5		$140,708
Undergraduate field assistant		Assist with field collections			0%	0.66		$20,138
							Sub Total	**$242,870**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Equipment	Supplies are needed for lab work [Slides and Cover slips ($880), Euparal ($200/100ml), 100% ethanol ($2,000; $518.50/4L*4); KOH ($186/500), Glacial acetic acid ($30)] and field collections[2-dram vials ($1,423; 142.34/144*10), Nalgene collection bottles ($500), Forceps ($100), Malaise traps ($150*15), Sweep nets ($300), Dip nets ($343), Propylene glycol ($200), 90% ethanol ($200); HOBO temperature loggers ($85x15)]. Lab materials are needed for DNA extraction and amplification [centrifuge tubes: ($416/500), pipetted tips and vials ($556)]. Reagents for DNA extraction ($609), DNA metabarcoding ($848), and DNA barcoding ($2,400/384 reactions).	Supplies needed for field and laboratory work					$11,420
							Sub Total	**$11,420**
Capital Equipment								

							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Funds will offset travel to field sites for insect collections in Minnesota. Vehicle rental: 1 vehicle for 5 weeks each during year 1 and 2 of the project @ $385/week= $3,850. Mileage for 2 years of fieldwork requiring 12,000 miles (600 miles/10 event* events*2 yrs) of travel for collecting adult and larval samples @ $0.23 per mile = $2,760). Two sampling events for immature insects each year (4 lodging nights per person @$150/night + 5 days of meals @$59/day per person for 3 (yr 1) and 2 (yr 2) people (state per diem rate) = $8,950) and adult insects in yr 1 (5 events @ 1 lodging nights per person @$150/night + 2 days of meals @$59/day per person for 2 (yr 1) people (state per diem rate) = $2,090).	Travel for field research					$17,650
							Sub Total	**$17,650**
Travel Outside Minnesota								
	Conference Registration Miles/ Meals/ Lodging	Travel support for PostDoc (1 yr) & Graduate Research Assistant (2 yrs) to attend professional meetings.	Delivery of research findings	X				$3,000
							Sub Total	**$3,000**
Printing and Publication								
	Publication	Publication cost for 2 open access research publications ($1,500 x 2)	To publish on the findings of the proposed research					$3,000
							Sub Total	**$3,000**
Other Expenses								

		Cost of DNA barcoding and metabarcoding (est. $5,060; 90 samples in each year 1 and 2; 3 technical replicates; indexing = $17/sample; Aviti24 sequencing $1,000/each year); Sequencing for advanced non-destructive species detection ($15,000);	DNA metabarcoding at the UMN Genomics Center for next generation sequencing					$20,060
							Sub Total	**$20,060**
							Grand Total	**$298,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel Outside Minnesota	Conference Registration Miles/Meals/Lodging	Travel support for PostDoc (1 yr) & Graduate Research Assistant (2 yrs) to attend professional meetings.	Presentations are needed to disseminate project methods, results, and implications at the Annual Meeting of the Entomological Society of America or similar national conference

Non ENRTF Funds

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

Total Project Cost: $298,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: ff959ab7-ae2.pdf

Alternate Text for Visual Component

Images show threats to coldwater streams and and illustrate how aquatic insects and their biotic function are reduced in impacted systems. A solution is presented to investigate landscape threats to these system, develop DNA-based tools for rare aquatic insect detection, and to convene a workshop to coordinate state efforts....

Supplemental Attachments

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

Title	File
Authorization Letter	db94fdb4-19f.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:

Christopher Harper, College of Food, Agricultural, and Natural Resource Sciences, University of Minnesota

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