



# Environment and Natural Resources Trust Fund

2027 Request for Proposal

## General Information

**Proposal ID:** 2027-242

**Proposal Title:** Developing Biological Benchmarks for Resilient Lakes

## Project Manager Information

**Name:** Tyler Butts

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

**Office Telephone:** (608) 547-4753

**Email:** butts051@umn.edu

## Project Basic Information

**Project Summary:** We will evaluate biological recovery of Minnesota lakes after meeting water quality standards and identify any mismatches between chemical, contaminant, and biological standards inclusive of aquatic plants, zooplankton, and fish.

**ENRTF Funds Requested:** \$359,000

**Proposed Project Completion:** June 30, 2029

**LCCMR Funding 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?**

Statewide

**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 lakes are a central cultural and economic asset fueling tourism, recreation, and biodiversity across the state. Lakes are under threat from climate and land use changes driving increases in nutrient pollution, contaminants, extreme weather, and invasive species. Maintaining ecosystem services in the face of global change offers substantial benefit, yet requires a holistic view of lake biology. Aquatic plants provide critical habitat and control nutrients, zooplankton improve fisheries health and water clarity, and fisheries are an economic engine within Minnesota.

Following the Clean Water Act, Minnesota's Pollution Control Agency assesses waterbodies every two years across 80 watersheds that fail to meet water quality standards of nutrient pollution or contamination from mercury or PFAS. While de-listing is positive, it is unclear whether this translates to improved outcomes for the lake's biology; namely, aquatic plant distribution, zooplankton dynamics, and fisheries productivity.

Minnesota has unparalleled lake biological community data. We will leverage datasets compiled by the MN Department of Natural Resource, the University of Minnesota, and the MN Pollution Control Agency to quantify the critical, yet overlooked, biological response of lakes to ensure improving water quality standards effectively produces fish that are safer to eat and lakes that are safer to enjoy.

### **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.**

We will leverage the Minnesota impaired waters list (1992 - present) to assess the biological resilience of aquatic plants, zooplankton, and sport fisheries to declining nutrient pollution, contamination, or both. We will focus on lakes newly listed, continuously listed, or recently de-listed to effectively disentangle the multiple interacting drivers of biological responses in lakes. While de-listed lakes may meet water quality standards, recovery in biological communities may lag behind and contaminants may stabilize rather than continue to decline. Conversely, newly listed lakes may display biological decline years before water quality standards went unmet.

Partnering with the MN PCA and MN DNR we will analyze state-wide aquatic plant, zooplankton, fisheries, and contaminant data all constituting thousands of surveys and decades of effort. Using these data, we will be able to assess improvements in ecosystem services provided by biological communities (e.g., waterfowl habitat, tourism, fishery productivity) generated by state restoration efforts. Moreover, we will generate much-needed evaluations on the relationship between improving water quality and biological recovery to pinpoint delayed responses within biological communities and contaminant cycling. Developing such biological benchmarks will expand the assessment tools of state management agencies and help manage lakes to be more resilient to future change.

### **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?**

Quantifying the concurrent biological responses to changes on the impaired waters list provides an opportunity to assess whether biological indicators are successfully restored and improved with water quality improvement. Healthy biological communities fuel key ecosystem services like fisheries productivity, waterfowl habitat, recreation, and tourism. Biotic indices are a cornerstone of the MN DNR Lake Biomonitoring and Assessment Program and developing more biological assessment tools is broadly relevant for lake management. We will explore these opportunities with MN DNR and MN PCA staff, and expand assessment tools that are directly related to improving ecosystem services for Minnesota anglers, boaters, and recreators.

## Activities and Milestones

### Activity 1: Assessing biological recovery in de-listed lakes

**Activity Budget:** \$176,923

**Activity Description:**

We will collate statewide zooplankton data (458 lakes, 1986-2024), aquatic plant data (856 lakes, 1999-2025), and fisheries, mercury, and PFAS data (4,148 lakes, 1937-2023) across the state. We will then filter each dataset to lakes newly listed, continuously listed, or recently de-listed from the impaired waters list. Causal relationships are exceedingly difficult to infer with patchy data and patchier time series. With the breadth of data available here we will employ empirical dynamic modeling, to capture complex dynamics with imperfect data. We will be able to quantify biological responses and forecast outcomes of changes in water quality in addition to assessing dynamics of contaminants inclusive of mercury and PFAS over time. Ordination methods will identify key species and groups of species that drive responses to improving water quality across the state. Our efforts will develop common responses to de-listing with a specific focus on whether lags exist between water quality improvement, biological improvement, and contaminant reduction.

To ensure this data is preserved, we will develop a data management plan for datasets used, aggregated, and compiled for this project and a reproducible pipeline to pull and process such data for future MN DNR and MN PCA priorities.

**Activity Milestones:**

Description	Approximate Completion Date
Interoperable dataset on zooplankton, fisheries, plant, and water quality for lakes	December 31, 2027
Quantify biological response to a lake's de-listing from the impaired waters list	June 30, 2028
Prepare open-access products for publication	June 30, 2028
Data management plan for aggregated biological dataset and plan for data preservation	June 30, 2029
Webinar for MN lake associations with impaired waters to discuss findings	June 30, 2029
Present findings at North American Lake Management Society Annual Meeting	June 30, 2029

### Activity 2: Defining biological benchmarks for Minnesota lakes

**Activity Budget:** \$182,077

**Activity Description:**

Using the filtered datasets described in Activity 1, we will develop biological benchmarks that quantitatively connect improved water quality and lake health with ecosystem services such as maintaining stable plant and animal populations, robust fish and waterfowl habitat, and efficient filtering of nutrient pollution and contaminants. We will work with MNDNR to develop benchmarks of 'biological improvement', establish further management guidelines for impaired waters, and streamline data with existing databases and online visualization tools. To do so, we will formulate multivariate hierarchical modeling approaches and structural change analysis to pinpoint thresholds of change that can be used as biological benchmarks. These benchmarks will be developed for plant, zooplankton, and fisheries data and represent levels where biological communities are substantially contributing to ecosystem services. Furthermore, these data may also be used to assess patterns of contaminant persistence and recycling within impaired and improving lakes to inform decision-making capacity for both mercury and PFAS. We will partner with MN PCA and MN DNR to identify opportunities to highlight biological benchmarks for lakes in existing tools (e.g., MPCA's Water Quality Dashboard, MN DNR's LakeFinder, or the MN DNR's Watershed Health Assessment Framework: Lakes).

**Activity Milestones:**

Description	Approximate Completion Date
Develop, test, and refine biological benchmarks for improved ecosystem services	June 30, 2028
Co-develop guidelines with MN DNR and tools to holistically evaluate Minnesota's impaired waters	June 30, 2029
Develop data visualization and data analysis pipelines with MN DNR and MN PCA	June 30, 2029

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Jeffrey Strom	Minnesota Pollution Control Agency	TMDL Plan Writer and Lake and Eutrophication Expert, liaison to MN PCA	No
Jake Walsh	UMN Department of Fisheries, Wildlife and Conservation Biology	Assistant Professor, co-PI	Yes
Gretchen Hansen	UMN Department of Fisheries, Wildlife and Conservation Biology	Assistant Professor, co-PI	Yes
Heidi Rantala	MN DNR Division of Fisheries and Wildlife	Fisheries Research Scientist, liaison to MN DNR	No
Derek Bahr	MN DNR Division of Ecological and Water Resources	Fisheries Research Specialist, co-PI	No
Denver Link	UMN Department of Fisheries, Wildlife, and Conservation Biology	Research Scientist, co-PI	Yes

## 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.**

We will develop a data management plan that preserves data and maximizes accessibility in direct collaboration with MN DNR and MN PCA partners from inception to completion of the project. We will disseminate results through manuscript publication, a webinar with MN lake associations containing waters on, or recently de-listed from, the impaired waters list, and we will present results of this project at a manager-focused annual meeting, the North American Lake Management Society. Products derived from this work will be incorporated in existing tools such as MN PCA's Water Quality Dashboard, MN DNR's LakeFinder, or the MN DNR's Watershed Health Assessment Framework: Lakes.

ENRTF will be acknowledged in all dissemination activities and products as per the ENRTF Acknowledgement 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?**

The research outcomes herein can be directly implemented into existing MN DNR and MN PCA staffing and programming. Many outcomes can be directly translated into existing MN DNR databases and web pages (e.g., LakeFinder, WHAF-L). The biological benchmarks, data management plan, and reproducible pipelines to collate biological and contaminant data will provide long-term benefits to the Lake Biomonitoring and Assessment Program and MN PCA. Furthermore, the outcomes would prove to be an unparalleled collection of biological data to generate hypotheses and answer management-relevant research questions. Such work would be funded through LCCMR or the Minnesota Aquatic Invasive Species Research Center.

## Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Protecting Coldwater Fish Habitat in Minnesota Lakes	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 07a	\$561,000
Operationalizing State Zooplankton Data to Support Lake Health	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 03dd	\$423,000

## Project Manager and Organization Qualifications

**Project Manager Name:** Tyler Butts

**Job Title:** Research Scientist

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

Dr. Tyler Butts is a postdoctoral associate in the UMN-TC Department of Fisheries, Wildlife, and Conservation Biology currently funded through the LCCMR project, "Operationalizing state zooplankton data to support lake health". Should this proposal be funded, Dr. Butts will transition to a Research Scientist role.

Dr. Butts publishes widely on lake ecology (11 manuscripts and data products, 7 first-author, 3 in preparation to be published), with a particular focus on relationships between lake biology and ecosystem function in response to management action and global change. Prior to Dr. Butts' position at UMN, he worked for two and a half years at the UW-Madison Center for Limnology and the United States Geological Survey.

Through these positions, Dr. Butts' background and professional experience includes: 1) 10 years conducting and analyzing zooplankton, plant, and fish surveys (3 undergraduate, 5 doctoral, 3 post-doctoral) including identification and measurement of tens of thousands of invertebrate taxa, 2) two years designing and managing a field and lab research program collecting limnological and microbiological data supervising two Ph.D students and five research technicians, and 3) eight years of co-leading research (5 doctoral, 3 post-doctoral) aggregating, cleaning, and organizing chemical, biological, and physical data from lakes from long-term and spatially extensive datasets including the 40+ year north temperate lakes long-term ecological research program, the 30+ year Cascade program, and more recently a global repository of zooplankton data. Dr. Butts has gained expertise on complex data and research management with a particular emphasis on data management and analysis of biological data.

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

**Organization Description:**

The UMN College of Food, Agricultural, and Natural Resources Sciences (CFANS) works to advance Minnesota as a global

leader in food, agriculture, and natural resources management through extraordinary education, science-based solutions, and dynamic public engagement that nourishes people and enhances the environment in which we live. This project will be housed within the UMN CFANS Department of Fisheries, Wildlife and Conservation Biology (FWCB) whose mission is to inspire and create solutions for biological conservation and management in a diverse and changing world. FWCB utilizes multidisciplinary research to advance informed natural resources decision-making about the habitats and landscapes on which healthy animal populations are sustained.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Principal Investigator, Dr. Tyler Butts		Lead all aspects of the project including study design, supervision of staff and collaborators, data collection and analysis, interpretation and communication of results, and engagement with partners (1 FTE per year for 2 years)			36.6%	2		\$225,232
Co-Principal Investigator, Dr. Jake Walsh		Consult on study design, data collection and analysis, aquatic plant and zooplankton data availability, interpretation and communication of results, and engagement with partners (0.04 FTE for years)			36.6%	0.08		\$15,709
Co-Principal Investigator, Dr. Gretchen Hansen		Consult on study design, data collection and analysis, fisheries data availability, interpretation and communication of results, and engagement with partners (0.04 FTE for years)			36.6%	0.08		\$19,058
Co-Principal Investigator, Research Scientist, Denver Link		Consult on study design, data collection and analysis, contaminant data availability, interpretation and communication of results, and engagement with partners (0.5 FTE for two years)			32.2%	1		\$93,668
							<b>Sub Total</b>	<b>\$353,667</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	-
<b>Equipment, Tools, and Supplies</b>								
							<b>Sub Total</b>	-
<b>Capital Equipment</b>								
							<b>Sub Total</b>	-

<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Conference Registration Miles/ Meals/ Lodging	Conference registration, lodging, and travel for NALMS (ex: Duluth, MN). \$550 registration. Three nights lodging at \$220 per night (\$660). Per diem (First and last day 64.5*2 + 86 = \$215). Mileage 0.725*300 miles (\$217.5).	Present results at in-state, practitioner-focused conference					\$1,643
							<b>Sub Total</b>	<b>\$1,643</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
	Publication	1 open access publication at ~\$3,690	Disseminate research findings					\$3,690
							<b>Sub Total</b>	<b>\$3,690</b>
<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	<b>\$359,000</b>

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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## Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
<b>State</b>				
In-Kind	MN Department of Natural Resources	Salary contribution for Derek Bahr of in-kind hours and salary fringe estimating 108 hours	Pending	\$5,693
			<b>State Sub Total</b>	<b>\$5,693</b>
<b>Non-State</b>				
In-Kind	University of Minnesota foregone indirect costs (54% of MTDC)	Administrative costs associated with support of research activities including payroll and human resources, finance, facilities, and IT. If this award is reduced from the requested amount, the proposed cost sharing will be reduced proportionately.	Secured	\$193,860
			<b>Non State Sub Total</b>	<b>\$193,860</b>
			<b>Funds Total</b>	<b>\$199,553</b>

**Total Project Cost: \$558,553**

**This amount accurately reflects total project cost?**

Yes

## Attachments

### Required Attachments

#### *Visual Component*

File: [6755b62f-754.pdf](#)

#### *Alternate Text for Visual Component*

Poster showing algal-dominated water next to clear water asking how well do improvements in water quality reflect recovery in biological communities, namely fish, zooplankton, and aquatic plants along with a reduction in PFAS and Mercury that cycle within those communities. Defining biological benchmarks within lakes will ensure meaningful lake standards....

### Supplemental Attachments

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

Title	File
Sponsored Projects Administration proposal endorsement	<a href="#">696cc852-39c.pdf</a>
Partner Letter MN DNR for Derek Bahr	<a href="#">62fed3bd-e23.pdf</a>

## 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:**

Jake Walsh, Gretchen Hansen, Denver Link (University of Minnesota-Twin Cities); Heidi Rantala, Derek Bahr (MN DNR); Jeff Strom (MN PCA)

**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