



Environment and Natural Resources Trust Fund

2024 Request for Proposal

General Information

Proposal ID: 2024-173

Proposal Title: Wildfire Impacts on Mercury Cycling in Wilderness Lakes

Project Manager Information

Name: Christopher Filstrup

Organization: U of MN - Duluth - NRRRI

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Project Basic Information

Project Summary: Increasing wildfires in Minnesota are mobilizing mercury and degrading water in wilderness lakes, potentially causing increased mercury concentrations in fish. We will develop approaches to protect our lakes and fish.

Funds Requested: \$297,000

Proposed Project Completion: June 30, 2027

LCCMR Funding Category: Water Resources (B)

Project Location

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

Region(s): NE

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 is known for iconic wilderness lakes, which provide important recreational opportunities and vital ecosystem services. Protecting these pristine lakes and their fisheries under climate change presents complex management challenges for agencies and tribes. While wildfires are often associated with the West, increases in temperature and droughts may increase wildfire frequency and severity in Minnesota. The 2021 Greenwood Fire near Isabella was the 9th largest wildfire since 1984, and we showed that lakes within the burn zone had elevated nutrients, sediment, and dissolved organic carbon the following summer, creating conditions that can cause hypoxia, mercury methylation, and unsafe fish mercury concentrations. However, it is unclear if wildfire impacts will persist or how long lakes take to recover from them. Many of our study lakes contain manoomin stands, but how wildfire-induced water quality changes impact their growth and reproduction requires further study. Wildfires can also mobilize mercury, but it is unknown if mercury deposited near lakes and entering via runoff can bioaccumulate in fish. Elevated mercury in fish is a primary impairment of Minnesota's lakes, so this proposal addresses the impacts of wildfires on water quality and mercury bioavailability to determine long-term effects on fisheries and manoomin.

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.

To protect Minnesota's lakes and their ecosystem services, we will collect water quality, mercury and methylmercury, and bacterial methylmercury processing genes data from lakes within the Greenwood Fire burn zone. We will measure water quality in 30 lakes (15 burned, 15 unburned), including 17 manoomin-producing lakes, in 2024 and 2025 that represent a gradient of watershed burn extent and severity. We sampled these lakes in 2022 and found significant changes in water quality one year post-fire, but we do not know if these lake responses are short-term or will be sustained to have long-term effects on lake health. To fully evaluate how wildfires affect mercury mobilization and bioaccumulation in fish, we will measure mercury and methylmercury concentrations in water, surface sediments, and fish tissue in a subset of our lakes (15 total) categorized as high burn severity, smoke exposed, and control (5 lakes each). Additionally, we will use molecular approaches to identify which bacteria in the water and surface sediments are responsible for mercury processing (methylation, demethylation genes) to better understand what conditions contribute to mercury mobilization in lakes. We will work with our partners to turn our findings into predictive tools to inform management decisions.

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?

Little is known about how increasing fire regimes will affect the health of Minnesota's pristine wilderness lakes, which complicates management strategies to sustain healthy fisheries and manoomin production after wildfires. Our proposed study will identify if wildfire impacts on lakes are sustained, how quickly lakes can recover from wildfires, what thresholds in burn extent and severity lead to water quality impacts, and what factors lead to increased mercury methylation and bioaccumulation in fish. This information is needed by agencies and tribes to develop effective forest management strategies and post-fire responses to preserve sustainable fisheries and manoomin production.

Activities and Milestones

Activity 1: Create predictive tools of lake responses to wildfires based on Greenwood Fire to support management decisions and protect vulnerable lakes

Activity Budget: \$164,790

Activity Description:

We will measure lake responses to the 2021 Greenwood Fire by measuring water quality in 15 impacted lakes (burned watersheds) and 15 reference lakes (unburned watersheds; controls). We sampled these same lakes in 2022 (1 year post-fire) using federal funding, so we can leverage previous findings and data to better understand both immediate (previous project) and long-term responses or recovery from disturbance (this project). Previous findings demonstrated that fire-impacted lakes had higher nutrient, sediment, and dissolved organic carbon concentrations, potentially creating conditions conducive to mercury methylation and bioaccumulation (Activity 2). Lakes will be sampled monthly from May through September to capture seasonal dynamics in lake responses. For continuity with our previous study, we will measure physical (clarity, dissolved oxygen, pH, suspended solids, temperature), chemical (alkalinity, dissolved organic carbon, ionic composition, nitrogen, phosphorus), and biological (chlorophyll a) variables to comprehensively assess diverse water quality changes. When combined with data collected in 2022, we will have three years of water quality data to create predictive tools of lake sensitivity to wildfires, identify thresholds in wildfire conditions causing impairments, and determine recovery times of different lake types from wildfires.

Activity Milestones:

Description	Approximate Completion Date
Collect and analyze water samples from 30 lakes in Year 1	June 30, 2025
Collect and analyze water samples from 30 lakes in Year 2	June 30, 2026
Data analysis and interpretation to develop decision support tools	June 30, 2027

Activity 2: Evaluate how post-wildfire lake responses alter mercury transport, lake concentrations, and sediment cycling to understand mercury bioaccumulation in fish

Activity Budget: \$95,261

Activity Description:

We will measure mercury and methylmercury concentrations in water, surface sediments, and fish tissue in 15 of our study lakes categorized as high burn severity, smoke exposed, and control (5 lakes each) due to analytical costs. Water samples will be collected at snowmelt (or early spring), during normal flow conditions, and after a storm event during routine monthly sampling (see Activity 1) in 2024 and 2025 to evaluate continued watershed transport of mercury during forest recovery. Surface sediment samples will be collected once each year (midsummer) in 2024 and 2025 to measure the accumulation of mercury and methylmercury since the wildfire. Because microorganisms are responsible for converting mercury into methylmercury, we will sequence and quantify DNA and RNA in surface sediments to identify microbial communities associated with mercury methylation and to determine under what conditions post-wildfire mercury loads result in methylmercury formation and subsequently bioaccumulation in fish. Fish samples will be collected once each year (spring) in 2024 and 2025, targeting young-of-year perch to measure mercury concentrations in fish tissues (mostly as methylmercury) to evaluate bioaccumulation in fish.

Activity Milestones:

Description	Approximate Completion Date
Analyze water, surface sediment, and fish for mercury from 15 lakes in Year 1	June 30, 2025

Analyze water, surface sediment, and fish for mercury from 15 lakes in Year 2	June 30, 2026
Data analysis and interpretation to identify the effects of wildfires on mercury cycling in lakes	June 30, 2027

Activity 3: Develop effective management strategies with partners to inform future responses to wildfires to improve manoomin production and maintain healthy fisheries

Activity Budget: \$36,949

Activity Description:

We will use data collected in Activities 1 and 2 to improve understanding of how wildfires affect water quality, mercury transport and mobilization, and mercury bioaccumulation in fish. We will be able to answer important management questions: are previously documented wildfire impacts on lakes sustained?, do thresholds exist in burn characteristics that increase the likelihood of significant water quality impairments?, do wildfires create conditions favorable for mercury methylation and unsafe mercury concentrations in fish?, and is manoomin production negatively impacted by wildfire-induced changes in water quality? We will work with our partners to develop predictive tools and materials that are useful for management purposes. We will host project kickoff and wrap-up meetings, and meet with partners prior to field sampling to incorporate their input, and once initial data analyses have been completed. To expand the project’s reach, we will present findings at regional meetings, such as the St. Louis River Summit and the Water Resources Conference, and international conferences. Through project reporting and scientific publications, we will share our findings so that other state agencies and tribes may use them to guide their wildfire response efforts.

Activity Milestones:

Description	Approximate Completion Date
Host project meetings and get advice from partners in Year 1	June 30, 2025
Host project meetings with partners and develop management tools in Year 2	June 30, 2026
Host final project meeting, deliver project outputs, and disseminate findings	June 30, 2027

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Jennifer Brentrup	Minnesota Pollution Control Agency	Brentrup works with MPCA's Environmental Analysis and Outcomes Team with a focus on mercury cycling in Minnesota's surface waters and has expertise on wildfire impacts on lakes; she will assist with field sampling, data analysis and interpretation, project reporting and manuscript development, and outreach.	No
Chan Lan Chun	U of MN - Duluth - NRRI	Chun leads NRRI's Environmental Microbiology and Biotechnology Lab and will be responsible for microbial analyses of community composition and mercury cycling genes, data analysis and interpretation, project reporting and manuscript development, and mentoring the postdoctoral associate.	Yes
Sarah Janssen	US Geological Survey Mercury Research Lab	Sarah Janssen leads the USGS Mercury Research Lab at the University of Wisconsin-Madison, and will perform mercury and methylmercury analyses in water, sediment, and fish tissues at established analytical rates.	Yes
Randall Kolka	USDA Forest Service	Kolka and USDA Forest Service colleagues have expertise in studying mercury cycling in Minnesota lakes and fish, including post-wildfire impacts; USDA Forest Service will lead fish sampling efforts, provide insight on data interpretation, and provide feedback on the development of predictive tools.	No
Tyler Kaspar	1854 Treaty Authority	Kaspar is an Environmental Biologist specializing in fisheries and mercury cycling in lakes within the 1854 Ceded Territory; he will serve in an advisory role to ensure that findings and developed tools are useful to tribal communities, and will share data and knowledge on lakes included in this study.	No

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?

Project activities, including data collection, data analysis and interpretation, and tool development, will be completed during this project. Institutional funds will be used to fund products that are developed afterwards, such as publications or scientific presentations. Data will be archived on online repositories through University of Minnesota for data preservation and public accessibility at minimal cost. Project partners have a long history of collaboration and will continue to collaborate after this project as part of typical job duties. If new research directions are developed from LCCMR's investment in this project, partners will seek new funding from other grant opportunities.

Project Manager and Organization Qualifications

Project Manager Name: Christopher Filstrup

Job Title: Applied Limnology

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

Filstrup will be responsible for project management and administration, and has the scientific expertise and project management experience to successfully complete this research. Filstrup directs NRRI's Lake and Stream Ecosystem Ecology Lab along with the Central Analytical Lab, a state-certified water quality laboratory specializing in low-level detection of water quality parameters in the Laurentian Great Lakes and nutrient-poor lakes and streams in the Upper Midwest. He has studied water quality issues in lakes and reservoirs in the U.S. Central Plains for 20 years, including lakes across Minnesota, and excels at engaging natural resources agencies to translate scientific findings to improved management and restoration outcomes. Filstrup also specializes in working with large complex datasets from existing monitoring programs to generate new knowledge from publicly funded data. Filstrup currently manages several federal and state funded projects, including serving as PI on a \$3M USEPA-funded project investigating contaminants in the Great Lakes. Most related to this project, Filstrup (PI) was previously awarded short-term National Science Foundation

funding to study lake responses to the Greenwood Fire in this same subset of lakes for one summer only; while this project captured immediate impacts of wildfires on lake water quality, it did not provide information on delayed long-term impacts, lake recovery following short-term wildfires, or implications for mercury cycling and contamination of fish.

Organization: U of MN - Duluth - NRRRI

Organization Description:

The Natural Resources Research Institute (NRRRI) is a part of the University of Minnesota research enterprise and employs over 130 scientists, engineers and technicians. Its mission is to deliver integrated research solutions that value our resources, environment and economy for a sustainable and resilient future.

NRRRI collaborates broadly across the University system, the state and the region to address the challenges of a natural resource-based economy.

By partnering with industry, business leaders, agency decision-makers and many others, NRRRI researchers frame and deliver on real-world solutions. NRRRI scientists have extensive experience in managing large, interdisciplinary projects. Major objectives include the development of tools for environmental assessment, resource management, and industry opportunity development and assistance. NRRRI's role is as an impartial, science-based resource that develops and translates knowledge by characterizing and defining value-resource opportunities, minimizing waste and environmental impact, maximizing value from natural resource utilization and maintaining/restoring ecosystem function.

Major outcomes from NRRRI projects include informing environmental management and policy and assisting industry and communities in defining and maintaining the social license to operate in natural systems. NRRRI has established mechanisms for sharing outcomes through press releases, publication in peer-reviewed journals, technical reports, annual reports, periodicals, and through social media channels.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Christopher Filstrup		Filstrup will serve as Project PI and will be responsible for project administration, data analyses and interpretation, project reporting and manuscript development, and outreach			26.9%	0.24		\$29,632
Beth Bernhardt		Bernhardt will be responsible for supervising and coordinating water quality analyses, compiling laboratory data, and serving as the Quality Assurance Officer on this project. She will also assist with data interpretation and project reporting			24.24%	0.24		\$16,327
Jerry Henneck		Henneck will be responsible for coordinating field activities, leading field sampling activities, and training and supervision of the field team. Henneck will also be responsible for management of field data.			24.24%	0.45		\$41,587
Zachary Wagner		Wagner will be responsible for field work preparation and assisting with field sampling and laboratory analyses			24.24%	0.27		\$17,252
Eva Hendrickson		Hendrickson will assist with field sampling, laboratory analyses, statistical analyses of data, and project reporting			24.24%	0.24		\$14,193
Chan Lan Chun		Chun will lead microbial analyses of community composition and mercury cycling genes, and will be responsible for data analyses and interpretation, project reporting and manuscript development, and mentoring the postdoctoral associate.			26.9%	0.06		\$10,690
Leah Schleppenbach		Schleppenbach will be responsible for measuring organic carbon content of lake surface sediments			24.24%	0.04		\$2,003
Undergraduate researcher		TBD Undergrad student will assist with field sampling and laboratory preparation and analyses in Y1 & Y2, and assist with data analyses and reporting in Y3.			0%	0.51		\$16,197
Temporary Technician		TBD Temp / Casual will assist with field sampling and laboratory analyses.			7.64%	0.03		\$1,474
Postdoctoral Associate		TBD Postdoctoral Associate will be responsible for processing and analyzing microbial samples and			20.44%	0.24		\$17,964

		bioinformatics of molecular data, and will assist with data analyses and interpretation, project reporting, and manuscript development.						
							Sub Total	\$167,319
Contracts and Services								
To Be Determined	Professional or Technical Service Contract	Water quality analytical fees in each of Y1 & Y2. Y2 has 3% inflation added. 30 lakes x 5 sampling events = 150 samples each year Anion analytical fees in each of Y1 & Y2. Y2 has 3% inflation added. 30 lakes x 2 sampling events = 60 samples each year.				0.02		\$38,994
To Be Determined	Professional or Technical Service Contract	Metals analyses: Cation analyses in water in each of Y1 & Y2. 30 lakes x 2 sampling events = 60 samples. 60 samples @ \$27.00 + 2 batch fees @ \$30 = \$1650.				0.02		\$5,054
USDA	Professional or Technical Service Contract	Mercury analyses to be performed by USDA. Water quality analytical fees in each of Y1 & Y2, \$12,375 each year. Surface sediment analytical fees in each of Y1 & Y2, \$3,450 each year. Fish tissue analytical fees in each of Y1 & Y2, \$9,750 each year.				0.04		\$51,917
To Be Determined	Professional or Technical Service Contract	Molecular biological analysis: UMGC metabarcoding analysis: \$13.08/sample x120 samples x 2 targets + MiSeq sequencing \$2,631.98/lane x 2 lanes = \$6,834				0.02		\$6,834
							Sub Total	\$102,799
Equipment, Tools, and Supplies								
	Tools and Supplies	Sediment organic carbon content	Consumables for analyzing carbon content in surface sediments.					\$203
	Tools and Supplies	Field / Lab supplies	General field supplies (bottles, batteries, notebooks, pens, labels) in Y1 & Y2.					\$6,388
	Tools and Supplies	YSI maintenance / repair	YSI maintenance (replacement pH / conductivity sensors, calibration solutions) in Y1 & Y2.					\$2,740

	Tools and Supplies	Molecular biology analysis supply	RNA/DNA extraction kits, reagents for molecular biology analysis, and plasticwares					\$5,650
							Sub Total	\$14,981
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Field travel in each of Y1 & Y2. Y2 includes 3% inflation. 30 sampling events x 250 miles @ \$0.655 = 4912.50 30 days @ \$15 rental fee = \$450.00	Travel required to conduct fieldwork across Minnesota					\$10,886
							Sub Total	\$10,886
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
		Shipping costs	Costs to ship metals samples to RAL (from Duluth to Twin Cities; 2x per year) and mercury samples to USDA (from Duluth to Twin Cities; 5x per year).					\$1,015
							Sub Total	\$1,015
							Grand Total	\$297,000

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
State				
			State Sub Total	-
Non-State				
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% 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	\$163,351
			Non State Sub Total	\$163,351
			Funds Total	\$163,351

Attachments

Required Attachments

Visual Component

File: [a60c1727-c81.pdf](#)

Alternate Text for Visual Component

Visual shows multiple aerial images of smoke and burned watersheds from the 2021 Greenwood Fire near Isabella, Minnesota, showing mercury deposition from smoke and transport from burned watersheds. Bottom panels show methylmercury production in lake sediments and a bucket of perch with text that reads “Safe methylmercury levels?”....

Optional Attachments

Support Letter, Photos, Media, Other

Title	File
1854 Treaty Authority letter of support	8fe55469-470.pdf
USGS Mercury Lab letter of support	ddb2af1b-060.pdf
UMN Authorization Letter	c8ca98b7-653.pdf
MPCA letter of support	3f482f79-6e1.pdf
US Forest Service letter of support	35fddcbe-ad7.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

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

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 design, construction, or renovation of a building, trail, campground, or other capital asset costing \$10,000 or more?

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?

No