Environment and Natural Resources Trust Fund

M.L. 2024 Approved Work Plan

General Information

ID Number: 2024-173

Staff Lead: Lisa Bigaouette

Date this document submitted to LCCMR: June 6, 2024

Project Title: Wildfire Impacts on Mercury Cycling in Wilderness Lakes

Project Budget: $297,000

Project Manager Information

Name: Christopher Filstrup

Organization: U of MN - Duluth - NRRI

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Project Reporting

Date Work Plan Approved by LCCMR: June 20, 2024

Reporting Schedule: June 1 / December 1 of each year.

Project Completion: June 30, 2027

Final Report Due Date: August 14, 2027

Legal Information

Legal Citation: M.L. 2024, Chp. 83, Sec. 2, Subd. 04i

Appropriation Language: $297,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute in Duluth to evaluate the long-term effects of wildfires on lake water quality, mercury mobilization, and mercury bioaccumulation in fish and to develop predictive tools that inform management and help protect the health of fisheries and manoomin in wilderness lakes.

Appropriation End Date: June 30, 2027

Narrative

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.

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 20 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 (16 total) categorized as high burn severity and control (8 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.

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

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). Of our study lakes, 20 lakes (11 burned, 9 control) are manoomin-producing waters. 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 16 of our study lakes categorized as high burn severity and control (8 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 16 lakes in Year 1	June 30, 2025
Analyze water, surface sediment, and fish for mercury from 16 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 to disseminate findings and share management recommendations	May 31, 2027
Deliver final project report including predictive models and post online for easy access	June 30, 2027
Share findings with research community through peer-reviewed publications, conference presentations, and publicly available datasets	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

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.
Our research findings will be disseminated using diverse platforms to reach different stakeholders. While our primary goal is to help natural resources managers at state agencies and tribal communities develop monitoring and management strategies after wildfires, we will also share data and findings with our stakeholders to help inform safe harvesting practices for fish and manoomin and consumption guidelines. Additionally, we will engage with the scientific research community and public to improve understanding of how wildfires affect water quality and mercury cycling in lakes and public awareness of potential health hazards resulting from wildfires, respectively.

Partner engagement: Our project partners, including U.S. Forest Service and 1854 Treaty Authority, were actively involved in the development of this proposal, and we will look to expand our list of partners on this project. We will meet with project partners throughout the duration of this project to seek advice on our approach, interpretation of findings, and to ensure that project findings are useful to management purposes. We will host a project kickoff meeting in Year 1, as well as project wrap-up meetings in each of Years 2 and 3.

Presentations: Project personnel will present research findings at annual regional and state conferences, such as the St. Louis River Summit and the Minnesota Water Resources Conference, to facilitate integration of project findings into management decisions related to Minnesota's natural resources. Additionally, we will volunteer to present findings during diverse seminar series, such as Twin Ports Freshwater Folks and Twin Ports Climate Conversations, to reach different management audiences.

Peer-reviewed publications and society conferences: Project personnel are actively involved in numerous scientific societies and regularly publish in society journals and present at international conferences. We will use these platforms to share our findings with other state management agencies and tribal groups beyond Minnesota. We anticipate that this research will produce at least 2 peer-reviewed publications. We will present multiple talks at international society

conferences in each of Years 2 and 3.

Data availability: All data, excluding genomic data, will be made freely available and publicly accessible through upload to online data repositories, such as the Environmental Data Initiative (EDI) or the Data Repository of the University of Minnesota (DRUM). Mercury data will be released as a USGS data product, which is publicly available and receives a digital object identifier (DOI). For genomics data, Illumina sequencing raw data and processed metagenomic data will be deposited in the Metagenome Projects within the BioProjects Database in GenBank at National Center of Biotechnology Information (NCBI), allowing easy accessibility and downloadability by the public and research community. Data will be submitted following NCBI guidelines. Genomic data files will be transferred to the University of Minnesota Supercomputer Institute (MSI), which creates an automatic off-site backup for folders on its servers. All datasets will include fully documented metadata to facilitate use of data products. Upon publication or one year after the project concludes, all data will be made freely available and publicly accessible.

Popular media: Findings from this project will be of interest to the general public, especially as wildfires and smoke exposure have become more routine during summertime in Minnesota. We will work with the Natural Resources Research Institutes' Communications Specialist to coordinate media inquiries for the project team and to develop stories on various platforms (newsletters, online media) related to this project.

Funding acknowledgment: We will acknowledge the Environment and Natural Resources Trust Fund (ENRTF) through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications and outreach following requirements detailed in the ENRTF 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?

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.

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, model development and packaging, 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 bioinformatics of molecular data, and will assist with data analyses and interpretation, model development and packaging, project reporting, and manuscript development.			20.44%	0.24		$17,964
							Sub Total	**$167,319**
Contracts and Services								
UMD Natural Resources Research Institute Central Analytical Lab	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
University of Minnesota Twin Cities Research Analytical Lab	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
USGS Mercury Lab	Professional or Technical Service Contract	Mercury analyses to be performed by USGS Mercury Lab. 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
University of Minnesota Genomics Center	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 placticwares					$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 the University of Minnesota Research Analytical Laboratory (from Duluth to Twin Cities; 2x per year) and mercury samples to the USGS Mercury Lab					$1,015

			(from Duluth to Madison, WI; 5x per year).					
							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

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
In-Kind	Natural Resources Research Institute internal funds	Costs associated with peer-reviewed publication, including page charges and open-access fees	Potential	-
In-Kind	Natural Resources Research Institute internal funds	Travel costs for participants to present findings at regional and state conferences, such as the St. Louis River Summit and Water Resources Conference, throughout the project	Potential	-
			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?”....

Supplemental Attachments

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

Title	File
US Forest Service letter of support	35fddcbe-ad7.pdf
1854 Treaty Authority letter of support	8fe55469-470.pdf
USGS Mercury Lab letter of support	ddb2af1b-060.pdf
MPCA letter of support	3f482f79-6e1.pdf
UMN Authorization Letter	c8ca98b7-653.pdf
Accepted revised Research Addendum	865d87f5-b9b.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Modified text for budget descriptions, sampling design for mercury analyses (lake numbers in Narrative and Activity 2), and dissemination section to address comments from 6/3/2024.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must 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 agree to the UMN Policy.

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