



# Environment and Natural Resources Trust Fund

## 2023 Request for Proposal

### General Information

**Proposal ID:** 2023-177

**Proposal Title:** Quantifying Environmental Benefits of Peatland Restoration in Minnesota

### Project Manager Information

**Name:** John Nieber

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

**Office Telephone:** (651) 249-8698

**Email:** nieber@umn.edu

### Project Basic Information

**Project Summary:** We will quantify the capacity of restored peatlands to store and accumulate atmospheric carbon and their capacity to prevent release of accumulated mercury into streams, rivers and lakes.

**Funds Requested:** \$766,000

**Proposed Project Completion:** June 30, 2026

**LCCMR Funding Category:** Methods to Protect, Restore, and Enhance Land, Water, and Habitat (F)

### Project Location

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

Region(s): NE, NW,

**What is the best scale to describe the area impacted by your work?**

Region(s): NE, NW,

**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.**

Over 6 million acres (~12%) of Minnesota is peatlands, many of which were drained using thousands of miles of ditches in the early 20th century. These ditches, now commonly abandoned but still draining the peatlands, contribute to degradation of this unique ecosystem and lead to the release of large amounts of greenhouse gases to the atmosphere and mercury into streams. The greenhouse gases contribute to global climate change, and the mercury threatens the health and livelihoods of Minnesotans. There is potential for restoration of hundreds of thousands of acres of peatlands degraded by these ditches, and while some peatland restoration is already underway, we do not know the net water and air quality benefits of such restorations. This information is critical for developing science-based restoration policies and guidelines (e.g., The Nature Conservancy's Peatland Playbook). However, some policy-relevant scientific uncertainties must be addressed prior to expanding into large-scale restoration. Specifically, we need to determine the likely net environmental benefits of these restoration efforts on both greenhouse gases and mercury export to develop practical responses based on sound science. The proposed effort would provide information needed by state agencies and tribal partners to make informed management decisions.

### **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 fill the knowledge gap relating to comprehensive impacts of peatland ditch restoration on air and water quality using a three-pronged approach. First, by doing a synthesis of existing literature from other regions we will provide a foundation for decision-making based on current science. Second, by performing field research, we will determine likely effects of peatland restoration on net greenhouse gas fluxes and streamwater mercury. The field research will be located at peatlands that were restored ~ 1 (Sprague Creek, Lost River State Forest), ~5 (Sax-zim Bog) and ~ 23 (Browns Lake Bog) years prior to sampling, paired with nearby unrestored sites. This will allow us to determine short- and longer-term benefits of restoration. We will use tower- and chamber-based methods to measure the movement of carbon dioxide, methane, and mercury into and out of peatlands. We will sample water in streams draining peatlands to assess the effect of ditching on mercury export. Third we'll develop models to scale-up the field results. The three investigations will be synthesized into management and policy guidance and peer-reviewed publications. Partner organizations can use this to assess the net benefit of peatland restoration and prioritize projects for maximum benefit.

### **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?**

There is little data from Minnesota on the net benefits of peatland restoration. This study will provide a science synthesis, detailing peatland drainage and restoration impacts, and management and policy options, enabling state agencies to make science-based decisions about the net costs/benefits of peatland restoration for air (carbon dioxide and methane), climate, and water quality (mercury). Specifically, we will synthesize the policy-relevant scientific literature and perform new field studies on restoration impacts on net emissions of greenhouse gases, and net export of mercury into streamwater. Results and policy options will be shared in reports, peer-reviewed publications, and stakeholder meetings.

## Activities and Milestones

### Activity 1: Determination of likely impacts of peatland restoration on climate and water quality based on current scientific literature

**Activity Budget:** \$54,000

#### Activity Description:

Although there are studies of drainage effects on greenhouse gases and mercury in peatlands and water, none is focused on effects of restoration in Minnesota, and there is no comprehensive policy-relevant synthesis on the effects of peatland drainage and restoration on greenhouse gases (carbon dioxide, methane) and streamwater mercury in our region. To guide policy and management decisions for Minnesota we need data based on local studies. The impact of restoration activities is highly dependent on climate, vegetation, land use history and peat properties. We will carry out a thorough synthesis of existing studies from similar ecosystems to determine the likely impact of restoration of Minnesota peatlands on air and water quality. This literature synthesis will identify key areas of agreement and uncertainties in impacts of drainage and restoration on greenhouse gases and water quality. A report summarizing these findings will be developed in partnership with TNC and state agency partners, made public, and presented to stakeholders (state agencies, legislators, NGOS, environmental investment organizations, tribes, the public) in public meetings.

#### Activity Milestones:

Description	Completion Date
Literature review and report on peatland drainage and restoration on greenhouse gases and climate	December 31, 2023
Presentation of results at stakeholder meetings	March 31, 2024
Peer reviewed publication on the above findings	September 30, 2024

### Activity 2: Field and modeling assessments of restoration impacts on climate (greenhouse gases, energy balance)

**Activity Budget:** \$522,000

#### Activity Description:

Peatland restoration generally leads to positive climate impacts by sequestering carbon from the atmosphere, but there is insufficient evidence from our region, causing uncertainty in planning and prioritizing projects. To determine these benefits, we will measure carbon dioxide and methane fluxes, and energy exchange with the atmosphere, at three pairs of disturbed and restored (rewetted) sites at different times after restoration using state-of-the-art methods (high towers to measure gases above the ground surface- and small chambers for spot, on-the-ground measurements). This approach will allow us to determine the time-course of impacts. Peatland restoration will likely decrease carbon dioxide emissions, but it may increase methane emissions, in the short term, and methane is a potent greenhouse gas. In addition, land cover change can also alter other warming or cooling effects, such as the cooling effect of reflectivity of ecosystems, which can amplify or reduce the gas-based effects of restoration on climate. Tower-based methods (called eddy covariance) will provide the net transfer of gases between the peatlands and the atmosphere, whereas chamber-based methods will determine hotspots of gas flux. This information will inform best management practices for restoration, for example, by identifying plants that have the greatest impact on air quality.

#### Activity Milestones:

Description	Completion Date
Complete flux monitoring site 1, 5 years post-restoration and unrestored paired sites	September 30, 2024
Development of model for coupled moisture and heat flow, and carbon transport in peat	September 30, 2024
Complete flux monitoring site 2, 23 years post-restoration and unrestored paired sites	September 30, 2025
Calibrate model and apply coupled model to evaluation of future conditions	December 31, 2025

**Activity 3: Field and modeling assessments of the impact of peatland restoration on mercury export**

**Activity Budget:** \$190,000

**Activity Description:**

Methylmercury is a major threat to water quality. It is mobilized by drainage ditches from peatlands, bioaccumulates in fish and wildlife, and causes a serious threat to human health and local economies. Restoration-mediated changes in water table and plant communities can alter the amount of methylmercury mobilized into streams, and the amount of mercury volatilized back to the atmosphere. We will work with the Minnesota Pollution Control Agency to fill gaps in our understanding of the factors that regulate methylmercury mobilization in drainage ditches, and test restoration approaches that minimize that transport from peatlands. To do this, we will monitor the fluxes of total mercury and methylmercury from pristine, ditched, and restored sites associated with Activity 2. This will include both emissions of mercury to the atmosphere using gas sampling from towers, and sampling of mercury fluxes in streams from each of these three types of sites. Streams will be sampled at biweekly intervals during the ice-free season at these sites. Gases will be sampled via monthly campaigns at the different sites.

**Activity Milestones:**

Description	Completion Date
Develop model of coupled water flow, heat transport and mercury transport in peat	September 30, 2024
Monitoring of mercury export in air, site 1, 5 years post-restoration; restored and unrestored	September 30, 2024
Monitoring of mercury export in air, site 2, 23 years post-restoration; restored and unrestored	September 30, 2025
Calibrate model and apply coupled model to evaluation of future conditions	December 31, 2025
Monitoring of mercury export in streams for all sites, restored and unrestored	June 30, 2026
Monitoring of mercury export in air site 3, 1 year post-restoration; restored and unrestored	June 30, 2026

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Randy Kolka	US Forest Service	Collaborator, oversee mercury water sampling effort. Dr. Kolka has decades of experience in studying peatland impacts on mercury cycling. As head of the Marcell Experimental Forest in Grand Rapids Minnesota, he is also an expert on Minnesota peatlands	No
Kristen Blann	The Nature Conservancy	Aquatic Ecologist for TNC. Dr. Blann will help translate the science into restoration plans, facilitate coordination with TNC and share results with the public.	No
Erik Lillekov	US Forest Service	Collaborator, oversee chamber-based flux work and related sampling. Dr. Lillekov is a research ecologist with the USDA Forest Service who has extensive experience studying carbon cycling and microbial processes in peatlands of the upper Midwest and around the world.	No
Suzanne Rhees	BWSR	Partner, coordination on BWSR wetland bank restoration goals, stakeholder engagement. Ms. Rhees is Conservation Projects Coordinator at the Minnesota Board of Water and Soil Resources.	No
Dan Shaw	BWSR	Partner, coordination on BWSR wetland restoration methods and assessment, Dan is a wetland restoration specialist at the Minnesota Board of Water and Soil Resources.	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?**

The results of the proposed project will be provided to stakeholders in publications and workshops, as described above. We are currently working closely with TNC on the assessment of restored peatlands. TNC will carry out the long-term implementation of peatland restoration as part of their peatland restoration strategy for the state, working with the state agencies. Together these resources should provide a solid basis for decision-making as to the benefits of peatland restoration needed to guide management and policy. Funding for follow-on research will be sought from federal funding sources such as the NSF and DOE.

## Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Techniques for Water Storage Estimates in Central Minnesota	M.L. 2017, Chp. 96, Sec. 2, Subd. 04h	\$250,000
Setting Realistic Nitrate Reduction Goals in Southeast Minnesota	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04m	\$350,000

## Project Manager and Organization Qualifications

**Project Manager Name:** John Nieber

**Job Title:** Professor

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

John Nieber has over 40 years of experience working as a professional hydrologist in conducting teaching and research activities related to hydrology and water quality. He has management dozens of projects funded by state and federal sources to investigate various aspects of the hydrologic cycle including groundwater flow and transport, wetland hydrology and water quality processes, flooding, droughts, agricultural water use, and urban stormwater quantity and

quality. He was the lead project manager for a five-year contract (under the Master contract list) with the MPCA for the Impaired Waters Program. He has managed three LCCMR projects and has been involved as a collaborator in several others. The three LCCMR projects which he managed were related to water resources sustainability, mapping of water storage across central Minnesota, and assessment of the effectiveness of nitrogen management BMPs for protecting surface waters and groundwater. He is the author of over 100 refereed research articles in the scientific literature. He has worked closely with Dr. Lenhart and Dr. Griffis, successfully carrying out research and teaching classes.

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

**Organization Description:**

CFANS is composed of twelve academic departments and ten research and outreach centers. It also administers the Minnesota Landscape Arboretum, the Bell Museum, and a number 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.

Undergraduate students can choose from 14 majors and more than 25 minors. We also have 13 graduate programs. Our students complete their degrees and leave here well prepared for the workforce because of our emphasis on hands-on learning, internships, and global perspectives.

Almost 93 percent of students who earn CFANS undergraduate degrees find jobs in their career field or enter graduate school within six months of graduation.

With a legacy of innovation — both the Honeycrisp apple and the process of artificially inseminating dairy cows were born here — our research has made a difference, both large and small, in many lives.

The vision of the college is to advance Minnesota as a global leader in food, agriculture, and natural resources through extraordinary education, science-based solutions, and dynamic public engagement that nourishes people and enhances the environment in which we live.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
John Nieber, PI		Project management and modeling activities			33.5%	0.12		\$23,337
Chris Lenhart		data acquisition, data interpretation and modeling			33.5%	0.18		\$18,753
Timothy Griffis		Management of micromet towers and data analysis/interpretation, and modeling			33.5%	0.18		\$37,923
Post-doctorate researcher		Manage and monitor micromet towers, data collection, data analysis, report writing			20.9%	3		\$195,494
graduate research assistant		Monitor micromet towers and small column experiments, data collection, data analysis, modeling			53.1%	1		\$107,109
assistant scientist		Assist with setting up and maintaining micromet towers			28.7%	0.45		\$36,559
undergraduate research assistant		assist with field data collection and system maintenance, results illustration.			0%	0.84		\$24,973
							<b>Sub Total</b>	<b>\$444,148</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Equipment, Tools, and Supplies</b>								
	Equipment	Micrometerological towers	To measure the exchange of carbon dioxide and methane with the surface of the peatland test sites.					\$230,000
	Tools and Supplies	general supplies	required supplies for setup of experimental measurements at peatland sites					\$7,726
							<b>Sub Total</b>	<b>\$237,726</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	<b>-</b>

<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	27 trips, 47628 miles (\$0.585/mile), 1 person: 135 nights hotel (\$85/night), 162 days meals (\$45/day)	travel to field sites to set up equipment, maintain experimental sites, and acquire data					\$46,626
							<b>Sub Total</b>	<b>\$46,626</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
	Publication	publication of guidance documents and scientific articles	to distribute information about project results					\$3,000
							<b>Sub Total</b>	<b>\$3,000</b>
<b>Other Expenses</b>								
		chemical analysis	to test for mercury concentrations in water samples					\$31,500
		shipping	To transport water samples to chemical analysis lab					\$3,000
							<b>Sub Total</b>	<b>\$34,500</b>
							<b>Grand Total</b>	<b>\$766,000</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	University of Minnesota	Indirect costs on project	Secured	\$289,440
			<b>State Sub Total</b>	<b>\$289,440</b>
<b>Non-State</b>				
In-Kind	The Nature Conservancy	Ongoing restoration work at the Sax-zim bog	Secured	\$175,000
			<b>Non State Sub Total</b>	<b>\$175,000</b>
			<b>Funds Total</b>	<b>\$464,440</b>

## Attachments

### Required Attachments

#### *Visual Component*

File: [a97cc859-c93.pdf](#)

#### *Alternate Text for Visual Component*

Top diagram conceptualizes greenhouse gases entering the air, and mercury entering streamwater, from ditched peatlands, impacting climate, water quality, and human health. Maps show ditching in Minnesota's peatlands, and locations of the three restoration study sites in northern Minnesota. A photo of an eddy flux tower is shown....

### Optional Attachments

#### *Support Letter or Other*

Title	File
LoS LCCMR peat proposal letter from KBlann	<a href="#">d165e915-a4b.pdf</a>
Nieber LCCMR letter from US Forest Service	<a href="#">f2114187-002.pdf</a>
Institutional Approval to submit	<a href="#">3c01a9f8-c09.pdf</a>

## 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

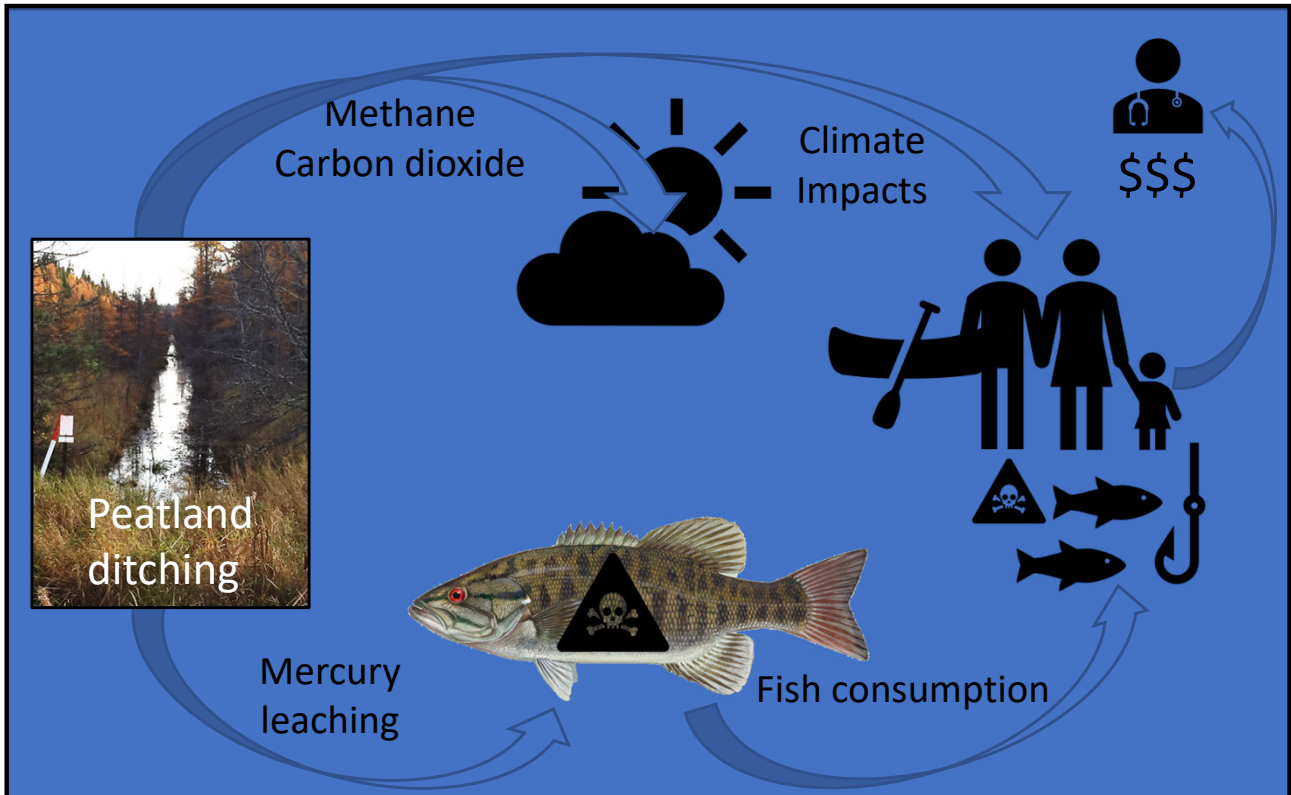
**Does your project include original, hypothesis-driven research?**

Yes

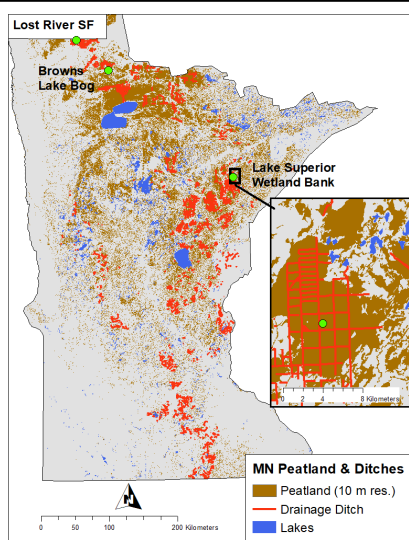
**Does the organization have a fiscal agent for this project?**

No

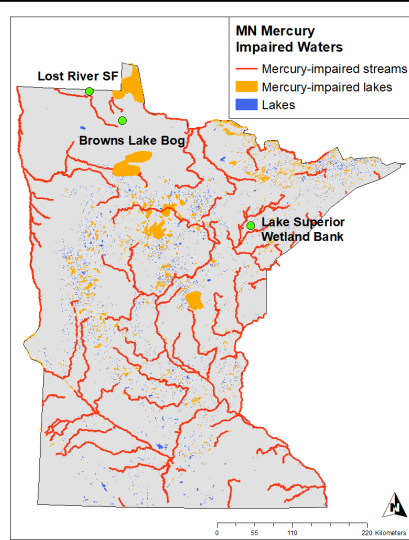
# Quantifying environmental benefits of peatland restoration in Minnesota



Greenhouse gases and mercury are draining from ditched peatlands, affecting climate, water quality, fisheries, economies, and human health. Restoration of ditched peatlands is a promising climate-, flood-, and streamwater mercury mitigation tool requiring validation—the focus of the proposed research.



Ditching (red lines) is widespread in Minnesota's 6 million+ acres of peatlands. Restoration (ditch blocking) is already underway (green circles) allowing us to determine impacts on air and water.



Streams draining ditched peatlands are high in mercury. Effects of ditch restoration on peatland mercury export are untested but will be determined in the proposed study.



Methane and carbon dioxide fluxes between the peatlands and the atmosphere will be measured on unrestored and restored peatlands using "eddy flux" towers like this one run by us in a Minnesota peatland.