



# Environment and Natural Resources Trust Fund

## 2021 Request for Proposal

### General Information

**Proposal ID:** 2021-357

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

### Project Manager Information

**Name:** Timothy Griffis

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

**Office Telephone:** (612) 625-3117

**Email:** timgriffis@umn.edu

### Project Basic Information

**Project Summary:** This study will provide scientific data, management- and policy options enabling state agencies to make science-based decisions about the net benefits of peatland restoration for air quality, climate, and water quality.

**Funds Requested:** \$742,000

**Proposed Project Completion:** 2024-12-31

**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): NW, NE,

**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 associated release of large amounts of greenhouse gases to the atmosphere and mercury into streams. This mercury concentrates in fish, threatening the health of Minnesotans who eat fish and causing economic damage to local fishing economies. Although some peatland restoration is already underway, we do not know the net benefit of these restorations for water and air quality. This information is critical for developing science-based restoration policies that can guide effective restoration management.

There is potential for restoration of hundreds of thousands of acres of peatlands degraded by these ditches. However, some policy-relevant scientific uncertainties must be addressed prior to moving forward with large-scale restoration. Specifically, we need to determine the likely net environmental impacts 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 MPCA, BWSR, MN DNR, and tribal partners to make informed resource management decisions.

### **What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.**

We will fill the knowledge gap relating to comprehensive impacts of peatland ditch restoration on air and water quality using a two-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 (Lake Superior Wetland Bank) and ~ 23 (Browns Lake Bog) years prior to sampling, paired with nearby unrestored sites. This will allow us to determine short- and longer-term impacts 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. Combined with the literature review, this will be synthesized into management and policy guidance reports including policy options, peer-reviewed publications, and shared at stakeholder meetings. Agencies and non-profits can use this to assess the net benefit of peatland restoration at a larger scale.

### **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:** \$53,715

#### 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, 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 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 impacts on stream and atmospheric mercury levels	2022-06-30
Literature review and report on peatland drainage and restoration on greenhouse gases and climate	2022-06-30
Presentation of results at a stakeholder meeting	2022-09-30
Peer reviewed publications on the above findings	2023-03-31

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

#### Activity Budget

**Activity Budget:** \$411,322

#### Activity Description:

Peatland restoration often leads to positive climate impacts by sequestering carbon from the atmosphere, but there is insufficient evidence from our region, leading to uncertainty in the planning process. 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 (tower- and chamber-based). This approach will allow us to determine the time-course of impacts. Peatland restoration will likely decrease carbon dioxide emissions, leading to net uptake. Yet it may also increase methane emissions, at least 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. See activity 4 for synthesis.

#### Activity Milestones:

Description	Completion Date
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Begin flux monitoring site 1, 5 years post-restoration and unrestored paired sites	2021-09-30
Begin flux monitoring site 2, 23 years post-restoration and unrestored paired sites	2022-09-30
Complete flux monitoring site 1, 5 years post-restoration and unrestored paired sites	2022-09-30
Begin flux monitoring site 3, 1 year post-restoration and unrestored paired sites	2023-09-30
Complete flux monitoring site 2, 23 years post-restoration and unrestored paired sites	2023-09-30
Complete flux monitoring site 3, 1 year post-restoration and unrestored paired sites	2024-09-30

### Activity 3: Field determination of impacts of peatland restoration on mercury export

**Activity Budget:** \$237,427

**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. See activity 4 for synthesis.

**Activity Milestones:**

Description	Completion Date
Begin monitoring of mercury export in streams and air, site 2, 23 years post-restoration	2022-09-30
Complete monitoring of mercury export in streams and air, site 1, 5 years post-restoration	2022-09-30
Begin monitoring of mercury export in streams and air, site 1, 5 years post-restoration	2022-09-30
Begin monitoring of mercury export in streams and air site 3, 1 year post-restoration	2023-09-30
Complete monitoring of mercury export in streams and air, site 2, 23 years post-restoration	2023-09-30
Complete monitoring of mercury export in streams and air site 3, 1 year post-restoration	2024-09-30

### Activity 4: Synthesis and recommendations

**Activity Budget:** \$39,536

**Activity Description:**

Combining the literature synthesis (Activity 1) and field sampling efforts (Activities 2 and 3) we will be able to:

1. Provide the first literature synthesis and direct estimates of the short- and long-term impact of peatland hydrologic restoration on climate and stream water quality in Minnesota, and
2. Use this information to provide data synthesis products that support state agency efforts to evaluate the impacts and feasibility of peatland restoration as part of a portfolio of climate change and water quality mitigation efforts.
3. By enhancing the health of our wetlands, streams and lakes; their fish and wildlife; and the people that depend upon them, this project will support the ENRTF mission “to preserve, protect, restore, and enhance all of the bountiful, rare, and threatened natural resources that are the collective heritage of every Minnesotan.”

**Activity Milestones:**

Description	Completion Date
Peer reviewed publications	2024-06-30
Stakeholder meeting to present results and discuss implications for policy and management	2024-06-30
Synthesis of literature and field research results into report on mercury impacts	2024-06-30
Synthesis of literature and field research results into report on climate impacts	2024-06-30

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
David Urban	Ecosystem Investment Partners	Partner, coordination with landowner, Lake Superior Wetland Bank	No
Charlie Tucker	MN DNR, Brown's Lake SNA	Partner, coordination on work at site 2, Brown's Lake SNA	No
Edward Nater	Univ. of MN, Dept. of Soil, Water, and Climate	Collaborator. Analyze water samples for elemental and methyl mercury. Dr. Nater is an expert on the biogeochemistry of mercury in the environment.	Yes
Randy Kolka	US Forest Service, Northern Research Station	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
Erik Lilleskov	US Forest Service, Northern Research Station	Collaborator, oversee chamber-based flux work and related sampling. Dr. Lilleskov 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
Evan Kane	Michigan Technological University	Collaborator, contribute to chamber-based flux work and related sampling. Dr. Kane is an Associate Professor at Michigan Technological University, and studies peatland carbon cycling, and in particular the role of peat and porewater chemistry in determining the rate of peatland carbon cycling.	No
Rod Chimner	Michigan Technological University	Collaborator, provide expertise on peatland restoration, contribute to chamber-based flux work. Dr. Chimner is a Professor of Wetland Ecology at Michigan Technological University, studying carbon cycling and restoration in peatlands around the world.	No
Amanda Kueper	MN DNR, Division of Forestry	Partner, coordination on MN DNR needs, stakeholder engagement. Ms Kueper is Minnesota DNR Forestry Division's Applied Science Coordinator.	No
Bruce Monson	Minnesota Pollution Control Agency	Partner. Scientific liaison for MPCA with the proposed study to assist with data interpretation and facilitate data-sharing with other relevant mercury studies in Minnesota. Dr. Monson is a research scientist, coordinating fish contaminant monitoring, conducting mercury cycling studies, assessing waters impaired for mercury, and advising regulatory staff on mercury issues.	No
Suzanne Rhees	MN 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
Douglas Serrine	MN DNR, Lost River State Forest	Partner, coordination on work at Site 3, Lost River State Forest	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 be funded?**

The results of the proposed project will be provided to stakeholders in publications and workshops, as described above. In a parallel effort, we are also continuing our peatland ditching impact mapping efforts funded by the USDA Forest

Service. Those results will be available to stakeholders in 2021. Together these resources should provide a solid basis for decision-making as to the benefits of peatland restoration needed to guide management and policy. Based on these findings we will continue to seek to fill any gaps in our understanding of impacts that will support agency efforts to pursue science-based policy and management.

## Project Manager and Organization Qualifications

**Project Manager Name:** Timothy Griffis

**Job Title:** Professor

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

Dr. Tim Griffis is a professor in the Department of Soil, Water, and Climate at the University of Minnesota ([www.biometeorology.umn.edu](http://www.biometeorology.umn.edu)). He has been a faculty member at the University of Minnesota since 2002. He teaches courses in micrometeorology and climatology, specializing in boundary-layer meteorology and biometeorology. His research involves the use of boundary layer theory, isotope techniques, and land-atmosphere modeling to study atmospheric transport processes, water budgets, and the greenhouse gas budgets of natural and managed ecosystems at the field to regional scales. He has managed several large-scale projects funded by the National Science Foundation, Department of Energy, and USDA. In the proposed project he will oversee the measurement and modeling activities and ensure that all reporting requirements are met.

### Professional Preparation

2002 NSERC Postdoctoral Fellow, Biometeorology, Univ, of British Columbia, BC, Canada

2000 Ph.D., School of Geography and Earth Sciences, McMaster University, ON, Canada

1995 B.Sc., Physical Geography, Brock University, ON, Canada

### Appointments

2012-current Professor, Department of Soil, Water, and Climate, University of Minnesota- Twin Cities, USA

2012 Visiting Fellow: School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut, USA

2006-2012 Associate Professor, Department of Soil, Water, and Climate, University of Minnesota- Twin Cities, USA

2002-2006 Assistant Professor, Department of Soil, Water, and Climate, University of Minnesota-Twin Cities, USA

2000-2002 Natural Sciences and Engineering Research Council Postdoctoral Fellow, Biometeorology and Soil Physics Group, University of British Columbia, Canada

1997-2001 Research Assistant, Canadian Land-Atmosphere Surface Scheme Project, Meteorological Service of Canada

### Synergistic activities:

- American Meteorological Society – Chair Board on Atmospheric Biogeosciences
- Co-Director of Graduate Studies in Land and Atmospheric Science, Dept. of Soil, Water, and Climate, University of Minnesota, 2009-2015
- Member of the National Ecological Observatory Network (NEON Inc.)- Fundamental Instrument Unit, Working Group, 2009-2015
- Editor, Agricultural and Forest Meteorology, 2008-present

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

### **Organization Description:**

The University of Minnesota, Twin Cities, is a public research university in the Twin Cities of Minneapolis and Saint Paul, Minnesota. The Twin Cities campus comprises locations in Minneapolis and St. Paul approximately 3 miles apart. This campus is the oldest and largest in the University of Minnesota system and has the sixth-largest main campus student body in the United States, with 51,327 students in 2019-20. It is the flagship institution of the University of Minnesota System, and is organized into 19 colleges, schools, and other major academic units. The university is classified among R1:

Doctoral Universities – Very high research activity. The University of Minnesota is a member of the Association of American Universities and is ranked 14th in research activity, with \$881 million in research and development expenditures in the fiscal year ending June 30, 2015. University of Minnesota faculty, alumni, and researchers have won 26 Nobel Prizes and three Pulitzer Prizes. The university was ranked 14th overall among the nation's top research universities by the Center for Measuring University Performance.



## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
post-doctoral associate		running EC CO2 and CH4, and related, help with chamber-based work			25.4%	3		\$197,680
post-doctoral associate		chamber-based fluxes from ditches, mercury sampling			25.4%	3		\$197,680
Researcher 3		set up EC towers			31.8%	0.3		\$19,771
undergrad student worker		in support of chamber-based field work			0%	0.6		\$15,000
							<b>Sub Total</b>	<b>\$430,131</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	-
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	misc materials for field work, lab work eg. filters, tubing, chemicals, and electrical supplies for maintaining our micrometeorological flux measurements and chamber based measurements.	misc materials for field work, lab work eg. filters, tubing, chemicals, and electrical supplies for maintaining our micrometeorological flux measurements and chamber based measurements.					\$8,166
							<b>Sub Total</b>	<b>\$8,166</b>
<b>Capital Expenditures</b>								
		eddy covariance towers plus equipment, some tower costs for mercury gas sampling	Two micrometeorological eddy covariance systems are requested. These systems will consist of sonic anemometers and infrared gas analyzers and radiation equipment. These systems will permit					\$230,000

			measurement of carbon dioxide, methane, mercury, and energy fluxes. This equipment will be part of a long-term measurement network in Minnesota that aims to quantify the energy and carbon balance of different land use types across the state.					
							<b>Sub Total</b>	<b>\$230,000</b>
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	travel to field sites	travel to field sites					\$40,703
							<b>Sub Total</b>	<b>\$40,703</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
	Publication	publication costs	cost for sponsored publications to disseminate research results					\$3,000
							<b>Sub Total</b>	<b>\$3,000</b>
<b>Other Expenses</b>								
		shipping	sample shipping for mercury analysis					\$3,000
		lab analysis	analytical mercury analysis					\$27,000
							<b>Sub Total</b>	<b>\$30,000</b>
							<b>Grand Total</b>	<b>\$742,000</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 DNR	coordination of proposed study with MN DNR - in kind salary support for Kueper	Secured	\$900
In-Kind	BWSR	coordination of proposed study with BWSR, in-kind salary support for Rhees	Secured	\$2,100
			<b>State Sub Total</b>	<b>\$3,000</b>
<b>Non-State</b>				
In-Kind	US Forest Service	support research activities, in-kind salary support for Kolka and Lilleskov	Secured	\$22,152
In-Kind	Michigan Technological University	support research activities, in-kind salary support for Kane and Chimner	Secured	\$16,527
			<b>Non State Sub Total</b>	<b>\$38,679</b>
			<b>Funds Total</b>	<b>\$41,679</b>

## Attachments

### Required Attachments

#### *Visual Component*

File: [9978ac36-19c.pdf](#)

#### *Alternate Text for Visual Component*

At the top is a diagram describing that greenhouse gases (carbon dioxide and methane) are going into the air, and mercury is draining in streamwater, 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.

We provided a map showing that ditching is widespread in Minnesota’s 6 million+ acres of peatlands. Restoration (ditch blocking) is already underway at three sites, allowing us to determine impacts on air and water in this study. We provided another map showing that streams and rivers in many peatland areas are high in mercury. 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. We showed a picture of an eddy flux tower. Methane, carbon dioxide, and mercury 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.

### Optional Attachments

#### *Support Letter or Other*

Title	File
MN DNR Redlake Wildlife Management Area ltr	<a href="#">3081a034-ee7.pdf</a>
MN DNR Division of Forestry letter	<a href="#">9179f3f7-9b4.pdf</a>
Ecosystem Investment Partners letter	<a href="#">eec2b299-c7b.pdf</a>
MN DNR and Roseau River WMA letter	<a href="#">dcf0d61f-be5.pdf</a>

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

**Does your project have patent, royalties, or revenue potential?**

No

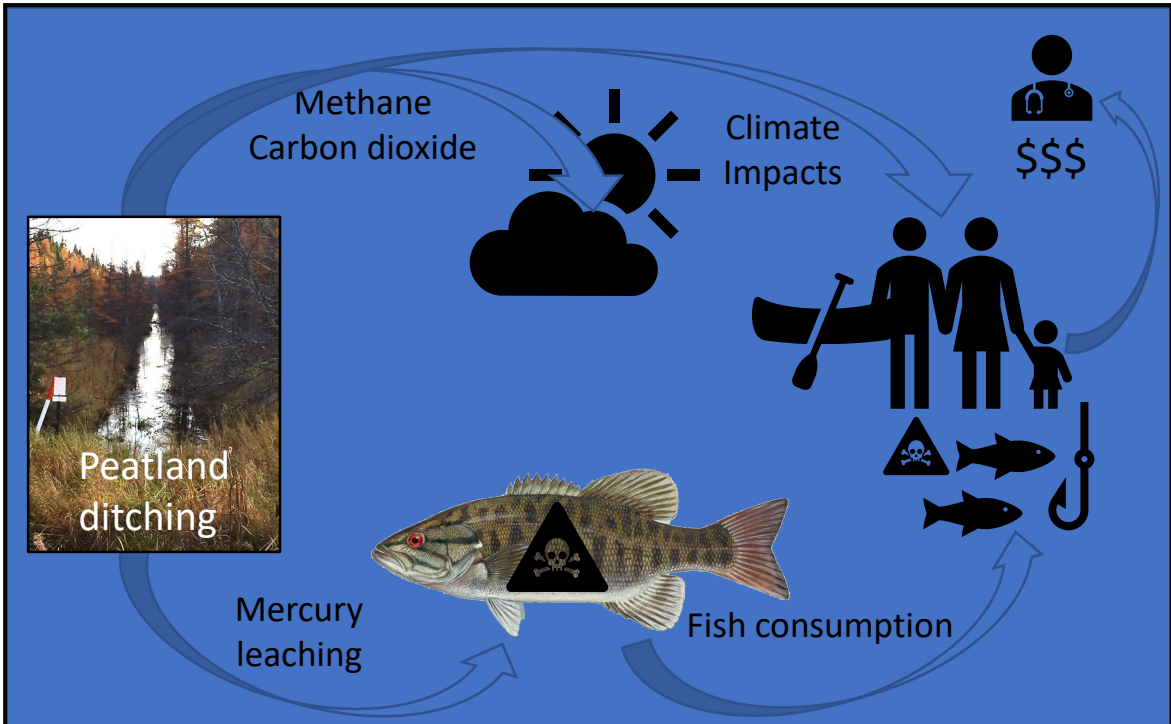
**Does your project include research?**

Yes

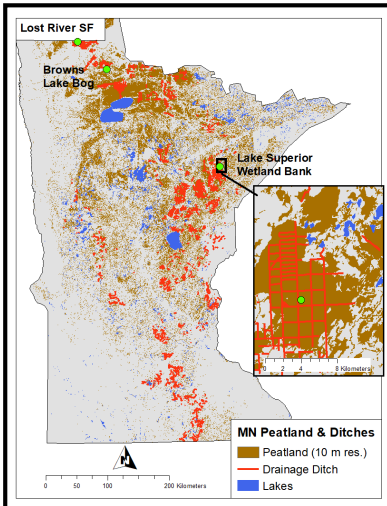
**Does the organization have a fiscal agent for this project?**

Yes, Sponsored Projects Administration

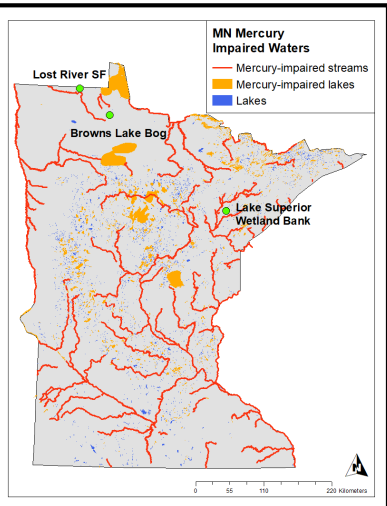
# Quantifying environmental benefits of peatland restoration in Minnesota



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.