

**Environment and Natural Resources Trust Fund  
2016 Request for Proposals (RFP)**

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**Project Title:**

**ENRTF ID: 070-B**

Predicting Climate Change Effects on Mercury in Peatlands

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**Category:** B. Water Resources

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**Total Project Budget:** \$ 643,088

**Proposed Project Time Period for the Funding Requested:** 3 years, July 2016 to June 2019

**Summary:**

We seek to determine the effects of increased temperatures on release of mercury from Minnesota peatlands, which could greatly exacerbate existing human health problems associated with the consumption of fish.

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**Location**

**Region:** Statewide

**County Name:** Statewide

**City / Township:**

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**Alternate Text for Visual:**

Aerial view of the SPRUCE Project and the 10 environmental enclosures

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____ %



**Environment and Natural Resources Trust Fund (ENRTF)**

**2016 Main Proposal**

**Project Title:** Predicting Climate Change Effects on the Release of Mercury and Sulfur from Minnesota's Peatlands

**PROJECT TITLE:** Predicting Climate Change Effects on the Release of Mercury and Sulfur from Minnesota's Peatlands

**I. PROJECT STATEMENT**

Minnesota has a mercury problem. Eight percent of infants born in the Lake Superior Basin in Minnesota have mercury concentrations in fetal cord blood that exceed human health standards, apparently related to fish consumption by their mothers. *In addition, 95% of the stream reaches and lakes assessed for mercury in fish have been listed as impaired*, posing a threat to human and environmental health. This problem will be exacerbated if increased temperatures expected with climate change increase decomposition in peatlands, which in turn will release at least a fraction of the vast stores of mercury and sulfur they have accumulated from both anthropogenic and natural sources in atmospheric deposition. This release would directly increase mercury and sulfur concentrations in streams and lakes and also enhance the formation of methylmercury, the most toxic form of environmental mercury.

We have a unique opportunity to determine how climate change will affect the more than 6 million acres of peatlands in Minnesota and the mercury and sulfur stored within them: it is called the SPRUCE project (<http://mnspruce.ornl.gov>), a 10 year, 50 million dollar Department of Energy-funded climate change experiment located on a peat bog at the Marcell Experimental Forest north of Grand Rapids, MN. The SPRUCE infrastructure consists of 10 large (40 ft dia., 30 ft tall) open-topped, controlled-environment enclosures. The atmosphere and soil (peat) in the enclosures will be maintained at 5 different temperatures (no change, +4, +8, +12, and +16° F) relative to temperatures measured outside the enclosures throughout the 10 year period of the experiment. Heating will commence in June, 2015.

We propose to measure the effects of increased temperature on the release and fate of mercury and sulfur from peatlands and to use that knowledge to predict their specific impacts on Minnesota's aquatic ecosystems. Both of these elements can be released to surface waters, with additional impacts on local aquatic ecosystems that are already of concern, or volatilized to the atmosphere to be more widely dispersed. Consequently, we will analyze and predict both pathways for each element.

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1:** Determine the effects of increased temperatures on the rate and environmental fate of mercury and sulfur released from peat decomposition.

**Budget: \$643,088**

Measure microbial activity, peat decomposition rates, and the distribution of chemical species of mercury and sulfur in the SPRUCE warming experiment. Determine the chemical species of mercury and sulfur in peat, porewater, and runoff waters, and measure their fluxes to the atmosphere, over three growing seasons as a function of warming. Coordinate our measurements with other SPRUCE researchers to develop a comprehensive understanding of how these processes are affected by temperature and how they may respond to climatic drivers. All results will form the basis for predictions of how future temperature increases will influence the amount of mercury and sulfate in MN surface waters and be volatilized to the atmosphere.

<b>Outcome</b>	<b>Completion Date</b>
1. Collect and analyze samples of peat, waters and gas fluxes over 3 growing seasons	December 31, 2018
2. Statistical analysis of data and development of a predictive model of the environmental fate of mercury and sulfate under elevated temperatures.	March 31, 2019
3. Write reports and disseminate information to collaborators and state agencies	June 30, 2019



## Environment and Natural Resources Trust Fund (ENRTF)

### 2016 Main Proposal

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### III. PROJECT STRATEGY

#### A. Project Team/Partners

Project Partners Receiving Funds:

- Dr. Ed Nater, Dr. Brandy Toner, and Dr. Jessica Gutknecht [\$643,088]: Plan, direct, and conduct the project; oversee project personnel. Measure mercury and sulfur in peat, pore and surface waters, and in the atmosphere. Determine relationships between temperature and peat decomposition rates, rates of release of mercury and sulfur, and net methylation of mercury. Develop a predictive model for understanding effects of elevated temperatures on the release of mercury and sulfur species to the environment.

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Project Partners Not Receiving funds:

- Dr. Randall Kolka and Dr. Stephen Sebestyen, US Forest Service Northern Research Station: Provide sampling support, technical expertise, and liaisons with the SPRUCE project. Assist in overseeing project personnel; contribute to the development of a predictive model for understanding the effects of elevated temperature on the release of mercury and sulfur species to the environment.
- Collaborators: Pat McCann (MDH), Bruce Monson and Edward Swain (MPCA), Mike Berndt (MNDNR)

#### B. Project Impact and Long-Term Strategy

We do not anticipate any extension of this project beyond the proposed end date. In anticipation of the proposed project, the project partners have already completed two years of method development and baseline measurements at the SPRUCE site and have supported 1 postdoctoral fellow, 3 graduate students and 1 technician (\$267,760) to obtain those measurements. In the coming year (present to July 2016) we will support 2 graduate students and 1 technician (\$120,254) to obtain 1 additional year of measurement and to collect and preserve samples prior to the start of the proposed LCCMR project. During the project period, the project partners will support a graduate student for one year (\$40,380), for a minimum total investment of \$428,394 over the course of the project. The proposed project will leverage these preliminary results as well as the SPRUCE infrastructure and operational costs (\$50 million) and data collected by SPRUCE partners (additional millions) to conduct our project and more fully interpret our results. SPRUCE is the largest climate change experiment in existence, is extensively instrumented, and has more than 100 researchers involved across the sciences and from around the globe. Protocols for data sharing and data archiving have been established and implemented.

We will periodically update our collaborators and share findings with personnel in state agencies (MDH, MPCA, MNDNR) over the course of the project. At the conclusion of the project, we will disseminate our findings and reports broadly to interested parties in Minnesota, the federal government, and elsewhere, as well as to other researchers through the peer-reviewed literature.

#### C. Timeline Requirements

We propose to start the project in July, 2016. Prior to the start of the project and following spring thaw in 2016, project partners will begin sample collection and preservation. This effort will be supported by other funds and our US Forest Service partners. After the project start date, these preserved samples will be analyzed, thereby allowing us to measure mercury and sulfur release over 3 full field seasons, avoiding the possibility of having results biased by an anomalous weather year. Sample analyses will be completed by 31 December, 2018. Statistical analyses of our data in conjunction with other relevant data collected by SPRUCE partners will be completed by the end of March, 2019, and reports will be finalized by the end of June, 2019. We do not anticipate any additional stages of this project.

## 2016 Detailed Project Budget

**Project Title: Predicting Climate Change Effects on the Release of Mercury and Sulfur from Minnesota's Peatlands**

### IV. TOTAL ENRTF REQUEST BUDGET 3 years

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
<b>Personnel:</b> Postdoctoral Fellow (1.0 FTE, 3 yrs). Lead project person for mercury and sulfur work. (Salary/Fringe Benefits: \$139,091/\$31,156)	\$ 170,247
<b>Personnel:</b> Graduate Student (0.5 FTE, 3 yrs). The graduate student will work with Jessica Gutknecht to conduct microbial assays (Salary/Fringe Benefits: \$66,680/\$54,390)	\$ 121,070
<b>Personnel:</b> Technicians (1.0 FTE, 2.5 yrs; 0.5 FTE, 2 yrs). Collect, process, analyze samples (Salary/Fringe Benefits: \$114,414/\$31,350)	\$ 145,764
<b>Personnel:</b> Undergraduate Researcher (1,600 hours over 3 yrs) Work with technicians and grad students (Salary/Fringe Benefits: \$17,600/0)	\$ 17,600
<b>Personnel:</b> Faculty (Nater, Toner, Gutknecht) summer salary (0.051 FTE, 3 yrs) Coordinate project, oversee employees, analyze data, write reports. (Salary/Fringe Benefits: \$48,536/\$16,357)	\$ 64,893
<b>Professional/Technical/Service Contracts:</b> N/A	\$ -
<b>Equipment/Tools/Supplies:</b> Laboratory supplies, chemicals, ultrapure chemicals, standards, septa, cleanroom supplies (class 100 gloves, cleanroom wipers, HEPA filters, others), ultrapure analytical gases, sampling equipment (pumps, tubing, filters, PVC pipe) and containers (teflon bottles, glass bottles, plastic bottles, bags, other containers), coolers, dry ice, cool packs, and numerous other miscellaneous supplies.	\$ 75,400
<b>Acquisition (Fee Title or Permanent Easements):</b> N/A	\$ -
<b>Travel:</b> In-State Travel to Marcell Experimental Forest (400 mi round trip) to collect samples and make analyses. Includes mileage, lodging, per diem for 18 trips per year for two people for three years.	\$ 30,114
<b>Travel:</b> Travel to synchrotron beamline (out of state travel). The project requires the use of a high-energy synchrotron for specific chemical analyses; there are none located within Minnesota. Consequently, we request a waiver on out of state travel. Travel would consist of 2 trips per year for 2 or 3 people, typically 4 to 5 days duration. Similar trips have been averaging approximately \$3,000 per trip over the last two years.	\$ 18,000
<b>Additional Budget Items:</b> N/A	\$ -
<b>TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =</b>	<b>\$ 643,088</b>

### V. OTHER FUNDS

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
<b>Other Non-State \$ To Be Applied To Project During Project Period:</b> Graduate Student (0.5 FTE, 1	\$ 40,380	Secured
<b>Other State \$ To Be Applied To Project During Project Period:</b> N/A	\$ -	
<b>In-kind Services To Be Applied To Project During Project Period:</b> N/A	\$ -	
<b>Funding History:</b> Personnel expenses prior to start of project: one Postdoctoral fellow (2 yrs, 1.0 FTE, \$104,190, US Forest Service), Graduate students (2 graduate students, 2 yrs, 0.5 FTE, \$161,520, US Forest Service, University of Minnesota), (1 graduate student, 1 yr, 0.5 FTE, \$40,380, University of Minnesota), one Technician (2 yrs, 1.0 FTE, \$122,304, US Forest Service).	\$ 428,394	Spent or Encumbered
<b>Remaining \$ From Current ENRTF Appropriation:</b> N/A	\$ -	

**PROJECT TITLE:** Predicting Climate Change Effects on the Release of Mercury and Sulfur from Minnesota's Peatlands



Aerial view of the SPRUCE Project and the 10 environmental enclosures located on the S1 bog at the Marcell Experimental Forest north of Grand Rapids, MN. The inset is a ground view of one of the enclosures as construction nears completion.

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### **Project Manager Qualifications**

Ed Nater is a professor in the Department of Soil, Water, and Climate at the University of Minnesota. He has more than 25 years of experience managing research projects at the University of Minnesota and more than 20 years of experience conducting research on mercury in the environment. He served as the Head of the Department of Soil, Water, and Climate for eight and a half years where he was responsible for the academic, research, human resource, and fiscal portfolio of the department. He recently managed the University of Minnesota's portion of the LCCMR project titled "Measuring conservation outcomes with new and revised estimators" conducted by the Board of Water and Soil Resources.

### **Organization Description**

The organization managing the proposed project will be the University of Minnesota, Twin Cities campus.