

**Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 123-E

Determining Climate Change Effects on Mercury in Peatlands

Category: E. Air Quality, Climate Change, and Renewable Energy

Total Project Budget: \$ 442,779

Proposed Project Time Period for the Funding Requested: 3 Years, July 2014 - June 2017

Summary:

Elevated concentrations of mercury have been observed in children living along the North Shore. Potential increases in mercury in surface waters resulting from climate change may exacerbate that situation.

Name: Edward Nater

Sponsoring Organization: U of MN

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St. Paul MN 55108

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Web Address

Location

Region: Northeast

County Name: Carlton, Cook, Itasca, Koochiching, Lake, Lake of the Woods, St. Louis

City / Township:

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



PROJECT TITLE: Determining Climate Change Effects on Mercury in Peatlands

I. PROJECT STATEMENT

Peatlands hold vast reservoirs of mercury accumulated over thousands of years. Warming climates have the potential to increase microbial degradation of peats, releasing mercury to the environment. Mercury can be released to surface waters as a component of dissolved organic carbon compounds, or it can be released to the atmosphere in gaseous form and dispersed globally. Warmer temperatures may also enhance the formation of methylmercury, the most toxic common form of mercury, thereby increasing mercury concentrations in aquatic food webs and increasing environmental and human health risks. Minnesota already faces a crisis with respect to elevated concentrations of mercury in children living along the North Shore; increases in mercury and/or methylmercury in surface waters will only exacerbate that situation.

The main goals of this project are to determine the potential effects of climate change on the release of mercury from peatlands, the most probable pathways for release, and the potential impact of such a release on human health and environmental risk. Outcomes of this project would be an enhanced understanding of the potential effects of climate change on mercury contamination of the environment that would be communicated to state and federal agencies.

This project will leverage the resources of the SPRUCE (Spruce and Peatland Responses Under Climatic and Environmental change) project located on the S1 bog at the Marcell Experimental Forest north of Grand Rapids. SPRUCE is a large, Department of Energy funded (\$50 million) ecosystem warming experiment designed to assess the response of northern peatland ecosystems to increases in temperature and carbon dioxide concentrations. The warming experiments are conducted in 17 large (12 meter diameter) chambers and are scheduled to start operating in Spring, 2014 (see attached graphic). We will utilize SPRUCE and Marcell Experimental Forest resources to measure the effects of warming on mercury release to surface waters and the atmosphere.

From the combination of studies described below we will determine the potential effects of climate change on the fate and behavior of mercury currently stored in peatlands. This information will be communicated to state and federal agencies concerned with mercury in the environment.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Fate of peatland mercury under simulated climate change

Budget: \$442,779

Outcome	Completion Date
<p>1. SPRUCE Chamber-based Measurements</p> <p>SPRUCE chambers (soil and air), will be maintained at temperatures 0, 1.5, 3, 4.5, 6, 7.5, and 9°C above ambient. Water table depths are uncontrolled and will fluctuate naturally with precipitation and evapotranspiration. We will measure net methylation, mercury volatilization, and dissolved organic carbon and aqueous mercury in chamber runoff waters.</p> <p>Outcomes: Determine the effect of elevated temperatures on:</p> <ul style="list-style-type: none">• net methylation,• rates of production of dissolved organic carbon and aqueous mercury, and• rates of mercury volatilization from peat.	06/30/2017
<p>2. Microcosm Measurements</p> <p>Small (< 1 square meter) microcosms will be constructed near the SPRUCE chambers. We will control water table depth in these microcosms, allowing us to separate effects due to</p>	06/30/2017



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<p>warming from those due to changes in water table. In addition, we will use isotopically-labeled mercury to simultaneously measure rates of methylation and demethylation.</p> <p>Outcomes: Measure the effects of changes in water table depth on:</p> <ul style="list-style-type: none">• rates of production of dissolved organic carbon and aqueous mercury,• rates of volatilization of mercury from the peat,• net methylation, and• rates of mercury methylation and demethylation.	
<p>3. Lab Measurements</p> <p>Lab studies will provide additional information regarding these processes. Under tightly controlled conditions we will measure the effects of temperature and water table depth on the rates of microbial degradation of peat, rates of dissolved organic carbon and aqueous mercury production, rates of mercury volatilization, and isotopically-derived rates of mercury methylation and demethylation.</p> <p>Outcomes: Measure the effects of changes in temperature and water table depth on:</p> <ul style="list-style-type: none">• rates of production of dissolved organic carbon and aqueous mercury,• rates of volatilization of mercury from peat,• rates of peat decomposition,• rates of mercury volatilization,• net methylation, and• rates of mercury methylation and demethylation.	06/30/2017

III. PROJECT STRATEGY

A. Project Team/Partners

Professor Ed Nater and Assistant Professor Brandy Toner, Department of Soil, Water, and Climate, U of Minnesota, will co-manage the project; work with the postdoc, technician, and researchers; design experiments; analyze data; and write reports. Nater and Toner will receive 0.5 and 1.0 months summer funding per year, respectively; each will contribute 1% of their salary in in-kind services.

Drs. Randall Kolka and Stephen Sebestyen, Research Scientists, USDA Forest Service, Northern Forest Research Station, Grand Rapids, MN. Kolka and Sebestyen are directors of the Marcell Experimental Forest. Both are co-PIs on the SPRUCE project, and Kolka is also a member of the Intergovernmental Panel on Climate Change. They will aid in design of infrastructure, experiments, and measurements; and coordinate with Marcell Experimental Forest and SPRUCE personnel and resources.

B. Timeline Requirements

The project duration is 36 months. SPRUCE is scheduled to begin warming experiments in summer, 2014. We believe it will take one full year for the enclosed ecosystems to stabilize with respect to their new enhanced temperature regimes, and we will need 2 full years of data gathering to attain our goals.

C. Long-Term Strategy and Future Funding Needs

Nater and Toner are SPRUCE project collaborators and currently have a pilot project focused on obtaining background (prior to initiation of the warming experiments) data on mercury concentrations and net methylation in the S1 bog, determining the role of sulfate on mercury methylation, and developing experimental designs and analytical protocols for additional studies once SPRUCE is fully operational.

Future funding is not anticipated for this project.

2014 Detailed Project Budget

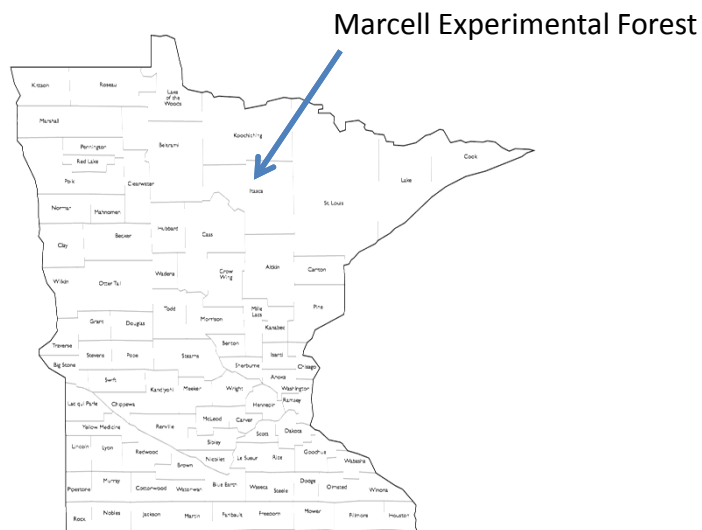
Project Title: Determining Climate Change Effects on Mercury in Peatlands

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM (See "Guidance on Allowable Expenses", p. 13)	AMOUNT
Personnel: Ed Nater will be paid 0.5 months (5.6% FTE) of summer salary to manage the project, design experiments and analytical protocols, analyze data, oversee the activities of the postdoc, technician, and undergraduate researchers, write reports, and communicate results to interested state and federal agencies. 93.7% of the request is salary and 6.3% is fringe benefits. The time period will be for the duration of the project	\$ 24,491
Personnel: Brandy Toner will be paid 1.0 months (11.1%) of summer salary to design experiments and analytical protocols, analyze data, mentor researchers in field research and laboratory, write reports, and communicate results to interested state and federal agencies. 93.7% of the request is salary and 6.3% is fringe benefits. The time period will be for the duration of the project.	\$ 31,739
Personnel: Post-doctoral Researcher. The post-doctoral researcher will be the lead scientist on the project and will help design experiments, conduct field and laboratory research, collect, process, and analyze samples, perform statistical analyses, and interpret results. 82.8% of the requested funds are for salary and 17.2% are for fringe benefits. This will be one full time (1.0 FTE) position for the duration of the project	\$ 149,290
Personnel: Technician. The technician will help the post-doctoral researcher conduct field and laboratory experiments, collect samples, and analyze them. This will be two half-time (0.5 FTE) positions lasting the duration of the project. 73.1% of the requested funding is salary and 26.9% is fringe benefits.	\$ 126,851
Personnel: Undergraduate Researchers. Undergraduate students will be hired to help the postdoctoral researcher and technician. They will collect samples, help with field and laboratory installation of experiments, prepare samples for analyses, wash laboratory glassware, and other tasks as needed. In Yrs 1 and 2, two students will be hired full time for the summer and at an approximate rate of 10 hrs per week during the academic year. In Yr 3, 1 student will be hired full time for the summer and at an approximate rate of 10 hrs per week during the academic year. 96.6% of the requested funds are salary and 3.4% for fringe benefits.	\$ 41,408
Contracts: N/A	\$ -
Equipment/Tools/Supplies: Equipment to construct the microcosms, consisting of 4 enclosures, 4 data loggers, 20 moisture and temperature probes, and 2 pumps to control water table depth. (Yr 1 only)	\$ 8,000
Equipment/Tools/Supplies: Laboratory and field consumables, including chemicals and reagents, disposable clean room gloves, sample bottles and containers, Teflon vials and containers, supplies for incubation experiments, standard reference materials, standards, and other consumables (over 3 yrs)	\$ 27,000
Acquisition (Fee Title or Permanent Easements): N/A	\$ -
Travel: Total of 22 weeklong sampling trips to Marcell, MN from St. Paul, MN including mileage, hotel, and per diem.	\$ 25,000
Additional Budget Items: Mercury isotopic analyses (60 samples @ \$150/ea over 3 years)	\$ 9,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 442,779

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ Being Applied to Project During Project Period: N/A	\$ -	
Other State \$ Being Applied to Project During Project Period: N/A	\$ -	
In-kind Services During Project Period: 1% cost shared effort for PI, Ed Nater and co-PI Brandy Toner	\$8,586	Secured
In-Kind Services During Project Period: unrecovered IDC at the rate of 52% MTDC	\$230,245	Secured
Remaining \$ from Current ENRTF Appropriation (if applicable): N/A	\$ -	
Funding History: N/A	\$ -	



Spruce and Peatland Responses Under Climate and Environmental Change (**SPRUCE**)

(Above) Full-scale prototype of a SPRUCE chamber for testing and evaluation. Constructed at Oak Ridge National Laboratory, Department of Energy. A ten year experiment with 17 chambers will begin at Marcell Experimental Forest in 2014.



(Left) Aerial photograph of the S1 bog in Marcell Experimental Forest showing a SPRUCE chamber (prior to installation of its walls) and part of the boardwalk system currently installed.

Project Manager Qualifications

Dr. Edward A. Nater

Current Appointment:

Professor, Department of Soil, Water, and Climate, University of Minnesota

Education:

Ph.D., Soil Science, University of California, Davis, July, 1987.

M.S., Natural Resources, University of Wisconsin - Stevens Point, December, 1982.

B.S., Botany, Western Illinois University, Macomb, December, 1973.

Relevant Experience:

Dr. Nater has more than 20 years experience conducting landscape-scale research on mercury in the environment, including research on atmospheric deposition, hydrologic transport, bioaccumulation and biomagnification in the food chain, volatilization, the role of atmospheric sulfur deposition on mercury methylation, and watershed mass balance of mercury inputs, transport, and outputs. Dr. Nater is a participant in the SPRUCE project working on mercury methylation.

Dr. Nater will be responsible for joint oversight of the project, coordinating tasks among collaborators, budget oversight, project reporting, and communication of results with state and federal agencies.

Dr. Brandy M. Toner

Current Appointment:

Assistant Professor, Department of Soil, Water, and Climate, University of Minnesota

Education:

Ph.D., Environmental Science, Policy, and Management, UC Berkeley

M.S., Civil and Environmental Engineering, UC Berkeley

B.S. Environmental Studies, Bemidji State University

Relevant Experience:

Dr. Toner has 13 years of experience conducting research in environmental chemistry and geochemistry, including use of advanced X-ray microscopy and analytical techniques for metals in soil, sediment, and water. Dr. Toner is a participant in the SPRUCE project working on mercury methylation.

Dr. Toner will be responsible for joint oversight of the project, designing experiments, working with the postdoc, technician, and collaborators, writing reports, and communication of results to state and federal agencies.

Organization Description:

The University of Minnesota is a highly-ranked land grant research university with excellent instrumentation, and research and computational facilities.