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

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Project Title:

Identifying Causes of Exceptionally High Mercury in Fish

Category: B. Water Resources

Total Project Budget: $ 2,700,869

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

Other Non-State Funds: $ 347,000

Summary:

Quantify the probable causes of high mercury levels in fish from five impaired Minnesota rivers, providing the scientific basis to guide further mercury reductions.

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Sponsoring Organization: MN Pollution Control Agency

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Location

Region: Central, Northwest, Northeast

County Name: Statewide

City / Township:

MP: 0613-2-057-proposa
Budget: 0613-2-057-bud
Qual: 0613-2-057-qualifi
Map: 0613-2-057-map-2
Resolution:
List:

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

PROJECT TITLE: Identifying Causes of Exceptionally High Mercury in Fish

I. PROJECT STATEMENT

Mercury is toxic to the nervous system and eating fish is the primary route of exposure to humans and wildlife. More than two-thirds of Minnesota lakes and streams evaluated by the Minnesota Pollution Control Agency (MPCA) are mercury in fish are "impaired." One in 10 of these impaired waters have exceptionally high mercury in fish, including the five rivers that are the focus of this proposal. Mercury in Minnesota waters comes primarily from releases into the air by burning of coal and other compounds, after which snow, rain and dust carry the mercury into surface water. Less than 1% of the mercury entering Minnesota's watersheds comes from wastewater discharges. Mercury in the environment can convert to a form that accumulates in the food chain, increasing in concentration as it moves from microscopic plants, to tiny animals, to fish, and and eventually to humans and wildlife (see graphic).

The first step in solving the problem of mercury in fish is reducing the amount of mercury entering lakes, streams and wetlands. Toward this end, the MPCA is implementing a plan to reduce the mercury released from Minnesota smokestacks by 93 percent and continue to reduce mercury from wastewater discharges. This large reduction in mercury releases in Minnesota, coupled with global reductions , will fully restore about 90% of Minnesota's water bodies from the effects of mercury pollution.

This proposal is for the 10 percent of mercury-impaired waters that are exceptionally high in mercury and need more actions to fully protect human health. These waters are more efficient at concentrating mercury into fish. Scientists understand some of the factors that cause this enhanced mercury accumulation, but not well enough to know the relative importance of each factor and what actions could reduce the enhanced mercury accumulation. This proposal addresses this knowledge gap, focusing on five rivers with high mercury levels in fish: Kettle, Red River of the North, Roseau, St. Louis, and Vermilion. Comparing results from multiple rivers will strengthen the confidence in the conclusions. The results will be relevant to lakes as well.

MPCA is partnering with the Minnesota Department of Natural Resources (DNR) and the United States Geological Survey (USGS) to investigate mercury delivery from subwatersheds, production and destruction of methylmercury (the bioavailable form), mercury levels in the food web, and the effects of fish growth on mercury levels. Activities are designed to quantify each of these processes. The goal of this project is to achieve sufficient knowledge about the causes of exceptionally high mercury levels to inform additional efforts to reduce mercury in fish.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: ***Transport of mercury from land to water in five rivers*** **Budget:** $ 2,087,000

Measure the water flow and chemical concentrations at 25 sites over 2 years in key tributaries and within the 900 miles of the combined five rivers. Quantify variability from low to high flows and across seasons.

Outcome	Completion Date
1.Measure yields of methylmercury, mercury, organic carbon, and suspended solids	*Dec. 31, 2016*
2. Identify tributaries that are most efficient in delivering methylmercury to the rivers	*March 30, 2017*

Activity 2: ***Methylmercury production and destruction*** **Budget:** $ 168,300

Measure the rates of methylmercury production (methylation) and destruction (demethylation) in tributaries that have a range of methylmercury yields to determine if net methylation is higher in the high yield tributaries. Measure destruction of methylmercury by light in the rivers to determine if it is a significant process in these flowing waters (it is significant in lakes).

Outcome	Completion Date
1. Rates of production and loss of methylmercury measured	*June 30, 2017*
2. Quantify photodemethylation (breakdown of methylmercury by sunlight) in the rivers	*June 30, 2017*
3. Characterize the quality of organic matter and its relationship with methylmercury	*June 30, 2017*

Activity 3: *Food Web and Fish Life Histories* **Budget:** $ 339,600

Collect samples at all levels of the aquatic food web to measure mercury levels. Analyze the source of food and the length of food webs using stable isotopes. Acquire fish length and age data to calculate the growth rates of top predators and compare those rates to mercury levels in the fish.

Outcome	Completion Date
1. Complete analysis of mercury in food webs within the rivers	*June 30, 2017*
2. Determine if slow fish growth rates contribute to mercury levels in the fish	*June 30, 2017*

Activity 4: *GIS Database and Conceptual Model Development* **Budget:** $ 106,000

Compile all data for mercury in water, sediment, soil, and biota in a single database. Compile land cover and hydrology for each watershed in a GIS database. Perform statistical analysis of collected data. Compare and contrast the relative importance of factors controlling mercury availability across the five watersheds.

Outcome	Completion Date
1. Determine the statistical significance of possible causes of high mercury levels in fish	*June 30, 2017*
2. Develop a scientific framework that describes mercury bioavailability in each watershed	*June 30, 2017*
3. Create a database of all data for each watershed that can be accessed for future actions	*June 30, 2017*

III. PROJECT STRATEGY

A. Project Team/Partners

The following investigators and the organizations they represent will be receiving funds from the ENRTF and providing in-kind or matching support:

Bruce Monson is a Research Scientist 3 at the MPCA. He will be a co-lead investigator responsible for MPCA's portion of the project, which will include parts of all four activities. No salary from ENTRF

Michael Berndt is a Research Scientist 3 at the DNR. He will be a co-lead investigator responsible for DNR's portion of the project in activities 1, 3 and 4. Partial support of salary by "soft money," including ENTRF.

Mark Brigham is a Senior Hydrologist/Chemist at USGS's Minnesota office. He will be the co-lead investigator responsible primarily for pollutant load monitoring (activity 1) and collaborating in the development of the conceptual model (Activity 4). ENTRF funding would partially support salary.

The team will communicate and collaborate with the Environmental Protection Agency, Tribal representatives and interested stakeholders throughout the project.

B. Timeline Requirements

The project is designed for 3 years, the first 2 years will be for data collection to capture seasonal variability over a two year period, and the last year will be devoted to data analysis, synthesis, and preparation of reports and presentations.

C. Long-Term Strategy and Future Funding Needs

The long-term goal of this project is to protect public health by reducing mercury in fish. Understanding the relative importance of processes that cause high mercury levels in fish will inform future management activities. The eventual development of Total Maximum Daily Loads for these waters, funded by the Clean Water Legacy Fund, will benefit from the scientific results of this project.

2014 Detailed Project Budget

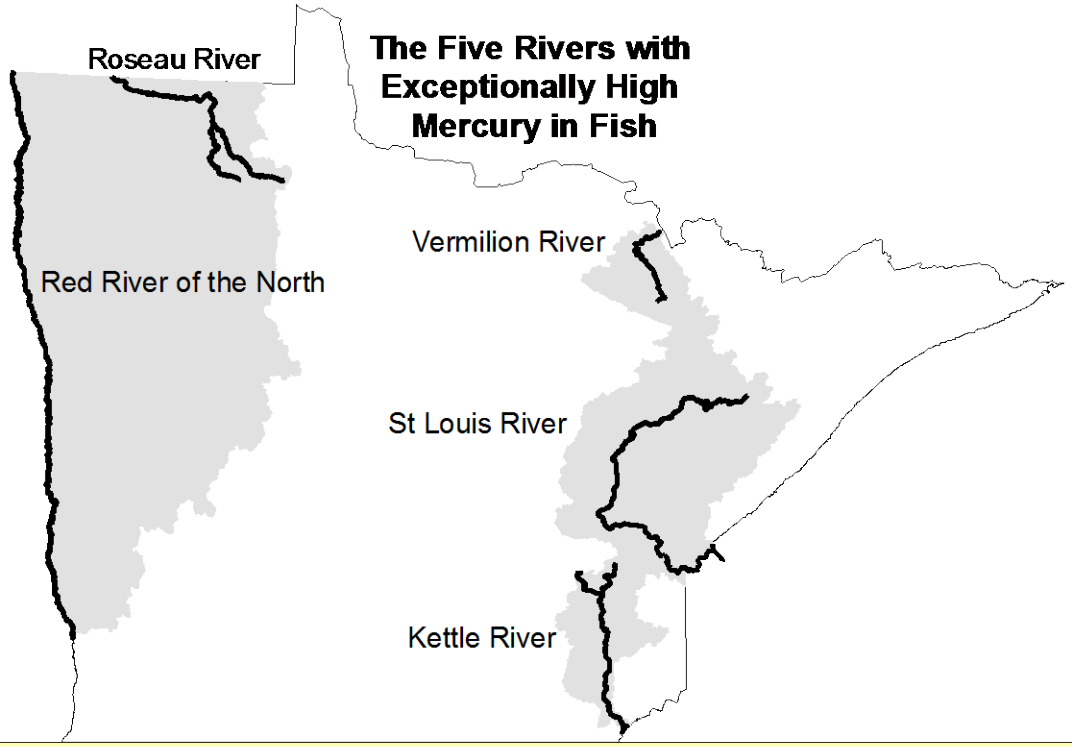
Project Title: Identifying Causes of Exceptionally High Mercury in Fish

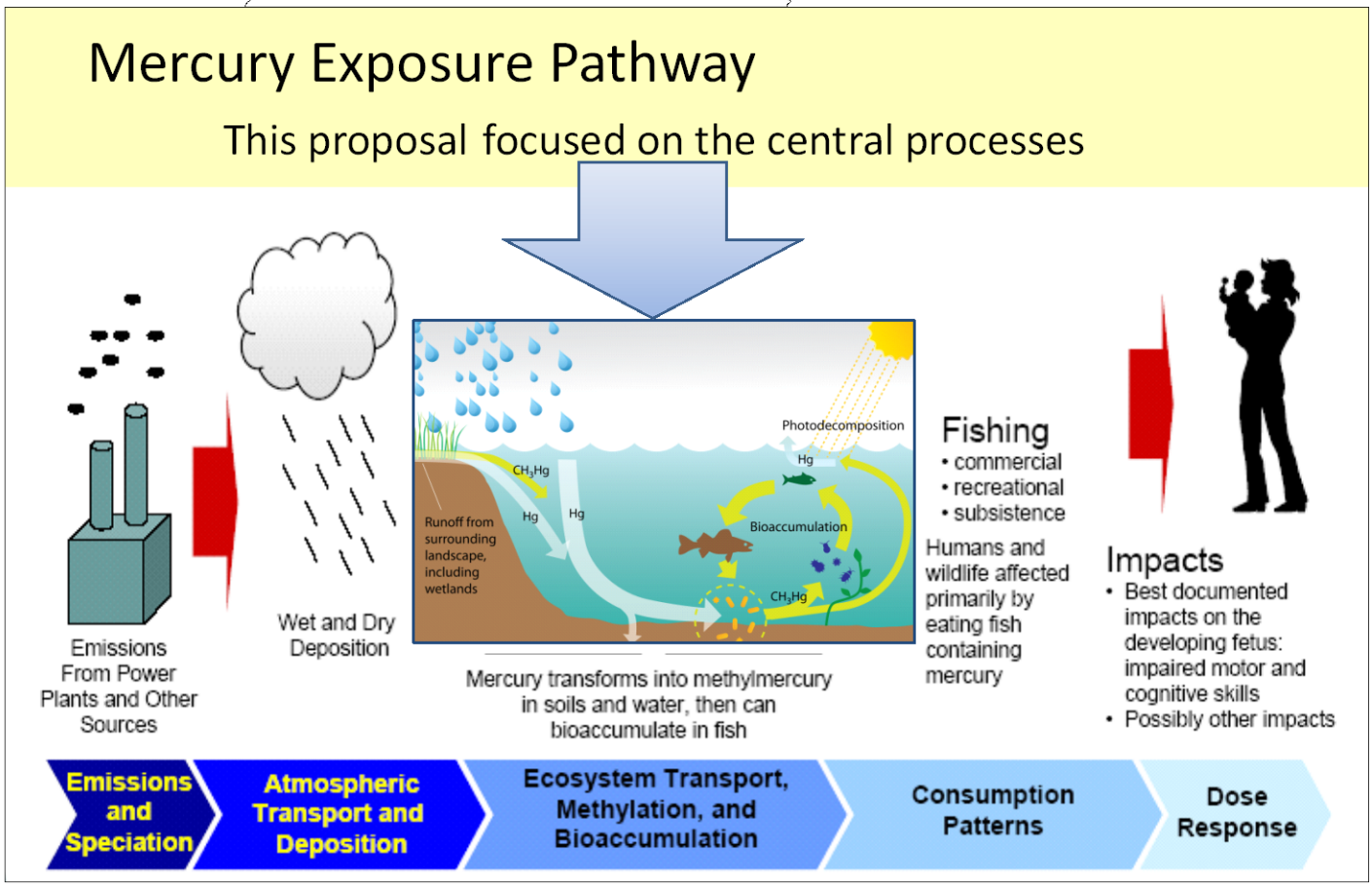
IV. TOTAL ENRTF REQUEST BUDGET [3 years]

BUDGET ITEM *(See "Guidance on Allowable Expenses", p. 13)*	**AMOUNT**
Contracts:	
United States Geological Survey (transport monitoring in Red, Roseau, & Kettle; data analysis; reporting -- contractee providing $347,000 for total cost of $1,044,000)	$697,000
Minnesota Department of Natural Resources (transport monitoring in St. Louis and Vermilion; data analysis; reporting -- contractee providing $50,000 for total cost of $597,857)	$547,857
Minnesota Department of Health Environmental Laboratory (water chemistry analyses: 13 analytes for 1200 samples)	$842,112
Methylation/demethylation Studies (contract with academic research laboratories)	$168,300
Biological Collections (contract with Fond du Lac Band of Lake Superior Chippewa and others)	$122,850
Biota mercury/methylmercury/stable isotopes (contract with isotope laboratory to measure carbon, nitrogen, and sulfur stable isotopes)	$216,750
	$106,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 2,700,869

V. OTHER FUNDS

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ Being Applied to Project During Project Period: USGS match	$ 347,000	*Pending*
Other State $ Being Applied to Project During Project Period: Contribution from DNR appropriation	$ 50,000	*Secured*
In-kind Services During Project Period: **MPCA 0.5 FTE (3 years)**	$ 156,000	*Secured*
Remaining $ from Current ENRTF Appropriation (if applicable):	$ -	
Funding History:	$ -	


The Five Rivers with Exceptionally High Mercury in Fish
Roseau River
Red River of the North
Vermilion River
St Louis River
Kettle River


Mercury Exposure Pathway
This proposal focused on the central processes
Emissions From Power Plants and Other Sources
Wet and Dry Deposition
Photodecomposition
Hg
CH_3Hg
Runoff from surrounding landscape, including wetlands
Bioaccumulation
Mercury transforms into methylmercury in soils and water, then can bioaccumulate in fish
Fishing
• commercial
• recreational
• subsistence
Humans and wildlife affected primarily by eating fish containing mercury
Impacts
• Best documented impacts on the developing fetus: impaired motor and cognitive skills
• Possibly other impacts
Emissions and Speciation
Atmospheric Transport and Deposition
Ecosystem Transport, Methylation, and Bioaccumulation
Consumption Patterns
Dose Response

Environment and Natural Resources Trust Fund (ENRTF)
2014 Main Proposal
Project Title: Identifying Causes of Exceptionally High Mercury in Fish

Project Manager Qualifications/Organization

Project Manager

Dr. Bruce Monson is a Research Scientist 3 in the Environmental Analysis and Outcomes Division of the Minnesota Pollution Control Agency. He will be a co-lead investigator for the project with responsibility for MPCA's portion of the study and overseeing management, project reporting, and contracting.

Qualifications

Education:

Ph.D.	1997	University of Minnesota, Minneapolis (Civil Engineering; minor: Water Resources Science). Dissertation: *Mercury Cycling in Low Alkalinity Lakes and Factors Influencing Bioavailability*.
M.S.	1982	University of Illinois, Champaign-Urbana (Biology)
B.S.	1979	University of Minnesota, Minneapolis (Zoology)

Work Experience:

2002-Present	Research Scientist 3, Minnesota Pollution Control Agency
1993-2002	Limnologist, Environmental Engineer, Barr Engineering, Minneapolis, Minnesota.
1991-1994	Graduate Research Assistant, Civil Engineering, University of Minnesota
1988-1991	Environmental Scientist, Limno-Tech, Inc., Ann Arbor, Michigan

Organization Description

The Minnesota Pollution Control Agency's mission is to protect and improve the environment and enhance human health. The MPCA monitors environmental quality, offers technical and financial assistance, and enforces environmental regulations.