



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-344

Proposal Title: Why are Crane Lake Mercury Levels So High?

Project Manager Information

Name: Jeff Jeremiason

Organization: Gustavus Adolphus College

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Project Basic Information

Project Summary: Mercury levels in Crane Lake fish exceed safe limits threefold. Is the deep, tan-colored water to blame, or is upstream industry the cause? Is there anything that can be done?

ENRTF Funds Requested: \$192,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Small Projects (G)

Secondary Category: Water (B)

Project Location

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

Region(s): NE

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

Statewide

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Crane Lake is like many lakes in NE Minnesota: highly colored, deep, and a popular fishing destination. However, fish mercury levels are amongst the highest in Minnesota and 3 times the safe consumption limit. As a global pollutant, controlling sources is challenging, but can anything be done at the regional level to lower fish mercury? The familiar color of NE Minnesota lakes originates in vast wetlands, which supply mercury to lakes. Colored water can also heat up faster at the surface and trap colder water in the bottom, creating conditions where bioaccumulative mercury can be produced. Crane also has elevated sulfate from upstream mine seepage, making it doubly susceptible to mercury pollution since sulfate is key to the bioaccumulation of mercury. A citizen group publicized that fish mercury levels correlate with sulfate levels in VNP, suggesting that reducing mine drainage will lower mercury levels. Recent yellow perch measurements in the large lakes of Voyageurs National Park show that one-year old Crane perch had elevated Hg levels after bottom waters experienced several months of low oxygen. Are the high mercury levels of mercury in Crane Lake fish a result of surrounding wetlands, mine seepage, and low oxygen in bottom waters?

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.

The reasons why fish mercury levels are high in lakes like Crane must be understood to find potential solutions. Could lowering sulfate levels or aerating bottom waters reduce the formation of bioaccumulative mercury?

This proposal seeks to identify if strong thermal layering of highly colored Minnesota lakes makes them particularly vulnerable to mercury bioaccumulation. Colored material from wetlands and sulfate from industry are known from prior studies to be important precursors to elevated fish mercury in some Minnesota lakes. The importance of thermal layering for mercury bioaccumulation in Minnesota lakes has not been studied.

We propose to measure detailed bioaccumulative mercury concentration depth profiles with dissolved oxygen, sulfate, and other important chemicals in Crane Lake and similar nearby lakes with less color. With mercury measurements in surface sediments and the Vermilion River inflow, we will distinguish between bioaccumulative mercury sources from outside the lake and those sources produced inside the lake.

We will use knowledge gained from studying these lakes to search through state lake databases to identify other highly colored, deep lakes that may be susceptible to this additional mercury bioaccumulation. The resulting understanding and a public database of potentially susceptible lakes could help inform future monitoring and management.

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?

One specific outcome will be understanding the importance of in-lake bioaccumulative mercury sources in a particularly susceptible system like Crane Lake. This understanding will support decisions about potential management solutions such as aeration or reducing sulfate loads. Another outcome will be presentations at the Minnesota Water Resources Conference and other lake management venues, such as webinars with Lake Associations who might be interested in lowering fish mercury levels.

Activities and Milestones

Activity 1: Mercury Measurements: Depth profiles in Crane and nearby lakes, surface sediments, and Vermilion River sampling – 2.5 field seasons

Activity Budget: \$162,000

Activity Description:

The strikingly rapid decrease in dissolved oxygen in Crane Lake bottom waters could foreshadow significant production of bioaccumulative mercury inside the lake. We will measure temperature and oxygen profiles during the ice out season in Crane Lake and two other nearby lakes: Mukooda and Little Vermilion. These lakes are less colored, have fewer upstream wetlands, and less sulfate inputs. Samples for mercury and related chemicals will be collected at depth intervals with more intensive collections when oxygen levels diminish. Sediments from the lake bottom will be collected to document bioaccumulative mercury production in oxygen-free conditions. Water samples from the Vermilion River will be collected to quantify external mercury inputs to Crane Lake. Measurements of mercury and supporting chemicals will allow us to determine if bioaccumulative mercury is produced in lake bottom waters. Bioaccumulative mercury in Crane bottom waters will presumably increase as the summer progresses and oxygen is depleted. Total production will be estimated from measurements over time and compared to mercury inputs from the Vermilion River, which will be estimated from mercury concentrations and available USGS water flow measurements. A few samples will be taken from Mukooda/Little Vermilion bottom waters to compare conditions with less extensive oxygen depletion.

Activity Milestones:

Description	Approximate Completion Date
Measurements of bioaccumulative mercury in Crane Lake reference lakes, and the Vermilion River	March 31, 2030

Activity 2: Database and mapping of lakes sensitive to bioaccumulative mercury from low oxygen in bottom waters

Activity Budget: \$20,000

Activity Description:

Using Crane Lake as a model, we will search for lakes in Minnesota with similar color, depth, and size that may be susceptible to high levels of mercury in fish. We have requested and received a database of lake names, lat/long, depth, water area, watershed area, and monthly color from the MPCA. Lake color estimates are derived from satellite data. We will create a database and map of highly colored, deep lakes that may be susceptible to bioaccumulative mercury formation due to dissolved oxygen depletion. A database of fish mercury levels from measurements already made by the State of Minnesota will be constructed and cross-referenced with these susceptible lakes as a validation of the importance of in-lake formation of bioaccumulative mercury. We will make this database publicly available as maps and with links to data for Lake Associations and the public to view. The database could also be used by state agencies to make management decisions and to target specific lakes for additional or first-time analysis of mercury in fish.

Activity Milestones:

Description	Approximate Completion Date
A public database and map quantifying the susceptibility to in-lake bioaccumulative mercury production	June 30, 2028

Activity 3: A public database and map quantifying the susceptibility to in-lake bioaccumulative mercury production

Activity Budget: \$10,000

Activity Description:

We will translate the technical findings from our study into potential management tools for state agencies and citizens concerned about lake health. The susceptibility database of similar high-risk, deep, colored lakes such as Crane Lake will be published with all supporting mercury mass-balance models to the University of Minnesota Digital Conservancy, ensuring open-access transparency for the broader citizen groups and the scientific community.

To ensure local impact, we will facilitate a series of technical webinars specifically for Lake Associations, focusing on how internal mercury cycles can affect accumulation in local fisheries. We will present our findings at the Minnesota Water Resources Conference, targeting a diverse audience of regional resource managers and engineers. The project will conclude with formal management briefings for MPCA staff involved in fish mercury and water quality monitoring and engineering firms involved in implementing lake management plans. These briefings will provide ideas for integrating our susceptibility criteria into state-level monitoring priorities and evaluating site-specific interventions, such as sulfate load reductions or bottom water aeration. This structured communication plan ensures that our research informs both immediate local management and long-term state environmental policy.

Activity Milestones:

Description	Approximate Completion Date
Presentations at conferences, webinars for Lake Associations, briefings with state managers and engineering firms	June 30, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Nathan Johnson	University of Minnesota-Duluth	Dr. Johnson's lab will be in charge of field sampling and will do some water chemistry analysis.	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

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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?

Our Crane Lake measurements and database of other potentially susceptible lakes will be publicly available at the University of Minnesota Digital Conservancy. We will also seek an audience with managers at MPCA, MDH, and the DNR involved in fish mercury and water quality monitoring. The interagency group that annually selects lakes for fish mercury analysis will be a specific target.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Prescribed-Fire Management for Roadside Prairies - Phase II	M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 08e	\$217,000

Project Manager and Organization Qualifications

Project Manager Name: Jeff Jeremiason

Job Title: Professor

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

Dr. Jeremiason has been studying mercury dynamics in the environment since 1998 while working at the MPCA where

his job was to conduct studies to understand how environmental contaminants accumulate in fish, and why Minnesota lakes exhibit such a wide range of contamination levels. He has a PhD in Environmental Engineering from the University of Minnesota and has been a professor at Gustavus Adolphus College since 2002. He has managed dozens of grant projects involving multiple collaborators from federal, state, academic, and private entities. He has expertise and published multiple papers on the impact of sulfate on the mercury cycle. Some early seminal work demonstrated that adding sulfate stimulated the formation of bioaccumulative mercury in certain wetlands. Later work on the Iron Range demonstrated a more nuanced impact of sulfate from mining activities on lakes, streams, and wetlands in the St. Louis River basin. Sulfate was a factor, but not the primary reason bioaccumulative mercury varied in these systems. This proposal seeks to understand why Crane Lake has such high fish mercury. Dr. Jeremiason recently discovered that the bottom waters of Crane Lake experience dramatic drops in oxygen. These are ideal conditions to form bioaccumulative mercury and could be the dominant source of mercury to fish in Crane Lake and similarly, highly colored, deep lakes. Sulfate may play a role, as Crane Lake does receive some from mine seepage from far upstream, but the proposal is focused on the impact of low oxygen levels. The proposed project is relatively small and only Gustavus Adolphus College and the University of Minnesota- Duluth are direct collaborators. The project will benefit the natural resources of the state of Minnesota, but most importantly could offer a tangible method to lower fish mercury levels in some Minnesota Lakes.

Organization: Gustavus Adolphus College

Organization Description:

Gustavus Adolphus College is a private liberal arts college.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Principal Investigator		We request 1.22 months of summer salary in each year of the award to support the Principal Investigator Dr. Jeremiason. During this time, Dr. Jeremiason will be in charge of all aspects related to the analysis of mercury and methylmercury in water samples and sediment. He will oversee the student researchers assisting with the operation of the mercury lab. He is also responsible for quality assurance/quality control, interpretation, presentation, and communication of all results. A 3% annual increase is requested for Dr. Jeremiason's pay each year of the grant. Fringe Benefits are set according to College Policy and are calculated at 13.43% with a 2% annual increase for faculty summer salaries.			13.43%	0.3		\$43,315
Undergraduate Student Assistant		Funds are requested to support an undergraduate student during the academic year each year of the grant working approximately 100 hours at \$13/hr and during the summer working 40 hrs/wk for 10 weeks at \$15.70/hr each year. During this time the student will process the water and sediment samples collected. They will also assist with sample collection. Students will present their work at Gustavus and regional undergraduate research conferences. A 3% increase in academic year and summer is requested each year. Fringe benefits for student pay is set according to College Policy and is calculated at 8.32% for summer students with a 2% annual increase.			8.32%	0.72		\$24,902
							Sub Total	\$68,217
Contracts and Services								
University of Minnesota-Duluth	Subaward	Dr. Nathan Johnson (Co-PI) and his lab at the University of Minnesota Duluth campus will be responsible for the field activities and study				1.2		\$99,924

		interpretation for vertical profiling, sample collection, and sample processing. Personnel: \$73,026 Equipment, Tools, and Supplies: \$10,950 Travel and Conferences: \$7,848 Other: \$8,100						
							Sub Total	\$99,924
Equipment, Tools, and Supplies								
	Tools and Supplies	Methylmercury isotope standard (\$1500), methylmercury and mercury standards (\$1200), oxidizing agent (\$600), reducing agents (\$350), buffers (\$150), trace-metal acid (\$350), glass vials (\$1260), misc. (gloves pipettors, tips, surface covers, centrifuge tubes) (\$360).	These items are supplies necessary for mercury analysis					\$5,770
	Tools and Supplies	Argon gas 3 tanks @ 500= \$1500), gold traps (6) (\$1400); Tenax traps (6) (\$1400), Autosampler needles (\$1350); mercury lamp (\$180), Heating coils and combustion units (\$1450), plasma torch (\$650), and interface cones (\$1300).	Consumables and replacement parts for MERX mercury analyzers and Agilent 7700 inductively coupled plasma - mass spectrometer.					\$9,230
							Sub Total	\$15,000
Capital Equipment								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Budget is based off of two trips per year with mileage totaling 350 miles round trip at \$0.725/miles. Lodging for two nights at \$148/night for two rooms. Meals at \$138/trip/person.	Travel is requested for Dr. Jeremiason and a student to travel to Crane Lake to assist in the collection of samples.					\$8,253
	Conference Registration	Budget is based on 1 trip in year three to a conference in Minneapolis with mileage totaling	Funds are requested for Dr. Jeremiason to attend a conference in					\$606

	Miles/ Meals/ Lodging	146 miles at \$0.725/miles and and conference registration at \$500	Minneapolis to report on findings from this research.					
							Sub Total	\$8,859
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
							Sub Total	-
							Grand Total	\$192,000

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
State				
			State Sub Total	-
Non-State				
			Non State Sub Total	-
			Funds Total	-

Total Project Cost: \$192,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [3bd759e9-f22.pdf](#)

Alternate Text for Visual Component

This graphic shows the dramatic decrease in oxygen in the bottom w of Crane Lake in 2025, a lake with very high fish mercury levels. Are these oxygen depletion events responsible? Do they act in tandem with sulfate inputs from mining? Are other Minnesota lakes susceptible? What can be done?...

Financial Capacity

Title	File
Evidence of Good Standing	965727d7-303.pdf
2025 Audit Report	38930b7c-ba2.pdf
IRS Non-Profit Determination Letter	c094c1d7-bea.pdf

Board Resolution or Letter

Title	File
Authorization Letter	eb2d2562-819.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the Commissioner's Plan applies.

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

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

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing \$10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Megan Fillbrandt, Gustavus Adolphus College, Director of Research and Sponsored Programs

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A