



## Environment and Natural Resources Trust Fund

### 2026 Request for Proposal

#### General Information

**Proposal ID:** 2026-212

**Proposal Title:** Sub Lethal Effects of Road Salt on Fish

#### Project Manager Information

**Name:** Allen Mensinger

**Organization:** U of MN - Duluth

**Office Telephone:** (218) 260-9641

**Email:** amensing@d.umn.edu

#### Project Basic Information

**Project Summary:** To examine the effects of deicing road salts containing magnesium (instead of sodium) on fish sensory systems to determine the concentrations that impact behavior.

**ENRTF Funds Requested:** \$189,000

**Proposed Project Completion:** June 30, 2029

**LCCMR Funding Category:** Small Projects (G)

**Secondary Category:** Fish and Wildlife (D)

#### Project Location

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

Statewide

**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.**

Salinization is one of the top threats facing freshwater ecosystems with road salts a major contributor to freshwater systems in northern climates. There are a variety of sodium chloride (NaCl) road salt alternatives, including other chloride-based salts [e.g., magnesium (MgCl<sub>2</sub>) and calcium chloride (CaCl<sub>2</sub>)]. These alternatives have several attractive advantages and can reduce the amount of salt needed to be applied because they increase road adhesion, are more effective at lower temperatures, and/or contain catalysts that speed ice melting. However, many manufacturers advertise that these products also offer increased environmental safety. Despite these claims, the little research that has investigated the impacts of these alternatives on aquatic organisms shows that many are more toxic than NaCl, with MgCl<sub>2</sub> often being the most toxic of the three chloride-based road salts. Despite these concerns, there are no environmental thresholds in the United States for MgCl<sub>2</sub> road salt, as the current US EPA thresholds were created solely based on NaCl. The experiments outlined in the proposal will determine the consequences of MgCl<sub>2</sub> road salt application to Minnesota aquatic environments to help establish application guidelines for transportation and natural resource agencies, to reinforce Minnesota's continuing commitment to clean water.

**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 goal is to determine the concentrations of magnesium containing road salts (e.g. Safestep 8300 magnesium chloride) that will affect fish physiology and behavior. The fish lateral line is used for detecting both prey and predators and magnesium salts (unlike sodium) can directly block the function of this critical sensory system. These experiments are novel as most toxicology studies examine lethal limits, however even low, non lethal concentrations of salts can diminish lateral line sensitivity and impact fish populations by inducing behavioral changes that expose fish to predation or significantly reduce growth rates due to difficulties in finding or absorbing food. Additionally, toxicology studies focus almost exclusively on prey fish (e.g. minnows) due to smaller size and lower cost, however magnesium will negatively impact predatory game fish leading to higher juvenile mortality, decreased growth rates and/or smaller populations. Controlled, laboratory studies will examine the effects of different concentrations of salts on minnows, sunfish and bass. Fish will be exposed to low, medium and high concentrations of magnesium chloride road salt and will be examined for swimming behavior, predator/prey interactions and growth to establish the baseline criteria to determine when these salts will impact the fish.

**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?**

The studies will establish guidelines to assist in the application of road salts to ensure the fitness of fish in Minnesota waters. The findings will be shared with the Minnesota Pollution Control Agency, the Minnesota Department of Transportation and the Minnesota Department of Natural Resources to provide the best guidance to balance road safety with the health of freshwater ecosystems.

## Activities and Milestones

### Activity 1: The effect of road salts on fish swimming behavior

**Activity Budget:** \$64,260

**Activity Description:**

Fish will be acclimated to control, low, medium and high concentrations of magnesium road salts. The experiments will use a prey (minnow) and two predatory species (sunfish and small mouth bass). The fish will be placed in swim tunnels that allow the investigator to measure the swimming direction and speed of the fish. The lateral line detects water flow and allows fish to exhibit rheotaxis (swimming into currents) by swimming directly into the water flow and staying in one position in the current. The lateral line also detects other fish and allows fish to closely school. Fish swimming and schooling (minnows only) will be observed under various water flow conditions. Fish movements will be recorded with video cameras and imaging software to track their swimming behavior and the minnow's ability to school. Each experiment will use a solitary sunfish, bass or a school of five minnows. Seven fish or schools will be tested at each salt concentration. When the concentrations of magnesium begin to effect the lateral line, it is expected that fish will not be able to stay in position and start to swim erratically. Additionally, minnows will no longer be able to closely school.

**Activity Milestones:**

Description	Approximate Completion Date
Schooling fish (minnows) trials	June 30, 2027
Predatory fish (sunfish, small mouth bass) trials	June 30, 2027
Analyze data and publish the results	June 30, 2027

### Activity 2: The effect of road salts on predator prey interactions

**Activity Budget:** \$62,370

**Activity Description:**

Fish will be acclimated to control, low, medium and high concentrations of magnesium road salts. The experiments will use minnows, sunfish and small mouth bass. The investigator has developed techniques that allows fish feeding to be assessed without visual input so the fish need to use their lateral line to find prey. Individual fish will be placed in the dark in circular tanks and live prey (adult brine shrimp or small fish) will be added remotely via feeding tubes. Fish feeding behavior will be filmed under dim red light that the fish cannot see. The distance that fish detect the prey and capture success will be monitored with tracking software. It is anticipated as the salt concentration increases, the detection distance will decrease and capture success will also decline. Ten fish will be tested at each salt concentration.

**Activity Milestones:**

Description	Approximate Completion Date
Complete predator prey trials	June 30, 2028
Analyze the trial data	June 30, 2028
Publish the results	June 30, 2028

### Activity 3: The effects of road salts on fish growth

**Activity Budget:** \$62,370

**Activity Description:**

Fish will be acclimated to control, low, medium and high concentrations of magnesium road salts. The experiments will

use minnows, sunfish and small mouth bass and fish will be maintained in individual tanks. Fish will be weighed and their length determined every two weeks throughout the three month experiments. The fish will be provided dried food (pellets) at previously determined percentages of their body weight daily (i.e. 1 to 3%) and allowed to feed for ten minutes per day. Any uneaten food will be retrieved and weighed after feeding. Short (one month) and long term (three months) growth rates will be determined at the conclusion of the experiment. These experiments will examine whole body physiology as the fish will not need an active lateral line to see and ingest the pellets. However, the different salt concentrations may have ionic, metabolic or physiology effects that are reflected in reduced metabolism and growth. Thus, in contrast to the previous two experiments, these trials will examine overall metabolism and growth rather than lateral line sensitivity. Ten fish of each species will be tested at each salt concentration. It is anticipated that higher salt concentrations will reduce growth rates.

**Activity Milestones:**

Description	Approximate Completion Date
Short term metabolic effects (one month)	June 30, 2029
Long term metabolic effects	June 30, 2029
Publish paper	June 30, 2029

## 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?**

The results will be disseminated to the MN PCA, MN DNR and MN DOT to guide the application and use of magnesium containing road salts.

## Project Manager and Organization Qualifications

**Project Manager Name:** Allen Mensinger

**Job Title:** Biology Professor

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

The project manager has been studying the sensory systems of fish for the past 30 years. He is a professor at the University of Minnesota Duluth and has mentored over 25 graduate students and 75 undergraduates with the vast majority coming from towns and colleges across Minnesota. One of his interests focuses on the fish lateral line system which detects water borne vibrations and is important in predator prey interactions. He has studied the structure and sensitivity of this sensory system and conducted numerous behavioral experiments that are able to determine the relative contribution of the visual system and lateral line to prey capture and predator avoidance. He has observed that subtle changes in the lateral sensitivity can have profound changes in fish swimming, behavior and survival.

**Organization:** U of MN - Duluth

**Organization Description:**

The PI is long time member of the Biology Department in the Swenson College of Science and Engineering at the University of Minnesota-Duluth. With more than 3,200 undergraduate and 200 graduate students, Swenson College is the largest college at UMD and the third largest in the University of Minnesota system. The Department of Biology is the hub for fundamental biological sciences at UMD. We are committed to furthering study of our natural world and have a strong collaborative network to support our students in a wide range of fields, from conservation to biomedical sciences. Our mission includes undergraduate education, research, graduate education, and service. With research, we specialize in ecology and cell and molecular biology. These emphases serve as major themes integrating our undergraduate, graduate, and research programs. Our department is one of eleven departments within Swenson College of Science and Engineering and is among the largest of UMD's programs, as we serve more than 700 Biology majors.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Biology Professor		Design and implementation of study			27%	0.18		\$38,896
Graduate Student		Conduct experiments and analyze data			45%	0.66		\$111,440
Undergraduate researcher		Assist graduate student during the summer with the experiments and water collection			0%	0.26		\$12,200
							<b>Sub Total</b>	<b>\$162,536</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Equipment, Tools, and Supplies</b>								
	Equipment	Spectrophotometer	The instrument is needed to determine the salt concentration in the water					\$4,800
	Tools and Supplies	Aquariums, water filters, water pumps, fish, fish food, brine shrimp, chemicals, road salts, water test kits, testing reagents, digital storage devices	The tools and supplies are needed to maintain the fish, conduct the experiments and sample the water					\$16,664
							<b>Sub Total</b>	<b>\$21,464</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Travel In Minnesota</b>								

	Conference Registration Miles/ Meals/ Lodging	Two MN DNR fisheries meetings registration, 400 miles rt. 2 people, 2 total nights with two rooms lodging, 2 total days of meals	The project manager and the graduate student will present the results of the studies at the MN DNR annual fisheries meeting					\$2,000
							<b>Sub Total</b>	<b>\$2,000</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Printing and Publication</b>								
	Publication	Peer reviewed papers	It is anticipated that this study will result in two peer reviewed papers. Journals in this field charge approximately \$1500 to publish each paper					\$3,000
							<b>Sub Total</b>	<b>\$3,000</b>
<b>Other Expenses</b>								
							<b>Sub Total</b>	<b>-</b>
							<b>Grand Total</b>	<b>\$189,000</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
State				
			State Sub Total	-
Non-State				
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 54% modified total direct costs.	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. ( <a href="https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs">https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs</a> )	Secured	\$82,078
			Non State Sub Total	\$82,078
			Funds Total	\$82,078

**Total Project Cost: \$271,078**

**This amount accurately reflects total project cost?**

Yes

## Attachments

### Required Attachments

#### *Visual Component*

File: [1d058ce6-8f8.pdf](#)

#### *Alternate Text for Visual Component*

The graphics outline the project and shows the magnesium road salts, indicates they may not be environmentally friendly as advertised and shows the three experimental tests designed for minnows, sunfish and bass. These are fish swimming (swim tunnel diagram), fish feeding with lateral line and fish growth....

### Supplemental Attachments

*Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other*

Title	File
UMN Authorization Letter	<a href="#">72ec6226-48c.pdf</a>

## 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 UMN Policy on travel 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?**

Yes, Sponsored Projects Administration (UMD)

**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:**

Michael Jacob and Claudia Carranza University of MN Duluth

**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

