# Environment and Natural Resources Trust Fund

2022 Request for Proposal

## General Information

**Proposal ID:** 2022-272

**Proposal Title:** Salt threatens Minnesota water quality and fisheries

## Project Manager Information

**Name:** Mark Edlund

**Organization:** Science Museum of Minnesota - St. Croix Watershed Research Station

**Office Telephone:** (612) 965-6946

**Email:** medlund@smm.org

## Project Basic Information

**Project Summary:** Salt levels are rising in Minnesota lakes, and biological impacts may be worse than we think. We determine effects on water quality and foodwebs, and how to save our lakes.

**Funds Requested:** $1,228,000

**Proposed Project Completion:** June 30 2025

**LCCMR Funding Category:** Water Resources (B)

## Project Location

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

Region(s): Central, Metro,

**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.**

Road salt is essential for human safety in Minnesota, but it also damages our fisheries and lake water quality. Salinity is a threat all across the state: salty discharges come from water treatment plants, water softeners, and fertilizer, not just from busy roads in the Metro. A proposed rule change by the MN Pollution Control Agency could further increase salty discharge from new sources. Past LCCMR funding helped identify the causes of salinization and fine-tune winter de-icing, but the effects of salt on lakes — on food webs, fish, water clarity, and noxious algae — remain largely unknown.

Lakes suffering from salt pollution are often our greenest lakes, rich in nutrients, choked with algae, with oxygen loss and fish kills. In addition, salt can harm the beneficial zooplankton Daphnia, which graze on algae to clear the water, and are a critical food source supporting fisheries. We do not currently understand how sensitive to salt Daphnia are, and thus how resilient our lake foodwebs are. What happens to fisheries and water quality when Daphnia are affected? What can we do to avoid the worst effects? What should we be monitoring for? How can we adapt fisheries management to the continuing salt wave?

**What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.**

We can solve this knowledge gap efficiently by comparing lakes that have been affected by salt to varying degrees. These lakes are chosen from Central Minnesota (support letter DCLA) and in the Twin Cities Metro, and provide a model for lakes across the state that could become saltier.

We will show how salt (in particular chloride) affects lake health, by using interlocking methods that illuminate each lake's present, past, and future conditions:
1) Lake surveys to determine current conditions: nutrient cycles, noxious algae, and food webs;
2) Historical analysis to determine when, why, and how much salt has changed nutrients, algae, and food webs;
3) Lake simulation experiments for "what if?" scenarios to understand how salinity alters lake oxygen and nutrients.

Because of the importance of these results to resource managers, communities, anglers, and other lake users, our proposed project also includes a robust plan for:
4) Communication of results and solutions for how to protect lakes from increasing salt.

Of great concern is identifying "tipping points," levels of salt beyond which irreparable damage to a lake occurs. And to protect fisheries, we also need to understand the early effects of salinization on Daphnia populations in our lakes.

**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 project benefits Minnesotans by:
1) identifying lakes and food webs that have resilience to salinization, and conserving them;
2) protecting vulnerable lakes and fisheries against damage from excessive levels of salt that approach "tipping points";
3) linking ecological processes, experiments, and lake simulations to determine ways to enhance and preserve salinized lakes.

It is difficult to remove salt, so we need to learn to both manage salt at the source and manage lakes that are already affected. Understanding these linkages and the thresholds beyond which lake quality and food webs suffer will inform policy and prioritize lakes for preservation.

## Activities and Milestones

### Activity 1: Measure differences among lakes under varying threat of salinization with intensive monitoring

**Activity Budget:** $536,091

**Activity Description:**
We will measure water quality and food webs monthly for two years in 15 lakes located throughout Central Minnesota and the Metro; the lakes are grouped in five 3-lake clusters. High frequency monitoring buoys will be deployed in all lakes to record water-column temperature, oxygen, and chloride every 30 minutes. Five lakes (Tanners, Parkers, Powderhorn, Little Johanna, Henry) are "impacted", with chloride levels 500-1000% above background concentrations. Five lakes (Medicine, Bde Maka Ska, Beaver, Wabasso, Uhlenkolts) are "at risk" showing chloride approximately 200% above background levels, and five lakes (Minnetonka, Cedar, Phalen, Josephine, Smith) are "least impacted" but still show chloride 50-100% above background.

Molecular analyses (DNA) will be used to characterize lake food webs. We will isolate 150 Daphnia pulicaria clones (~10 per lake) and survey for genes correlated with chloride tolerance. Daphnia pulicaria, a keystone species, maintains water clarity by eating algae, and serves as preferred forage for recreational fisheries. We will also characterize each lake's cyanobacteria using DNA to determine if genetic diversity of noxious algae is also correlated with chloride tolerance. Threshold changes in water quality and food web genetic diversity will define chloride tipping points for Minnesota lakes.

**Activity Milestones:**

| Description | Completion Date |
|---|---|
| Measure nutrients, salinity, algae, zooplankton, and lake behavior for two years in 15 study lakes | December 31 2024 |
| Use molecular tools to analyze lake food webs for chloride tolerance | December 31 2024 |

### Activity 2: Use core samples to reconstruct the history and threat of salinization

**Activity Budget:** $472,955

**Activity Description:**
Every lake accumulates sediments (mud) that record its history, like a stack of newspapers. We will collect sediment core samples from 15 study lakes and determine when and how much they have changed in response to salinization—their food webs, biology, nutrient and chloride levels—by analyzing multiple chemical and biological indicators. We will determine the ages of each core, then reconstruct historic food webs using Daphnia remains, reconstruct past chloride and nutrients using diatoms and existing monitoring data, and reconstruct historic algae using fossil pigments and other indicators of past productivity. We will test whether increasing chloride causes reductions in the abundance of good keystone Daphnia species, degrades the food web, and leads to poor water quality.

When salty snowmelt enters lakes, it flows downward and smothers the bottom, depleting the oxygen, releasing phosphorus, and turning lakes green with noxious algae. We will experiment in the lab on short sediment cores to test how different levels of salt and dissolved oxygen affect sediment release of phosphorus. We will also replicate these experiments with potassium acetate, an alternative to chloride road salt, to see if it is less harmful.

**Activity Milestones:**

| Description | Completion Date |
|---|---|
| Measure changes in sediment internal nutrient loading in salinized lakes | December 31 2024 |

| | |
|---|---|
| Collect, date, and analyze sediment cores from 15 lakes | June 30 2025 |
| Compare historical changes in water quality, salinity, and food webs in 15 study lakes | June 30 2025 |

## Activity 3: Identify critical salinity thresholds to stabilize the food web: reduce algae blooms and protect resilient food webs

**Activity Budget:** $218,954

**Activity Description:**
Lake and genetic simulation tools coupled with experiments will help solve the lake salinization crisis. We will mathematically simulate dense salty layers in lakes that cause low-oxygen bottom waters to determine critical thresholds of road salt or potassium acetate that cause density layers to form. This gives watershed managers scientifically based targets for reducing deicer applications and fixing lakes.

We determine resilience of lake food webs to salinization by measuring genetic relatedness of Daphnia populations among lakes. Study lakes are grouped into clusters, allowing us to explore how chloride-impacted lakes will exchange genes at different spatial scales. We will identify Daphnia populations that have "desired" genes and how likely these genes will be transported to other lakes, increasing lake resilience to increasing chloride—in short, this activity will determine which lakes are at risk for water quality and food web collapse and how we can fix them.

Through reporting, presentations, and outreach (lake associations, MPCA, Road Salt Symposium, MN Groundwater Association), we will spread our findings to help communities and agencies stop salt pollution before it threatens our favorite lakes and fisheries.

**Activity Milestones:**

| Description | Completion Date |
|---|---|
| Use lake and genetic modeling tools to determine lake and food web resilience to salinization | June 30 2025 |
| Develop reports, factsheets, and outreach to inform managers and Minnesotans on protecting their threatened lakes | June 30 2025 |

## 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 be funded?**

This project will determine chloride tipping points that lead to water quality and food web degradation, measure how and when lakes were salinized, identify lake and foodweb resilience to chloride, and test impacts of deicing alternatives. This information is needed at state and local levels to guide lake management and protection. We build on previous ENRTF funding and collaborations with other research groups, agencies, and stakeholders. Through reporting, presentations, and outreach (newsletters, MPCA, Road Salt Symposium, MN Groundwater Association), we will spread our findings to help communities and agencies stop salt pollution before it threatens our favorite lakes and fisheries.

## Other ENRTF Appropriations Awarded in the Last Six Years

| Name | Appropriation | Amount Awarded |
|---|---|---|
| Tracking and Preventing Harmful Algal Blooms | M.L. 2016, Chp. 186, Sec. 2, Subd. 04a | $500,000 |
| Determining Risk of a Toxic Alga in Minnesota Lakes | M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 06f | $200,000 |

## Project Manager and Organization Qualifications

**Project Manager Name:** Mark Edlund

**Job Title:** Senior Scientist

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

Dr. Mark Edlund has been a Senior Scientist at the St. Croix Watershed Research Station of the Science Museum of Minnesota since 2007. He has also held the position of adjunct Professor of Water Resources Science/Earth Sciences at the University of Minnesota since 2004. Dr. Edlund has a 20-year record of federal, state, and local project management in his areas of expertise: aquatic biology, limnology, paleolimnology, and phycology; environmental drivers of ecological change; lake sediment records to understand short- and long-term environmental change; and has authored or co-authored more than 100 publications on the subjects. Dr. Edlund's current research focuses on biomonitoring of lakes in Great Lakes Region National Parks; water quality in Lake of the Woods; and understanding and predicting harmful algal blooms (HABS).

**Organization:** Science Museum of Minnesota - St. Croix Watershed Research Station

**Organization Description:**

The Science Museum of Minnesota (SMM) is a private, non-profit 501(c)3 institution dedicated to encouraging public understanding of science through research and education. The St. Croix Watershed Research Station is the environmental research center of the SMM with the mission "we do the science that helps make our rivers and lakes clean" through research and outreach. The SCWRS supports an active year-round program in environmental research and graduate-student training, guided by a dedicated in-house research staff with direct ties to area universities and colleges. It collaborates closely with federal, state, and local agencies with responsibility for managing the St. Croix and upper Mississippi rivers and is a full partner with the National Park Service for resource management in parks of the western Great Lakes region. Its research has played a central role in setting management policy for the St. Croix and Mississippi rivers, for establishing water-quality standards for Minnesota lakes and for developing long-term monitoring plans for the National Park Service.

## Budget Summary

| Category / Name | Subcategory or Type | Description | Purpose | Gen. Ineligible | % Benefits | # FTE | Classified Staff? | $ Amount |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | | | | | | | | |
| Edlund, Senior Scientist | | Project coordination, Fieldwork, Sediment Analysis, Water Quality, Diatom Analysis, reporting | | | 43.7% | 1.5 | | $174,600 |
| Heathcote, Senior Scientist | | Water Quality, DNA, environmental statistics, reporting | | | 43.7% | 0.75 | | $79,660 |
| Myrbo, Assistant Scientist | | Water and Core sampling, Core experiments, Outreach | | | 43.7% | 1.5 | | $152,775 |
| Ulrich/Assistant Scientist | | Lake Modeling | | | 43.7% | 0.99 | | $93,629 |
| Field and Laboratory Technician | | Field work and lab analyses | | | 43.7% | 1 | | $45,300 |
| Science Communication Specialist | | Outreach, communication, and social media | | | 0% | 0.1 | | $12,000 |
| | | | | | | | **Sub Total** | **$557,964** |
| **Contracts and Services** | | | | | | | | |
| University of Oklahoma | Professional or Technical Service Contract | Collection and analysis of 150 Daphnia clones @ $1000 per clone ($150,000; University of Oklahoma or competitive bid) | | X | | 0 | | $150,000 |
| TBD | Professional or Technical Service Contract | Lab analysis of pigments samples:<br>Algal pigment analysis: 225 samples @ $150 ($33,750; University of Regina or competitive bid) | | | | - | | $33,750 |
| University of MN Genomics Center | Professional or Technical Service Contract | Lab analysis of Daphnia DNA: 150 samples @ $80 ($12,000; University of Minnesota or competitive bid) | | | | - | | $12,000 |
| University of MN Genomics Center | Professional or Technical Service Contract | Lab analysis of Cyano DNA:<br>16S water sample DNA sequencing: 75 samples @ $150 ($3,000; University of Minnesota or competitive bid) | | | | - | | $3,000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Sub Total** | **$198,750** |
| **Equipment, Tools, and Supplies** | | | | | | | | |
| | Tools and Supplies | Lab/Field supplies | Lab/Field supplies (bottles, reagents, preservatives, consumables, duplicate field gear for AIS prevention - $18,000) | | | | | $18,000 |
| | Tools and Supplies | Monitoring buoy supplies | Component sensors for constructing and installing monitoring buoys on 15 lakes | | | | | $67,500 |
| | | | | | | | **Sub Total** | **$85,500** |
| **Capital Expenditures** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Acquisitions and Stewardship** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Travel In Minnesota** | | | | | | | | |
| | Miles/ Meals/ Lodging | Water Quality and sediment core sampling ($12,345), 84 days, 2 field crew, 11,340 miles, 14 days in hotel | Water Quality and sediment core sampling | | | | | $12,345 |
| | Conference Registration Miles/ Meals/ Lodging | MN Lake Conference Outreach (i.e., Minnesota Water Resources Conference), formal presentation + booth for dissemination of project results results, 3 in-state conferences at $800 each | formal presentation + booth for dissemination of project results results | | | | | $2,400 |
| | | | | | | | **Sub Total** | **$14,745** |
| **Travel Outside Minnesota** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Printing and Publication** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Sub Total** | **-** |
| **Other Expenses** | | | | | | | | |
| | | Lab analysis of water samples: TN/TP, DIN/SRP, DOC, DIC, chlorophyll a, chloride: 420 samples @ $187 ($78,540) (unit prices for analysis at SCWRS) | Lab analysis of water samples | | | | | $78,541 |
| | | Lab analysis of sediment samples: 210-Pb (dating): 15 cores @ $2,500 ($37,500) (unit price for analysis at SCWRS) loss-on-ignition: 15 cores @ $800 ($12,000) (unit price for analysis at SCWRS) Sed P: 15 cores @ $1,875 ($28,125) (unit price for analysis at SCWRS) Diatoms: 15 cores @ $4,500 ($67,500) (unit price for analysis at SCWRS) BSi: 15 cores @ $825 ($12,375) (unit price for analysis at SCWRS) Core incubations: 27 treatments @ $5,000/treatment ($135,000) | Lab analysis of sediment samples | | | | | $292,500 |
| | | | | | | | **Sub Total** | **$371,041** |
| | | | | | | | **Grand Total** | **$1,228,000** |

## Classified Staff or Generally Ineligible Expenses

| Category/Name | Subcategory or Type | Description | Justification Ineligible Expense or Classified Staff Request |
|---|---|---|---|
| **Contracts and Services** - University of Oklahoma | Professional or Technical Service Contract | Collection and analysis of 150 Daphnia clones @ $1000 per clone ($150,000; University of Oklahoma or competitive bid) | This project involves a partnership with University of Oklahoma. Dr. Larry Weider's lab is the only facility with the capacity to clone and analyze Daphnia to address the food web questions we test in this proposal. Dr. Weider has worked on Minnesota lake resource issues for the last decade.<br>**This is a single source contract.** |

## Non ENRTF Funds

| Category | Specific Source | Use | Status | Amount |
|---|---|---|---|---|
| **State** | | | | |
| | | | **State Sub Total** | **-** |
| **Non-State** | | | | |
| In-Kind | All indirect project costs are provided in-kind by the Science Museum of Minnesota (federal indirect rate 40.09% on all direct costs = $502,252) | In-kind contribution of indirects | Pending | $502,252 |
| | | | **Non State Sub Total** | **$502,252** |
| | | | **Funds Total** | **$502,252** |

# Attachments

## Required Attachments

*Visual Component*

File: 21ad95aa-d99.pdf

*Alternate Text for Visual Component*

Salt levels are rising in Minnesota lakes, but the biological impacts are poorly understood. We determine how salt damages water quality and food webs and how to save our lakes...

## Optional Attachments

*Support Letter or Other*

| Title | File |
|---|---|
| Letter of Support - Douglas Cty Lake Assoc | 09daf31e-706.pdf |
| Letter of Support - Science Museum of MN | cea1a8a9-d4e.pdf |

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

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

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?**

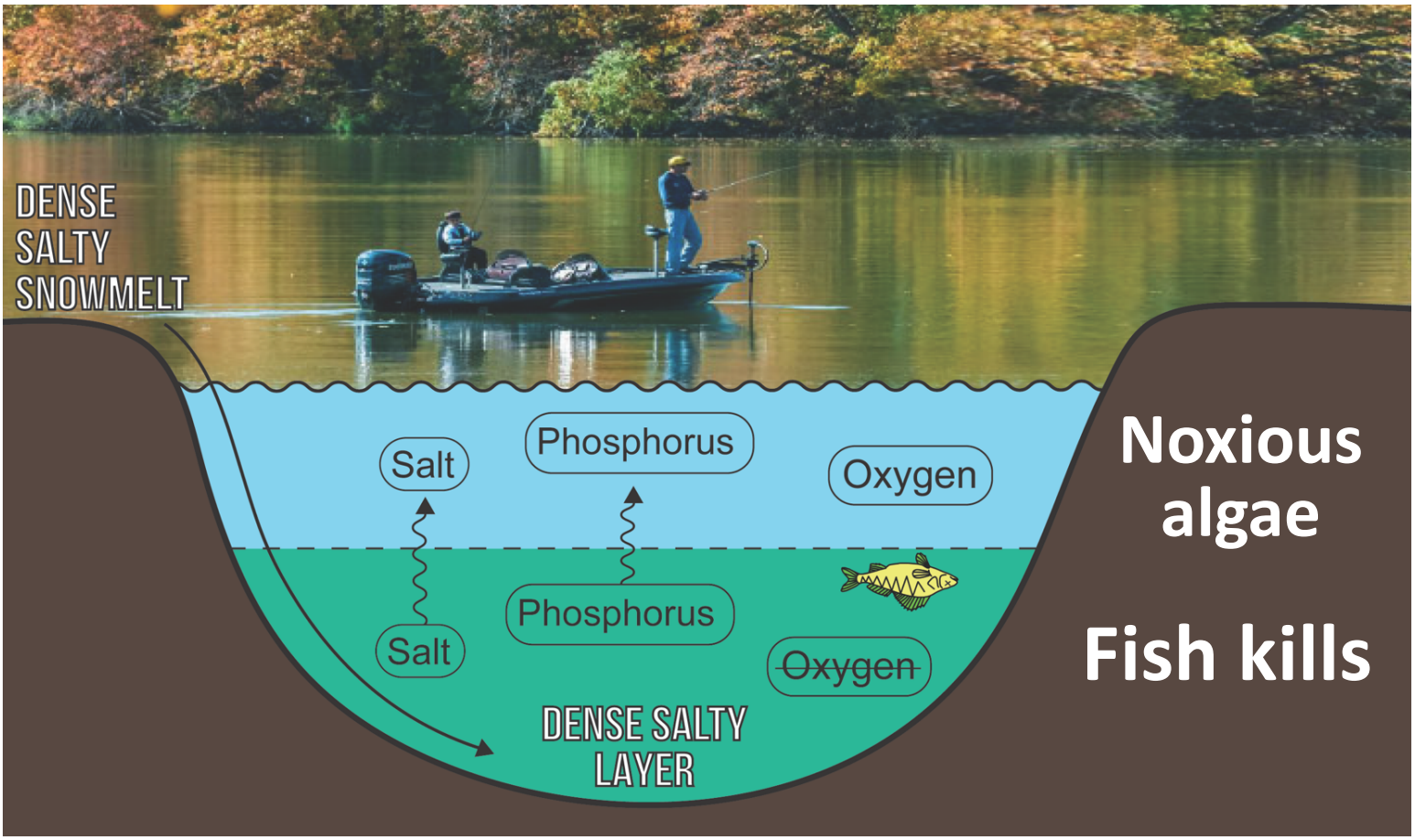
Yes

**Does the organization have a fiscal agent for this project?**

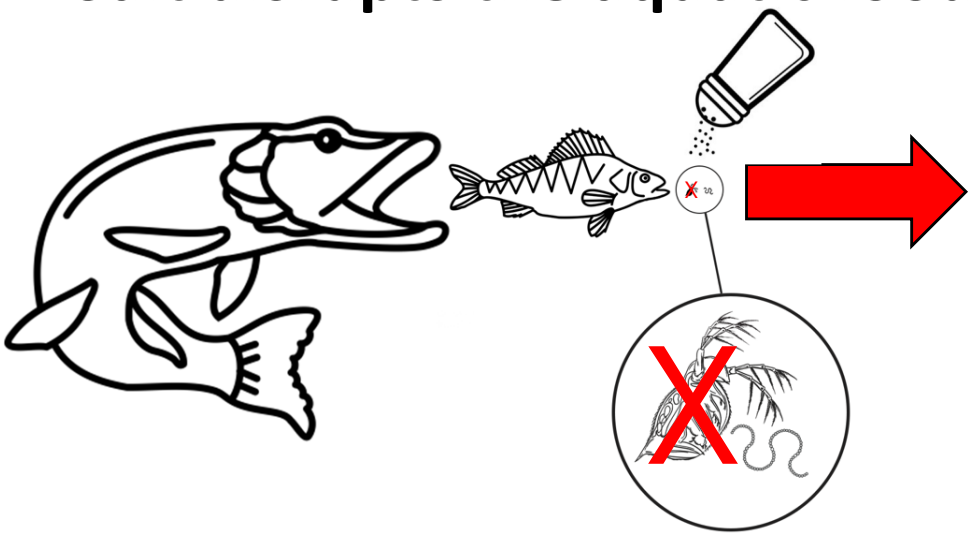
No

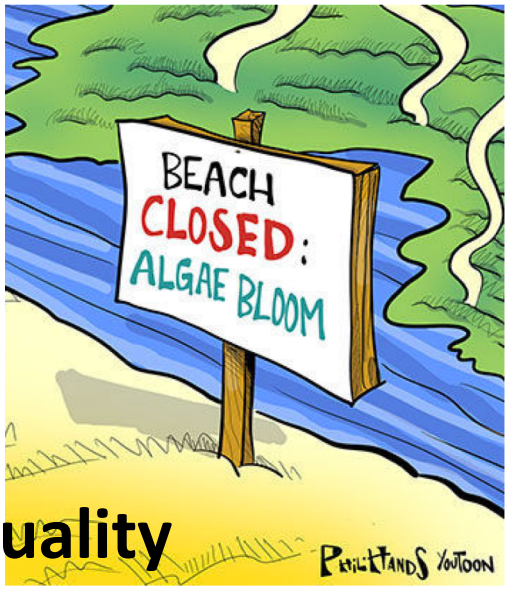
Environmental and Natural Resources Trust Fund (ENRTF)
2022 Main Proposal
Project: Salt threatens Minnesota water quality and fisheries

# Minnesota lakes are getting saltier




## Salt disrupts the aquatic foodweb…






## …and harms water quality

## Let's better protect & manage against salty lakes!