



## Environment and Natural Resources Trust Fund

### 2023 Request for Proposal

#### General Information

**Proposal ID:** 2023-237

**Proposal Title:** Didymo II – The North Shore Threat Continues

#### 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:** Didymo or rock snot has invaded our North Shore streams. We must prevent its further spread and adapt our management approaches to this new invader.

**Funds Requested:** \$394,000

**Proposed Project Completion:** June 30, 2026

**LCCMR Funding Category:** Water Resources (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.**

In 2018, the first nuisance growth of rock snot (aka *Didymosphenia geminata* or, more simply “didymo”) developed in the North Shore’s Poplar River and we didn’t know why. Didymo is a freshwater diatom (a type of algae) that can form nuisance mats of goo in coldwater streams worldwide, both in its native range and where it is invasive. Formation of didymo mats in streams has aesthetic, economic, and recreational impacts, including impacting angling and recreational activities. Local economic impacts to tourism have exceeded \$20 million per year following other worldwide invasions, a serious threat to the North Shore’s \$250 million summer economy. Didymo mats disrupt community structure and ecosystem function in streams, alter habitat and food web dynamics, impact fish and invertebrate community composition, abundance, diversity, and result in major shifts in bacterial composition.

Initial ENTRF funding is being used to assess the scope of the problem and determine the source of North Shore didymo. Initial results have been shocking—in 2021, didymo was found in seven additional North Shore streams forcing us to change our strategy from containment to preventing further spread and adaptive management in a future likely to include didymo.

### **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.**

Moving beyond the knowledge that didymo is established in many North Shore streams requires that we shift our emphasis to preventing its spread further and better understanding the full impact of didymo on stream functioning—from how nutrients are processed with and without didymo to how didymo will impact fisheries. Early funding focused on survey, seasonality, and sources of didymo. To prevent further spread of didymo and to develop a regional management response, we will show how didymo affects stream health, and how we must plan for the future by:

- 1) Continued survey of streams for didymo—the conditions that foster its invasion and which waters are vulnerable;
- 2) Intensive monitoring of streams with and without didymo to determine how didymo changes streams, their nutrient flow, algae, and lower food webs;
- 3) Stream fisheries assessment to quantify trout habitat, reproduction, and growth comparing fish population metrics to stream habitats to understand how didymo alters energy flow from nutrients to fisheries.

Because of the importance of these results to resource managers, anglers, and all North Shore visitors, our proposed project also includes a robust plan for:

- 4) Communication of results and solutions for how to protect streams from didymo.

### **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 will benefit Minnesotans by:

- 1) identifying North Shore streams with didymo and the risk of invasion that other streams face;
- 2) showing how didymo impacts stream functioning from nutrient flow to fish production; and
- 3) developing strategies to prevent further spread of didymo and management tools to best protect and enhance our North Shore streams and their fisheries in the face of didymo.

This project will first understand the linkages between didymo and stream risk and function and then develop policy and management strategies for our North Shore streams.

## Activities and Milestones

### Activity 1: Measure threat of didymo invasion to North Shore streams with intensive monitoring

**Activity Budget:** \$230,860

#### Activity Description:

We will monitor five indicator streams (three had documented didymo 2018-2021) and the Lake Superior shoreline near the mouth of the streams for two full years to determine year-to-year variability in didymo mat formation and determining the timing and environmental conditions associated with mat formation in the streams and lake. We will sample the stream-lakeshore pairs to document changes in environmental conditions, stream function, and food webs. Monthly, from May-November, sampling will include algae, chemical, and physical characteristics of the sites. Invertebrate communities will be sampled for abundance, diversity and diets under didymo and non-didymo conditions. Temperature and discharge will be measured continuously throughout the project. Molecular analyses (DNA) will be used to characterize the bacterial, algal, and animal components of the didymo and non-didymo mats. We will characterize the bacterial community by using 16S rRNA metabarcoding from periphyton mat DNA extractions and shotgun sequencing to predict broader ecological consequences of didymo and learn how nuisance blooms can be triggered in ultra-clean waters.

Two annual surveys will target 20 additional major North Shore stream-lakeshore pairs to assess current didymo presence and susceptibility of North Shore resources.

#### Activity Milestones:

Description	Completion Date
Describe the environmental conditions, algae, and foodwebs in 5 paired North Shore stream-lakeshore sites	April 30, 2026
Survey all major North Shore streams for Didymo and invasion susceptibility during peak growth	April 30, 2026
Use molecular tools to analyze lower food webs in didymo and non-didymo streams and shoreline	April 30, 2026

### Activity 2: Measure impacts of didymo on North Shore fisheries

**Activity Budget:** \$123,855

#### Activity Description:

Didymo invasions of streams throughout North America have led to documented changes in bacterial, algal, invertebrate, and fish communities. Initial research on the North Shore invasion has only addressed bacterial and algal impacts. We will use this funding to add monitoring of all stream compartments (bacteria to fish) in our intensive sites to determine impacts of didymo on full stream energetics. We will use elemental analysis of stream compartments (algal mats, invertebrates, young of year fishes, adult fish) in didymo vs non-didymo streams and reaches to generate a first-of-its-kind stream energetics model for North Shore streams. These data will guide our Activity 3 management response. Fisheries will be sampled twice each year for young-of-year production (July) and adult distribution and health (October) using electrofishing methods appropriate for each stream reach. Fish and gut contents will be sampled for diet. We will measure weight and length of fish and calculate growth of young-of year trout. We will measure habitat characteristics (temperature, stream size, substrate size) in the streams to quantify trout habitat, comparing fish population metrics to stream habitats.

#### Activity Milestones:

Description	Completion Date
Measure foodweb impacts on stream energetics in didymo and non-didymo streams and reaches	April 30, 2026
Sample fisheries in didymo and non-didymo streams and reaches	April 30, 2026

### Activity 3: Implement management strategy to protect our streams and fisheries

**Activity Budget:** \$39,285

**Activity Description:**

Understanding the threat and how didymo impacts our streams is the first step in planning for a North Shore future likely to include didymo. Results from Activities 1 and 2 will inform policy on how we prevent further spread of didymo and manage streams and nearshore Lake Superior under didymo threat. This activity will result in a) established monitoring protocols for detecting didymo presence, abundance, and food web impact, b) the designation of specific stream index reaches below the fish barrier in North Shore streams for stream and fish monitoring (currently missing for our stream fisheries), and c) a management response and plan for slowing didymo spread and developing adaptive management strategies to protect and enhance our North Shore in a future of change.

Through reporting, presentations, and outreach (SCWD, angler associations, MNDNR, tribal agencies, MN Waters Conference, social media), we will spread our findings to help stakeholders, agencies, and visitors recognize didymo and partner to slow its spread before it threatens more streams, lakes, and fisheries.

**Activity Milestones:**

Description	Completion Date
Inform North Shore stream management to minimize didymo threat and preserve fisheries	June 30, 2026
Develop reports, factsheets, and outreach to inform Minnesotans on protecting their threatened streams	June 30, 2026

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Heidi Rantala	MNDNR	Compile fisheries data. Assist with field collection, invertebrate analysis, statistical analyses, interpretation of data, and the creation of outreach materials and reports. Share information about the project and project results with stakeholder groups, partners, and agency scientists and leadership	No
David Burge	SMM-SCWRS	Assist with field collection, laboratory and statistical analyses especially molecular approaches, interpretation of data, and the creation of reports and materials. Share information about the project and project results with stakeholder groups, partners, and agency scientists and leadership.	Yes
Joe Mohan	SMM-SCWRS	Post-doc who will assist with field collection, laboratory and statistical analyses, interpretation of data, and the creation of reports and materials. Share information about the project and project results with stakeholder groups, partners, and agency scientists and leadership.	Yes
Robert Pillsbury	UW-Oshkosh	Assist with field collection, laboratory and statistical analyses especially bacterial molecular approaches, interpretation of data, and the creation of reports and materials.	Yes

## 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?**

Project results will be implemented with public awareness programming along the North Shore through our and project partner efforts, and using the reach of the Science Museum of Minnesota's exhibit, virtual, and education programming to target everyone in Minnesota. The Department of Natural Resources, partners in this effort, recognize the threat of didymo and is committed to adapting their North Shore and Lake Superior fisheries management and messaging in response to project results.

## Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Determining Risk of a Toxic Alga in Minnesota Lakes	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 06f	\$200,000
Invasive Didymosphenia Threatens North Shore Streams	M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 06g	\$197,000
Unprecedented Change Threatens Minnesota's Pristine Lakes	M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 20a1	\$482,000

## 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; invasive species; 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). He has worked on algal invasives in the Great Lakes and their watersheds including the recent North Shore didymo invasion.

**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
<b>Personnel</b>								
Dr. Mark Edlund, Senior Scientist, SMM/SCWRS		Project mgmt, field, synthesis, outreach and reporting			29%	0.9		\$104,760
Dr. Joe Mohan, Post doc, SMM/SCWRS		Project coordination, field, analytical, reporting and outreach			29%	1.5		\$117,855
Dr. David Burge, Assistant Scientist, SMM/SCWRS		Field assistance, analytical, genomics, reporting and outreach			29%	0.75		\$50,634
Communication Specialist		Outreach			0%	0.1		\$4,000
							<b>Sub Total</b>	<b>\$277,249</b>
<b>Contracts and Services</b>								
SCWRS Analytical Lab	Professional or Technical Service Contract	Water Quality analytical costs, 200 samples, \$198 per				-		\$39,600
UW-Oshkosh or competitive bid	Professional or Technical Service Contract	UW Oshkosh 16S genomics bacterial communities, 200 samples @ \$180.80 per				0		\$39,160
Univ of Minnesota Genomics Ctr	Professional or Technical Service Contract	UM Genomics Ctr, shotgun sequencing of stream samples, 200 samples @ \$60 per				0		\$12,000
							<b>Sub Total</b>	<b>\$90,760</b>
<b>Equipment, Tools, and Supplies</b>								

	Tools and Supplies	Lab and field supplies	Lab and field expendable supplies					\$8,619
							<b>Sub Total</b>	<b>\$8,619</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	-
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	12 field trips to North Shore streams and lakeshore sites, Marine on St Croix to Grand Portage MN	Sampling of North Shore streams and lakeshore sites, 2 field years					\$17,372
							<b>Sub Total</b>	<b>\$17,372</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
							<b>Sub Total</b>	-
<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	<b>\$394,000</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
<b>State</b>				
In-Kind	MNDNR in-kind, salary, Heidi M. Rantala, fisheries research, 5 % FTE in FY24-FY26, \$5362 per year (salary and benefits), \$16,087 total	Dr. Rantala will compile MNDNR Fisheries and stream data, assist in field work, coordinate invertebrate analysis, perform statistical analyses, and help create reports and outreach materials for the project.	Pending	\$16,087
			<b>State Sub Total</b>	<b>\$16,087</b>
<b>Non-State</b>				
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 = \$394,000)	In-kind contribution of indirects	Pending	\$161,146
			<b>Non State Sub Total</b>	<b>\$161,146</b>
			<b>Funds Total</b>	<b>\$177,233</b>

## Attachments

### Required Attachments

#### *Visual Component*

File: [8bf84bd0-84f.pdf](#)

#### *Alternate Text for Visual Component*

The Didymo threat to Minnesota's North Shore streams and shorelines is bigger than we thought. We must prevent Didymo's further spread and adapt management approaches to this new invader to protect Minnesota's treasured streams and fisheries....

### Optional Attachments

#### *Support Letter or Other*

Title	File
Letter of Support SMM	<a href="#">4511392a-240.pdf</a>
Science Museum Non Profit 990 form	<a href="#">c27fa16f-d57.pdf</a>
Letter of Support MN DNR	<a href="#">69fa133e-b7f.pdf</a>

## 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

# Rock Snot has invaded Minnesota's North Shore!

Didymo found in  
7 more streams in  
2021 (8 total)



Where else has Didymo spread?

How will North Shore food webs  
and fisheries be affected?

How do we protect our North  
Shore streams from further  
invasions?

