Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-256

Proposal Title: Invasive Rock Snot Threatens North Shore Streams

Project Manager Information

Name: Mark Edlund

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

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Project Basic Information

Project Summary: We examine the recent spread, origin, cause, and economic and ecological threat of nuisance rock snot formation in North Shore streams and Lake Superior to inform management and outreach.

Funds Requested: $197,000

Proposed Project Completion: June 30 2024

LCCMR Funding Category: Small Projects (H)

Secondary Category: Aquatic and Terrestrial Invasive Species (D)

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.

A North Shore stream was invaded by rock snot and the time to stop it is now! In 2018, the first nuisance growth of rock snot (Didymospenia geminata or "didymo") developed in the North Shore's Poplar River and we don't know why. Didymo is a freshwater diatom or algae that can form nuisance goo in coldwater streams worldwide, in its native range and where it is invasive. Formation of didymo mats has aesthetic, economic, and recreational impacts. Economic impacts to tourism have exceeded $20M annually following invasions elsewhere, a serious threat to the North Shore $250M summer economy. Didymo disrupts normal community structure and ecosystem function in streams, alter habitat and food webs, impact fish and invertebrate abundance and diversity, and result in major shifts in natural bacterial composition.

Two hypotheses may explain rock snot: 1) The aggressive colonization hypothesis maintains an aggressive strain of didymo is being introduced and invading coldwater streams. 2) The changing environmental conditions hypothesis states environmental conditions (e.g., nitrogen to phosphorus ratios or timing of nutrient delivery) have become favorable to the formation of didymo mats. Understanding which of these models is supported by data is vital to management response.

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.

With LCCMR support we will understand:
1) Distribution, dynamics, and effect of didymo in North Shore streams
2) Why rock snot formed in the Poplar River and what other streams are at risk?
3) The source of didymo in North Shore streams–which strain is it? A new invasive? A native gone bad?
4) Share information and solutions with resource managers, citizen groups, and users to stop the rock snot invasion

While didymo has been documented in the near shore algal community of Lake Superior with increasing frequency since the 1960s, the Poplar River, near Lutsen, is the first stream ever colonized. Didymo is unique because it only blooms in low nutrient waters and recently, mats have been observed more frequently in streams similar to those on the North Shore around the world, including New Zealand, South America, Canada, and the US. Research shows thicker didymo mats have formed along the Superior shoreline annually for over a decade; however, it was only in 2018 that didymo was first observed colonizing North Shore streams as single cells or mat form. It is unclear why the mat formed in the Poplar River and whether didymo is already invading other North Shore streams.

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?

We can solve rock snot! If populations in North Shore streams and Lake Superior are not each others closest relatives, efforts for prevention of didymo mat formation will be focused on preventing movement of alien didymo among streams, paralleling practices that prevent the spread of microbes in freshwater systems. Alternatively, if the stream didymo originated from Lake Superior populations, management practices will focus on understanding the specifics that promote mat formation. Regardless, we will fully understand the source and cause of mat formation and broadly communicate the threat, implications, and management response to didymo invasion of North Shore streams.

Activities and Milestones

Activity 1: Understand didymo mat formation and distribution in North Shore streams and Lake Superior

Activity Budget: $131,700

Activity Description:
We will monitor the Poplar River and Lake Superior shoreline near the mouth of the Poplar to determine if a didymo mat reforms in the next two years and monitor the timing and environmental conditions associated with mat formation in the stream and lake. We will similarly sample 3-4 other stream-lakeshore pairs along the North Shore to document changes in the algal community and associated environmental conditions. Sampling will be monthly from July-November 2022 and April-November 2023 and will include sampling of the algal community and chemical (e.g., nutrients, dissolved organic carbon) and physical characteristics of the stream. Temperature, water depth, and flow will be measured continuously throughout the project. During peak didymo growth (late Aug-Sept) a survey will target 20 major North Shore stream-lakeshore pairs to fully assess current didymo presence and susceptibility of North Shore resources. All sampling will adhere to MNDNR protocols for preventing spread of aquatic invasive species.

Activity Milestones:

Description	Completion Date
Survey all major North Shore streams for presence of didymo and invasion susceptibility during peak	December 31 2023
Describe algae and environmental conditions in 4-5 paired Lake Superior shoreline and North Shore tributaries	March 31 2024
Communicate findings and solutions to resource managers and citizens through presentations, signage, social media, publications	June 30 2024

Activity 2: Genetic variability in Minnesota didymo populations and the associated bacterial community

Activity Budget: $65,300

Activity Description:
We will collect genetic information on North Shore tributary and Lake Superior coastal didymo populations to determine if the populations in the Poplar River and other North Shore streams are most closely related to didymo populations in Lake Superior or to other didymo populations in North America. We will use whole-genome sequencing of pools of individuals to genotype multiple didymo populations from the Poplar River and Lake Superior, didymo populations encountered in any North Shore streams, and populations from the US and Canada. We will characterize the bacterial communities using 16S rRNA gene sequencing from total DNA extracted from the periphyton mat samples to predict broader ecological consequences of didymo and learn how nuisance blooms are triggered in ultra-clean waters.

Activity Milestones:

Description	Completion Date
Determine genetic structure of the microbial mat community among lake and stream pairs	March 31 2024
Sequence genetics of North Shore didymo populations to determine source of rock snot	March 31 2024
Communicate results to inform management through meetings, signage, and presentations to resource managers and stakeholders	June 30 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Heidi Rantala	Minnesota Department of Natural Resources	Dr. Rantala will coordinate and participate in fieldwork, deployment of samplers, data analysis, outreach and communication, and project reporting.	No
Robert Pillsbury	University of Wisconsin-Oshkosh	Dr. Pillsbury has worked on Lake Superior didymo and will provide specialized molecular analysis of algae mats.	Yes
Teofil Nakov	University of Arkansas	Dr. Nakov is an expert on didymo genetics and will provide specialize molecular analysis to identify source populations of didymo in North Shore streams.	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 be funded?

We will share the findings of this study with resource managers (MNDNR, including state parks; MPCA; watershed groups) and stakeholders throughout the study period through meetings and personal communication. Edlund and Rantala are periodically invited to give presentations within their organizations and to outside groups, and they will present this work upon invitation. We will communicate the findings of this study with the public through signage, fact-sheets, and social media (Twitter and Facebook) accounts associated with their agencies. We plan on publishing the results of this work as two peer-reviewed publications in relevant scientific journals.

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, tribal, 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								
Dr. Mark Edlund, Project Director and Senior Scientist at Science Museum of Minnesota		Project direction, periphyton analysis, diatom identification			43.7%	0.5		$57,000
2 Interns, Science Museum of Minnesota		Field work, lab tech			12%	0.4		$13,642
Communication Specialist, Science Museum of Minnesota		Communication, outreach, social media			43.7%	0.04		$2,000
							Sub Total	**$72,642**
Contracts and Services								
TBD	Professional or Technical Service Contract	Bacterial Genetic Analysis: 200 samples @ $130.80/sample (Total $26,160; University of Wisconsin-Oshkosh or competitive bid)				-		$26,160
TBD	Professional or Technical Service Contract	Didymo Genetic Analyses: 200 samples @ $149.10/sample (Total $29,820; University of Arkansas or competitive bid)				-		$29,820
							Sub Total	**$55,980**
Equipment, Tools, and Supplies								

	Equipment	Stream Gauging Equipment: five 13-foot water levels @ $495 each; software $75; communication cable $249	Equipment for stream gauging					$2,799
	Tools and Supplies	Consumable Supplies: $4,000 field supplies; $1,320 microbial DNA extraction kits	Consumable supplies for field work and microbial DNA extraction					$5,320
							Sub Total	**$8,119**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Travel for Field Work: Round-trip drive from St. Croix Watershed Research Station to Grand Marais, MN for 2 employees: 18 days each FY20 and FY21 ($16,000 over two yrs)	Travel for Field Work					$16,000
							Sub Total	**$16,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Cost of open access publication in e.g. PLOS ONE peer-reviewed open access scientific journal ($699)	Publication of article on this project's research					$699
							Sub Total	**$699**
Other Expenses								
		Water Chemistry Analyses	Water chemistry analyses, St. Croix Watershed Research Station, $198/sample (10 analytes)					$43,560
							Sub Total	**$43,560**

							Grand Total	**$197,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	MN Department of Natural Resources	Contribution of portion of Rantala Salary: FY23 10% of time (208 hr), salary $36.32/hr, fringe $8.99/hr; FY24 10% of time (208 hr), salary $37.63/hr, fringe $9.39/hr (Total $19,205 over 2 years)	Secured	$19,205
			State Sub Total	**$19,205**
Non-State				
In-Kind	UW-Oshkosh	Genetic Laboratory Fees are provided in-kind by Pillsbury at UW-Oshkosh ($1,744 total over 2 years)	Secured	$1,744
In-Kind	Science Museum of Minnesota	Indirect Costs for the project are provided in-kind by the Science Museum of Minnesota (federally negotiated indirect rate 40.09% on all direct costs = $78,977)	Secured	$78,977
			Non State Sub Total	**$80,721**
			Funds Total	**$99,926**

Attachments

Required Attachments

Visual Component

File: 6318615d-5d2.pdf

Alternate Text for Visual Component

We examine the recent spread, origin, cause, and economic and ecological threat of nuisance rock snot formation in North Shore streams and Lake Superior to inform management and outreach....

Optional Attachments

Support Letter or Other

Title	File
Letters of Support_Rocksnot	08a7a5e7-598.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?

Yes

Environment and Natural Resources Trust Fund (ENRTF)
2022 Main Proposal
Project Title: Threats and Dynamics of Rock Snot in Minnesota

Invasive Rock Snot Threatens North Shore Streams

An Ecological and Economic Disaster for the North Shore?

Why did the Poplar River go from this...

Changing environmental conditions? Aggressive algae strain?

...to this in 2018?

that's ROCK SNOT!

Where did rock snot come from? Is it in other streams? How is it impacting stream function?