Environment and Natural Resources Trust Fund

M.L. 2020 Approved Work Plan

General Information

ID Number: 2020-035

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: August 13, 2021

Project Title: Invasive Didymosphenia Threatens North Shore Streams

Project Budget: $197,000

Project Manager Information

Name: Mark Edlund

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

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Project Reporting

Date Work Plan Approved by LCCMR: August 13, 2021

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: July 31, 2023

Final Report Due Date: September 14, 2023

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 06g

Appropriation Language: $197,000 the second year is from the trust fund to the Science Museum of Minnesota to evaluate the recent spread, origin, cause, and economic and ecological threat of didymo formation in North Shore streams and Lake Superior to inform management and outreach.

Appropriation End Date: June 30, 2024

Narrative

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.

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.

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

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 2021 and April-November 2022 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, 2022
Describe algae and environmental conditions in 4-5 paired Lake Superior shoreline and North Shore tributaries	March 31, 2023
Communicate findings and solutions to resource managers and citizens through presentations, signage, social media, publications	June 30, 2023

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
Sequence genetics of North Shore didymo populations to determine source of rock snot	March 31, 2023
Determine genetic structure of the microbial mat community among lake and stream pairs	March 31, 2023
Communicate results to inform management through meetings, signage, and presentations to resource managers and stakeholders	June 30, 2023

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr Heidi Rantala	MN DNR	Dr. Heidi Rantala (MNDNR) will provide expertise related to stream ecology and coordinate communications with local stakeholders. All partners will contribute to data analyses and writing manuscripts.	No
Dr Robert Pillsbury	UW-Oshkosh	Dr. Robert Pillsbury (UW-Oshkosh) will provide specialized molecular analyses to the project. Funding to this institution is specifically for analytical molecular analyses and does not represent direct salary. All partners will contribute to data analyses and writing manuscripts.	Yes
Dr Teofil Nakov	U of Arkansas	Dr. Teofil Nakov (University of Arkansas) will provide specialized molecular analyses to the project. Funding is specifically for analytical molecular analyses and does not represent direct salary. All partners will contribute to data analyses and writing manuscripts.	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.
We will share the findings of this study with resource managers (MNDNR, including state parks; MPCA; watershed groups) 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, factsheets, 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.
The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgement Guidelines.

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

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			45.5%	0.6		$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			45.5%	0.05		$2,000
							Sub Total	**$72,642**
Contracts and Services								
University of Wisconsin-Oshkosh	Sub award	Bacterial Genetic Analysis: 200 samples @ $130.80/sample (Total $26,160; University of Wisconsin-Oshkosh, Dr. Robert Pillsbury, or competitive bid)				0		$26,160
University of Arkansas	Sub award	Didymo Genetic Analyses: 200 samples @ $149.10/sample (Total $29,820; University of Arkansas, Dr. Teofil Nakov, or competitive bid)				0		$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 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 (for suite of 10 analyses), 110 samples in FY21 and 110 samples in FY22 (Total $43,560)					$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				
			State Sub Total	**-**
Non-State				
In-Kind	Science Museum of Minnesota	Contribution of portion of Rantala Salary: FY21 10% of time (208 hr), salary $36.32/hr, fringe $8.99/hr; FY22 10% of time (208 hr), salary $37.63/hr, fringe $9.39/hr (Total $19,205 over 2 years)	Secured	$19,205
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
In-Kind	Pillsbury	Genetic Laboratory Fees are provided in-kind by Pillsbury ($1,744 total over 2 years)	Secured	$1,744
			Non State Sub Total	**$99,926**
			Funds Total	**$99,926**

Attachments

Required Attachments

Visual Component

File: 442e2249-e62.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
Institutional Letter of Support, Science Museum of Minnesota	7d296146-447.pdf
SF-990, Institutional Tax Exempt Form, Science Museum of Minnesota	8204cf17-0af.pdf
Background Check Certification Form	80769076-b99.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Sampling timetable and reporting timetable updated to reflect receipt of funding award in 2021.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must 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 agree to the Commissioner's Plan.

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

Environment and Natural Resources Trust Fund (ENRTF)
2021 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?