



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2020 ENRTF Work Plan (Main Document)

Today's Date: February 12, 2020

Date of Next Status Update Report: April 1, 2021

Date of Work Plan Approval:

Project Completion Date: June 30, 2022

Does this submission include an amendment request? ___

PROJECT TITLE: Invasive Rock Snot Threatens North Shore Streams

Project Manager: Mark Edlund

Organization: Science Museum of Minnesota

College, Department, or Division: St. Croix Watershed Research Station

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City, State, Zip Code: Marine on St. Croix MN 55047

Project Manager Direct Telephone Number: (651) 433-5953 ext. 26

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Location: North Shore, Lake and Cook counties

Total Project Budget: \$197,000

Amount Spent: \$0

Balance: \$197,000

Legal Citation: M.L. 2020, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

PROJECT STATEMENT:

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 (aka *Didymosphenia geminata* or, more simply “didymo”) developed in the North Shore’s Poplar River and we don’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, which includes Lake Superior, and where it is invasive. Formation of didymo mats in streams has aesthetic, economic, and recreational impacts, including impacting angling and recreation. Economic impacts to tourism have exceeded \$20 million per year following invasions elsewhere, **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 abundance and diversity, and result in major shifts in natural bacterial composition.

Summary: With LCCMR support we will understand:

- 1) the distribution, dynamics, and effect of *Didymosphenia geminata* in North Shore streams
- 2) why did rock snot form 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? Or a native gone bad?
- 4) share information and work with with resource managers, citizen groups, and resource users to stop rock snot invasion of North Shore streams.

Two hypotheses may explain rock snot: The **aggressive colonization hypothesis** maintains that an aggressive strain of *Didymosphenia geminata* is being introduced and invading coldwater streams. The **changing environmental conditions hypothesis** states that 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.*

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, MN, is the first stream that has been colonized—didymo has never before been found in Minnesota streams. Didymo is unique because it only blooms in oligotrophic (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 in either 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.

We can solve rock snot: If the populations in North Shore streams and Lake Superior are not each-other’s closest relatives (i.e., the stream didymo came from elsewhere), efforts for prevention of didymo mat formation will be focused on preventing movement of the alga among streams, paralleling practices that prevent the spread of other microbes in freshwater systems. Alternatively, if the stream didymo originated from Lake Superior populations, management practices should focus on understanding the specifics that promote mat formation. In both cases, we will fully understand the source and cause of mat formation and broadly communicate the threat, implications, and management response to didymo mat formation in North Shore streams.

II. OVERALL PROJECT STATUS UPDATES:

First Update April 1, 2021

Second Update October 1, 2021

Third Update April 1, 2022

Final Report between project end (June 30) and August 15, 2022

III. PROJECT ACTIVITIES AND OUTCOMES:

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

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 4–5 other stream-lakeshore pairs along the North Shore to document changes in the algal community and associated environmental conditions. Sampling will be monthly from April–November 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 2019) a single survey each year 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 1 ENRTF BUDGET: \$131,700

Outcome	Completion Date
<i>1. Describe the algal communities and environmental conditions in 4-5 paired Lake Superior shoreline and North Shore tributary sites</i>	<i>January 2022</i>
<i>2. Survey all major North Shore streams for presence of Didymo and invasion susceptibility during peak growth</i>	<i>December 2021</i>
<i>3. Communicate findings with natural resource managers, citizens, and scientists through presentations, signage, fact sheets, social media, and peer-reviewed publications.</i>	<i>June 2022</i>

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ACTIVITY 2 Title: Genetic variability in MN didymo populations and the associated bacterial community.

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 2 ENRTF BUDGET: \$65,300

Outcome	Completion Date
<i>1. Sequence genetics of North Shore didymo populations to determine source of rock snot</i>	<i>January 2022</i>
<i>2. Determine genetic structure of the microbial mat community among lake and stream pairs and how changes in these communities alter ecological function and nutrient pathways in these systems.</i>	<i>December 2021</i>
<i>3. Communicate results with natural resource managers (MNDNR, state parks, watershed groups, MPCA) to inform management through meetings, signage, and presentations.</i>	<i>June 2022</i>

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Second Update October 1, 2021

Third Update April 1, 2022

Final Report between project end (June 30) and August 15, 2022

IV. DISSEMINATION:

Description:

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](#).

First Update April 1, 2021

Second Update October 1, 2021

Third Update April 1, 2022

Final Report between project end (June 30) and August 15, 2022

V. ADDITIONAL BUDGET INFORMATION:

A. Personnel and Capital Expenditures

Explanation of Capital Expenditures Greater Than \$5,000: NA

Explanation of Use of Classified Staff: NA

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours for entire duration of project: 2026	Divide total personnel hours by 2,080 hours in 1 yr = TOTAL FTE: 0.97
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Total Number of Full-time Equivalent (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Contract Personnel Hours for entire duration of project: NA	Divide total contract hours by 2,080 hours in 1 yr = TOTAL FTE:NA
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VI. PROJECT PARTNERS:

A. Partners outside of project manager’s organization receiving ENRTF funding

Partners include Dr. Robert Pillsbury (UW-Oshkosh) and Dr. Teofil Nakov (University of Arkansas) who provide specialized sole source molecular analyses to the project. Funding to these two institutions is specifically for analytical molecular analyses and does not represent direct salary. All partners will contribute to data analyses and writing manuscripts.

B. Partners outside of project manager’s organization NOT receiving ENRTF funding

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.

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

The MNDNR, as well as local watershed groups, will use data from this study to understand what causes nuisance didymo mats in North Shore streams. Understanding why mats form (aggressive colonizer or changing environment) is critical to managing didymo in streams, as management activities differ depending on the cause of mat formation. After understanding conditions that favor didymo mat formation in North Shore streams, documenting the impacts on stream invertebrate, fish, and algal communities will be our next steps.

VIII. REPORTING REQUIREMENTS:

- Project status update reports will be submitted April 1 and October 1 each year of the project
- A final report and associated products will be submitted between June 30 and August 15, 2022

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

- A. Budget Spreadsheet
- B. Visual Component or Map
- C. Parcel List Spreadsheet
- D. Acquisition, Easements, and Restoration Requirements
- E. Research Addendum

Attachment A: Project Budget Spreadsheet
Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet



Legal Citation:

Project Manager: Mark Edlund

Project Title: 168-DH Invasive Rock Snot Threatens North Shore Streams

Organization: Science Museum of Minnesota

Project Budget: \$197,896

Project Length and Completion Date: 2 yrs, 30 Jun 2022

Today's Date: 12 Feb 2020

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET		Budget	Amount Spent	Balance
BUDGET ITEM				
Personnel (Wages and Benefits)		\$ -	\$ -	\$ -
Dr. Mark Edlund, Periphyton analyst at Science Museum of Minnesota, FY20, 25% of time (520 hr), salary \$37.50/hr, Fringe \$10.58/hr; FY21 32% of time (666 hr), salary \$37.50/hr, Fringe \$10.58/hr. Salary for diatom identification, \$57,000 over 2 yrs; this is a grant-funded position		\$ 57,000	\$ -	\$ 57,000
Salary for 2 part time interns at Science Museum of Minnesota, 800 hours total (400 hr FY20, 400 hr FY21) @ \$15/hr salary (FY20), \$1.80/hr fringe (FY20), \$15.45/hr salary (FY21), \$1.85/hr fringe (FY21). Salary for field work, lab tech. \$6000 for FY20 and \$6180 for FY21; total \$13,642; this is a grant-funded position		\$ 13,642	\$ -	\$ 13,642
Communication Specialist, Science Museum of Minnesota, 40 hours @\$50/hour, 0 hours in FY20, 40 hours in FY21. Salary for outreach and social media. Total FY21 \$2,000		\$ 2,000	\$ -	\$ 2,000
Professional/Technical/Service Contracts				
Water chemistry analyses, St Croix Watershed Research Station, \$198/sample (for suite of 10 analyses), 110 samples in FY20 and 110 samples in FY21, total \$43,560.		\$ 43,560	\$ -	\$ 43,560
Bacterial genetic analysis, sole source at UW-Oshkosh, 200 samples @ \$130.80/sample, total \$26,160		\$ 26,160		\$ 26,160
Didymo genetic analyses, sole source at University of Arkansas, 200 samples @ \$149.10/sample, Total \$29,820		\$ 29,820	\$ -	\$ 29,820
Equipment/Tools/Supplies				
Stream gaging equipment, five 13-foot water levels @ \$495.00 each, software \$75, and communication cable \$249		\$ 2,799	\$ -	\$ 2,799
Consumable supplies: \$4000 field supplies, \$1320 microbial DNA extraction kits		\$ 5,320	\$ -	\$ 5,320
Travel expenses in Minnesota				
Round Trip from St. Croix Watershed Research Station to Grand Marais, 2 employees, 18 days ea		\$ 16,000	\$ -	\$ 16,000
Other				
Cost of open access publication, PLOS ONE (\$699)		\$ 699	\$ -	\$ 699
COLUMN TOTAL		\$ 197,000	\$ -	\$ 197,000
SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT				
	Status (secured or pending)	Budget	Spent	Balance
In kind:				
Rantala Salary, in kind, FY20, 10% of time (208 hr), salary \$36.32/hr, Fringe \$8.99/hr; FY21 10% of time (208 hr), salary \$37.63/hr, Fringe \$9.39/hr, secured (Total \$19,205 over 2 years)		\$ -	\$ -	\$ -
	\$ 19,205			
All indirect project costs are provided in-kind by the Science Museum of Minnesota (federal indirect rate 45.13% on all direct costs = \$89,310, secured)		\$ 89,310		
Waived genetic laboratory fees, secured by Pillsbury (\$1744 total over 2 years)		\$ 1,744	\$ -	\$ -
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS				
	Amount legally obligated but not yet spent	Budget	Spent	Balance
1) "Determining Risk of Toxic Alga in Minnesota Lakes" M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 06f: \$200,000, Jul 2018-Jun 2021		\$ 141,867	\$ 593,000	\$ 451,133
2) "Tracking and Preventing Harmful Algal Blooms" M.L. 2016-186-2-04a: \$500,000, Jul 2016-Jun 2019		\$ 193,740	\$ 200,000	\$ 6,260
				\$ 193,740