

**Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 116-D

Will the Invasive Alga Didymosphenia Degrade Minnesota Waters?

Category: D. Aquatic and Terrestrial Invasive Species

Total Project Budget: \$ 207,213

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 - June 2020

Summary:

This project assesses the extent of the invasive alga Didymosphenia in Minnesota waters, examines bloom triggers and foodweb implications to lead to prevention and control measures, and includes outreach components.

Name: Paula Furey

Sponsoring Organization: St. Catherine Universtiy

Address: 2004 Randolph Ave, Mailstop 4246

St. Paul MN 55105

Telephone Number: (419)308-7770

Email pcfurey@stkate.edu

Web Address _____

Location

Region: Northeast, Southeast

County Name: Carlton, Cook, Fillmore, Goodhue, Houston, Lake, Olmsted, Pine, St. Louis, Wabasha, Winona

City / Township:

Alternate Text for Visual:

A) (Map of MN with vulnerable areas circled): The Threat: Didymo (Rocksnot) threatens to spread into trout streams in Minnesota. Didymo presence continues to expand in Lake Superior and may already be in nearby streams. B) (Images of rivers before and after Didymo invasion): Where would you prefer to fish? – Didymo blooms can form thick, mucilage-rich mats that cover up to 100% of river and lake-shore bottoms. Let's stop blooms and spread of Didymo in MN.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____ %



I. PROJECT STATEMENT

Didymosphenia geminata (also referred to as Didymo or Rock Snot) is an invasive alga that has recently formed habitat choking blooms in streams and rivers in Pennsylvania, Tennessee, Michigan and many western states. Didymo blooms have been reported to cover 100% of stream surfaces with up to an 8 inch thick mat of filaments in the locations where it invades. Blooms of this magnitude significantly alter ecosystem processes and habitat conditions that effect water quality, fish habitat and food web structure.

The Minnesota Aquatic Invasive Species Research Center (MAISRC) lists Didymo as a high priority species of concern. Didymo blooms occur in cold, low nutrient water, similar to many Minnesota trout streams. **The Didymo found along Lake Superior shorelines is expanding its range.** Both EPA researcher Jo Thompson (<http://www.mprnews.org/story/2010/11/08/Didymo-lake-superior>) and Bob Pillsbury (named on this proposal) have been tracking this expansion within Lake Superior since 2008 and have noted an increase in Didymo coverage over time. ***Due to the presence of Didymo in Lake Superior, the quality of our cold water streams and the potential for cell transport by water recreationists, we consider a Didymo invasion in Minnesota to be inevitable.***

Didymo cells, thought to be transported by water recreationists, can persist in a location without blooming indefinitely until a bloom is triggered, presumably by changing environmental conditions. Neither the vectors of Didymo invasion nor the triggers of harmful bloom development are well understood. Without this fundamental understanding there is little that resource managers can do to prevent or control invasions.

A Didymo invasion would threaten Minnesota’s cold-water fisheries (with a total estimated revenue of \$248 million/year supporting 3,400 jobs) by : **1)** changing food availability for fish at their most vulnerable stage (young of the year), **2)** creating blooms that deplete needed oxygen, **3)** changing the way nutrients are cycled within the water body –disrupting established food chains, and **4)** reducing the aesthetics of an area by coating all surfaces with a thick layer of slime which will cause trout anglers and tourists to choose other locations.

The activities we propose will provide much needed information on:

- The most vulnerable streams and rivers to Didymo blooms
- The presence of Didymo cells within 25 most vulnerable streams and rivers
- The impact of the existing Lake Superior bloom on ecosystem function

Activity 1: Assess risk and current extent of Didymo invasion in Minnesota waters

Budget: \$84,187

We will develop risk assessment criteria for Didymo invasion and use this to create a statewide Didymo vulnerability map for streams and rivers. Actual Didymo presence will be determined through field sampling and laboratory analysis. Initial sampling will target streams and rivers near Lake Superior where the spread of Didymo is highly likely. Results from this assessment will help agencies direct future monitoring efforts.

Outcome	Completion Date
1. Develop criteria to assess the risk of Didymo invasion based on analysis of existing data and scientific knowledge in literature. Relevant data may include water quality, streamflow, substrate material, dam presence/absence and fishing use.	Dec 2018
2. Identify and map vulnerable areas throughout the state using the risk assessment criteria developed based on stream characteristics (see Outcome #1).	Dec 2018
3. Survey water bodies to determine the presence and extent of Didymo in Lake Superior and the 25 Minnesota streams and rivers identified as most vulnerable (see Outcome #2).	Dec 2019
4. Develop a standardized protocol for this sampling procedure and reporting results that will be shared with stakeholders who may sustain monitoring efforts.	Dec 2019

Activity 2: Assess the impact and triggers of a Didymo invasion on MN natural resources

Budget: \$87,512

Didymo Impact: In areas along the North Shore of Lake Superior where Didymo mats and native algal mats exist side by side, we will compare changes in: **1)** various key nutrient pools (e.g. nitrogen, phosphorus), and **2)** food resources (both edible algae and invertebrates) available to fish fry. In areas where Didymo is present, we will manipulate small substrates with Didymo to determine **what triggers blooms.** We will alter nutrient ratios (using



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nutrient diffusing substrates), light, temperature, and current, then observe Didymo response. Results can be used to help prevent or control invasions of Didymo in MN. Safe handling protocols will be used throughout.

Outcome	Completion Date
1. Changes to ecology: Determine the impact of a Didymo blooms on water chemistry, benthic habitat and fish food resources such as mat-associated algae and macroinvertebrates.	Spring 2020
2. Understanding bloom triggers: Perform in situ manipulations (e.g. using nutrient diffusing substrata) of important environmental factors to determine optimal bloom conditions and monitor in-lake growth of cells under various, experimental conditions	Spring 2020
3. Complete a report which summarizes what events are likely to trigger blooms, and how this will impact resources for other aquatic organisms like fish	Spring 2020

Activity 3: Outreach and public engagement

Budget: \$35,513

To plan for continued **monitoring of Didymo** in MN, we will connect each site where Didymo is identified with interested stakeholders (i.e. a school, state park, or sports fishing group). Didymo is thought to be spread by water recreationists so it is important to connect with them to both prevent the spread of Didymo and to detect early warnings of a bloom. It is also crucial to disseminate knowledge to natural resource managers on the presence and bloom conditions of Didymo, along with control and prevention measures for MN waters.

Outcome	Completion Date
1. Create an informative, user friendly webpage with up to date info on how Didymo is spread (including how to avoid transport), how to identify Didymo and what to do if you suspect you see Didymo. History of observed sightings in Minnesota will be documented.	Dec 2019
2. Create a sampling and assessment protocol, and a safe handling protocol. Develop visual assessment criteria for streams and shorelines, then train citizen monitoring groups	June 2020
3. Communicate results that are relevant to state policy decisions at widely attended MN meetings including the Water Resource Conference, the Upper Midwest Stream Restoration Symposium, and the Conference on Great Lakes Research.	June 2020
4. Publish results in a peer-reviewed journal	June 2020

III. PROJECT STRATEGY

A. Project Team/Partners:

1) St. Catherine University, Dept. of Biology - **Dr. Paula Furey** (Assistant Prof.): project manager, field data collection, algal analysis. Undergraduate Research Team (field data collection and lab analysis). **2)** University of Minnesota, St. Anthony Falls Laboratory - **Dr. Amy Hansen** (Research Associate): field data collection, experimental setup, water chemistry assessment. **3)** University of Wisconsin Oshkosh - **Dr. Robert Pillsbury** (Prof.): sample collection, Lake Superior monitoring, web design, statistical analysis.

B. Project Impact and Long-Term Strategy

This project will help **determine the impact of blooms of Didymo** established along the North Shore of Lake Superior arguably the most important lake on earth. **This research will also inform water resource managers on the vulnerability of MN freshwaters to Didymo invasion.** Data will form a **baseline assessment** of current Didymo presence so that **rate of invasion** can be tracked through standardized procedures, thus **early invasion detection and response will be feasible.** The vulnerability map will help natural resource managers determine where to prioritize resources for longer term monitoring. We will share our results in avenues of engagement where citizen involvement is likely to educate those in the position to make the largest difference, i.e. the resource users and managers of the resources.

C. Timeline Requirements

This project depends on three full years (July 2017 to June 2020), including summer and fall seasons for field data collection and field / lab experiments. Each year builds on knowledge gained in the previous years to refine studies aimed at understanding, prevention and control.

2017 Detailed Project Budget

Project Title: *Will the invasive alga Didymosphenia degrade Minnesota waters?*

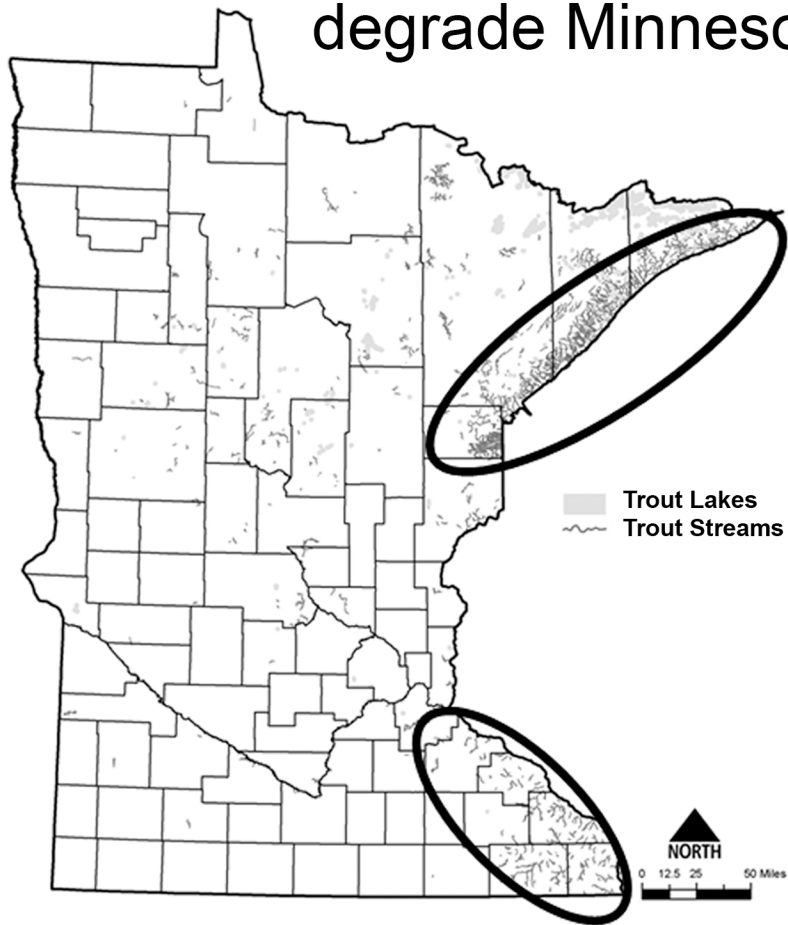
IV. TOTAL ENRTF REQUEST BUDGET 3 years: July 2017 to June 2020

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
Personnel:	
Dr. Paula Furey, Project Manager: Furey will: oversee project management, participate in field and lab work, including algal and invertebrate analysis, participate in outreach, manage the undergraduates.(83% salary, 17% benefits); 20% FTE for YR1; 23% FTE YR 2 + 3:	\$ 50,336
Dr. Amy Hansen, Project Co-PI, Research Assoc.: Hansen will participate in field data collection, experimental setup, and water chemistry assessment, develop the map of vulnerable areas. (79.25 % salary, 20.75 % benefits); 17% FTE YR1, 33 % FTE for YR 2	\$ 56,587
Dr. Bob Pillsbury, Project Co-PI, Ecologist: Pillsbury will: participate in field and lab work, Lake Superior monitoring , participate in outreach, and web design and statistical analyses; (45.5% salary, 54.5% benefits); 11% FTE for each of 3 yrs:	\$ 33,933
Undergrad Students, St. Catherine Univ. (\$11.50/hr): x2 -summer 2018, x1 summer 2019 (30 hrs/wk; 13 wks); x1 per semester - fall 2017, spring + fall 2018 + 2019 (8 hr/wk; 16 wks/semester). Univ. of MN: 2 students- summer Yr2), (\$10,400); All students = 100%	\$ 31,935
Professional/Technical/Service Contracts: Univ. of MN Water Lab: water chemistry technician (72.6% salary, 27.4% benefits) (\$2014), St. Anthony Falls Tech. support: Labor costs associated with building sensor housing for Lake Superior wave environment (63.2 salary, 36.8% benefits) (\$3830)	\$ 5,844
Equipment/Tools/Supplies:	
Field & Lab Supplies: slides: \$8.70/box x8 (\$69.60) coverslips \$7.30/box x8 (\$58.40), pipets: x2 box (\$37.9), forceps x2 (\$18), vials: x1 case (\$171), aluminum pans: 1 box (\$43), clay pots: \$0.80/pot x50 (\$40), silicon cement: \$9.00/tub x6 (\$54), Agar: \$104/500mg x2 (\$208), patio blocks: \$3.00/blk x 25 (\$75), Acetone-chl. a \$31.3/1 gal x 2 (\$62.60), GF filters \$104/pack x3 (\$312), Field materials i.e. batteries, bottles, waders (\$610), Onset HOB0 logger for temp. + DO; (\$1250), materials for housing to support ADV + sensors in wave environment (\$850)	\$ 3,860
Equipment: Microscope objective and camera (\$10874) for detailed analyses and image capture required for algal assessment and assessing bloom triggers	\$ 10,874
Laboratory services: analysis of 25 stream samples (NO3/2, NH4, TDN/DOC, DIC, TP, SRP, chl a) and 35 Lake Superior samples. (60 samples total at \$11.21/sample=\$673),	\$ 673
Travel:	
Activity 1: A) Stream vulnerability assessment 15 days: Lodging (\$142/night/rm) = (\$2130), Food (\$50/pers./day; x4 students 15days, X2 PI x5 days)=\$3500); Vehicle costs: \$41/day rental + mileage (~250 miles per trip; \$0.17/mile; [stream assessment = 3 trips], =\$850); Activity 1 +2: B). Lake Superior Monitoring: 3 trips/yr: Duluth-Grand Marais round trip: 220m x 3 =660 m/yr, 0.54/m/(no car rental) (\$1069). Activity 2: C) Impact/triggers of bloom: Lake Superior habitat impacts (x5 days): lodging (\$142/night/rm) = (\$710), food: (\$50/person/ day*2 people) = (\$500), St. Paul-Duluth: Round Trip: 304miles (\$0.17/m), Vehicle costs: \$41/day rental = (\$256.68); Activity 3: D). Outreach : St. Paul-Duluth: 1 person, 2 round trips: 304miles (\$0.54/m)=\$328), Lodging (\$142/night x2 nights/trip) = (\$568)	\$ 9,912
Presentation Travel: MN Water Resources Conf. (registration \$245) to present risk, current extent, monitoring details of Didymo in MN waters); in-state Great Lakes Conf. (reg. fee \$500) to present impact & prevention measures for Lake Superior and Tributaries.	\$ 745
Additional Budget Items:	\$ -
Publication , printing : Pub. fees for 1 peer reviewed article. (\$1000); fact sheets (x100, 2.39 color+ laminat. = \$239), Poster Great Lakes meeting (\$75), impact + prevention results	\$ 1,314
Shipping of water chemistry samples to lab (on ice; expedited; Y2 (\$1200)	\$ 1,200
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 207,213

V. OTHER FUNDS

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
Other Non-State \$ To Be Applied To Project During Project Period: None	N/A	
Other State \$ To Be Applied To Project During Project Period: none	N/A	
In-kind Services To Be Applied To Project During Project Period: A dditional salary support for PI (Pillsbury) 11% FTE for 3 years (\$33,933); St. Catherine University will not charge its typical overhead rate of 40.1% of the total salaries and benefits (\$22,256)	\$ 56,189	Secured
Funding History: St. Catherine Univ. provided funds for preliminary research spring 2016	\$ 3,100	Secured
Remaining \$ From Current ENRTF Appropriation:	05/07/2016	N/A

Will the invasive alga *Didymosphenia* degrade Minnesota waters?



October, 2005

Sources: DNR (GIS data available at <http://deli.dnr.state.mn.us>)

A) The Threat:
Didymo (Rocksnot) threatens to spread into trout streams in Minnesota (circles).

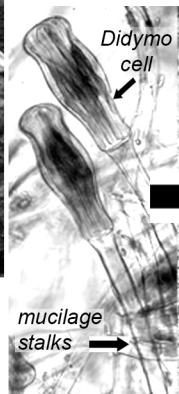
Didymo presence continues to expand in Lake Superior and may already be in nearby streams.

B) Where would you prefer to fish? - Didymo blooms can form thick, mucilage-rich mats that cover up to 100% of river and lake-shore bottoms. Let's stop blooms and spread of Didymo in MN.

A river **before** Didymo invasion



A river **after** Didymo invasion



www.duluthnews-tribune.com: Photo courtesy of Max Bothwell

Will the invasive alga *Didymosphenia* degrade Minnesota waters?

PROJECT MANAGER QUALIFICATIONS AND ORGANIZATION DESCRIPTION: LCCMR FY 2017

Dr. Paula C. Furey, St. Catherine University, St. Paul, MN.

Relevant Experience

Paula Furey has substantial research experience in **freshwater ecology** across a variety of river and lake systems, combined with expertise in algae and macroinvertebrates that will be key to this project. In collaboration with an ecologist from California, she examined the impacts of stream condition on the species composition and function of algal assemblages, including the nuisance alga *Didymo*, among Sierra Nevada Rivers and the implications for the foothill yellow-legged frog tadpole. Her experience with **public engagement** will strengthen the outreach components of this project. For example, she trains **citizen scientists** about how to collect, recognize, and monitor algae, including nuisance/harmful species. She manages **research grants** and prepares professional **publications** regularly.

Education

Postdoctoral Fellow, St. Catherine University. 2008 – 2011; UC Berkeley, 2008 – 2010
Ph.D., Biology, Bowling Green State University, OH, (Aquatic Ecology/Algology), 2008
M.Sc., Biology, University of Victoria, British Columbia, Canada, (Limnology), 2003

Relevant Publications

Furey, P.C., S.J. Kupferberg, & A.J. Lind. 2014. The perils of unpalatable periphyton: *Didymosphenia* and other mucilaginous stalked diatoms common downstream of hydropeaking dams as food for tadpoles. *Diatom Research; Special Issue: Didymosphenia*. 29: 267–280.
Holomuzki, J.R., P.C. Furey, R.L. Lowe, & M.E. Power. 2013. Microdistributional variability of larval caddisflies in Mediterranean-climate streams in N. California. *West. N. Am. Naturalist*. 73: 261–269.
Furey, P.C., M.E. Power, R.L. Lowe, & A. Campbell-Craven#. 2012. Midges, *Cladophora* and epiphytes: shifting interactions through succession. *Freshwater Science*. 31: 93–107.
Power, M., R. Lowe, P.C. Furey, J. Welter, M. Limm, J. Finlay, C. Bode, S. Chang, M. Goodrich, & J. Sculley. 2009. Algal mats and insect emergence in rivers under Mediterranean climates: Towards photogrammetric surveillance. *Freshwater Biology*. 54: 2101–2115.
Furey, P.C., R.N. Nordin, & A. Mazumder. 2006. Littoral benthic macroinvertebrates under contrasting drawdown in a reservoir and a natural lake. *J. North American Benthological Society*. 25: 19–31.

Additional Team Member Qualifications

Dr. Amy Hansen is a research associate at St. Anthony Falls Laboratory at the University of Minnesota. She is currently principal investigator on a project funded by the National Science Foundation investigating the potential role of wetlands in mitigating excess nitrate in agricultural landscapes. She has applied a variety of **engineering techniques to better understand factors that control aspects of water quality and ecosystem function**. Her doctoral research included investigations of microscale dynamics within vegetation, including filamentous algal assemblages, **similar to our proposed research on *Didymo* mats**.

Dr Robert Pillsbury, a full professor at the University of Wisconsin, Oshkosh, is **uniquely qualified** for this project. Much of his research focuses on monitoring invasive species and algae in the Great Lakes. As a long-time resident of the North Shore of Lake Superior, he collects historic documents on algal research within this area. In 2008, he established **14 long-term permanent monitoring locations** designed **to track the spread of *Didymo***. He also teaches Freshwater Algae and Aquatic Biology.

St. Catherine University is committed to academic excellence and has a diverse faculty and student body that actively conducts a variety of research. The Office of Research and Sponsored Programs (ORSP) provides research infrastructure, sponsored projects administration and faculty development, such as on compliance and grants management. ORSP helps maintain documentation for audit and ensures funds are spent in compliance with grant award terms.