

**Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 139-D

Determining Minnesota's Risk of a Toxic Algal Invader

Category: D. Aquatic and Terrestrial Invasive Species

Total Project Budget: \$ 243,000

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

This project will determine the historical distribution, abundance, and toxicity of the invasive blue-green alga, *Cylindrospermopsis raciborskii*, in Minnesota lakes using a combination of paleolimnological and contemporary monitoring techniques

Name: Adam Heathcote

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

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Telephone Number: (651) 433-5953 x24

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Web Address https://www.smm.org/scwrs

Location

Region: Statewide

County Name: Aitkin, Anoka, Big Stone, Blue Earth, Cass, Chisago, Clearwater, Cook, Crow Wing, Douglas, Hubbard, Kandiyohi, Lake, Lincoln, Mahnomen, Meeker, Morrison, St. Louis, Stearns, Swift, Waseca, Watonman

City / Township:

Alternate Text for Visual:

The visual aid shows a map of the 24 proposed study lakes, including two which are known to be infested with *Cylindro*. It also shows a micrograph image of a filament of the *Cylindro* algae.

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



PROJECT TITLE: Determining Minnesota’s risk of a toxic algal invader

I. PROJECT STATEMENT

- Invasive microbes are easily spread, but difficult to detect, control, or reliably assess for their environmental and public health risk. Cyanobacteria (blue-green algae) are one of the most abundant and obvious microbes in lakes, and recent work suggests a shift to more toxic forms – including the invasive species, *Cylindrospermopsis raciborskii* (*Cylindro*) – with consequences including dog deaths, human illness, and reduced natural resource value. Minnesota is outside the native range of *Cylindro*, but its arrival has recently been confirmed by ENRTF supported surveys carried out by the St. Croix Watershed Research Station and MPCA. It is likely that recent years with warmer summer temperatures and increased nutrient pollution have provided a new niche for this species to invade.
- There is little information on *Cylindro* in Minnesota and no data on the presence of toxins it produces. This information is particularly important to the State of Minnesota, because unlike other Cyanobacteria, *Cylindro* may bloom several feet below the lake surface, making it difficult to visually assess the quality and safety of waters where it is present. This project will be the first systematic survey of Minnesota for the occurrence of *Cylindro* and its cyanotoxins in Minnesota lakes – in both the water and bottom sediments. This study will determine present-day distribution and toxicity of *Cylindro*, its historic introduction and spread across the state, and develop predictive models for bloom occurrence, seasonality, toxicity, and invasion risk. These data are the critical first step in understanding and addressing the spread of any invasive species.
- This project leverages current ENRTF funding for harmful algal bloom (HABs) research in 10 of the 24 Sentinel Lakes that were selected by the DNR as a representative sample of Minnesota’s lakes. It would provide an additional year of monitoring for HABs on all 24 of the Sentinel Lakes during the peak bloom season and allow us to determine the historical presence of *Cylindro* through the occurrence of its toxins in sediment cores.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Use monitoring to determine where *Cylindro* is present in Minnesota

Budget: \$60,445

| Outcome | Completion Date |
|--|------------------------|
| 1. We will collect phytoplankton and water quality samples from the 24 Sentinel Lakes during peak bloom season to determine the presence and toxicity of <i>Cylindro</i> | October 2018 |
| 2. We will develop predictive criteria for the invasive spread of <i>Cylindro</i> that can be applied to Minnesota lakes based on its occurrence, abundance, and toxin production coincident with water and weather conditions | June 2021 |

Activity 2: Use sediment cores to determine the timing and spread of *Cylindro* in Minnesota

Budget: \$166,848

| Outcome | Completion Date |
|--|------------------------|
| 1. We will collect and date sediment cores from the 24 Sentinel lakes and measure the <i>Cylindro</i> toxin (CYN) and the general Cyanobacteria toxin (MC) to determine when <i>Cylindro</i> arrived in MN | June 2021 |
| 2. We will compare patterns of introduction and expansion of <i>Cylindro</i> to long-term | June 2021 |



| | |
|---|--|
| weather data to assess the role of warming lake temperatures on range expansion vs. alternative invasion scenarios (e.g. eutrophication, human transport) | |
|---|--|

Activity 3: Prepare Minnesota for an aquatic microbial invader

Budget: \$15,708

| Outcome | Completion Date |
|--|------------------------|
| 1. We will develop scientific reports and factsheets intended to inform managers and laypersons on the spread of <i>Cylindro</i> in Minnesota and its environmental and public-health impacts | June 2021 |
| 2. Research Station scientists will highlight this work at “Behind the Scenes” events, hosted three times a year by the Science Museum of Minnesota, which is open to all of the Museum’s thousands of daily visitors | June 2021 |
| 3. We will publicize the progress and results of this project via the Research Station’s news releases and social media presence as well as through our collaboration with the University of Minnesota Extension HABs outreach efforts | June 2021 |

III. PROJECT STRATEGY

A. Project Team/Partners

This project will be led by Associate Scientist Dr. Adam Heathcote, who is also responsible for coordinating other on-going HABs research at the St. Croix Watershed Research Station, and Senior Scientist Dr. Mark Edlund, who oversees the CHARM (Center for Harmful Algal Research in Minnesota) Laboratory, established at the Research Station with previous ENRTF funding. Additionally, this project would collaborate with other on-going and proposed HABs research being carried out by Dr. Andy Bramburger at the University of Minnesota Duluth and Natural Resources Research Institute.

B. Project Impact and Long-Term Strategy

This project will provide the first baseline data on the distribution of the toxin-producing aquatic invasive species *Cylindro* through space and time. The St. Croix Watershed Research Station is currently collaborating with other research groups in Minnesota on HABs, including the St. Anthony Falls Hydraulics Laboratory, University of Minnesota Extension, and the Natural Resources Research Institute. We will continue that effort so that data collected for this and other ongoing projects will be shared collectively (including standardized protocols and inter-laboratory quality control) to provide the best possible scientific product for the people of Minnesota.

C. Timeline Requirements

The project will require three years to complete, including one summer field season (2018) and one winter field season (2019) to collect sediment cores. The remainder of the time will be spent on the laboratory components of algal identification and sediment core processing. Results will be summarized in a final report to be submitted to LCCMR by June 30, 2021.

2018 Detailed Project Budget

Project Title: Determining Minnesota's risk of a toxic algal invader

IV. TOTAL ENRTF REQUEST BUDGET 3 years

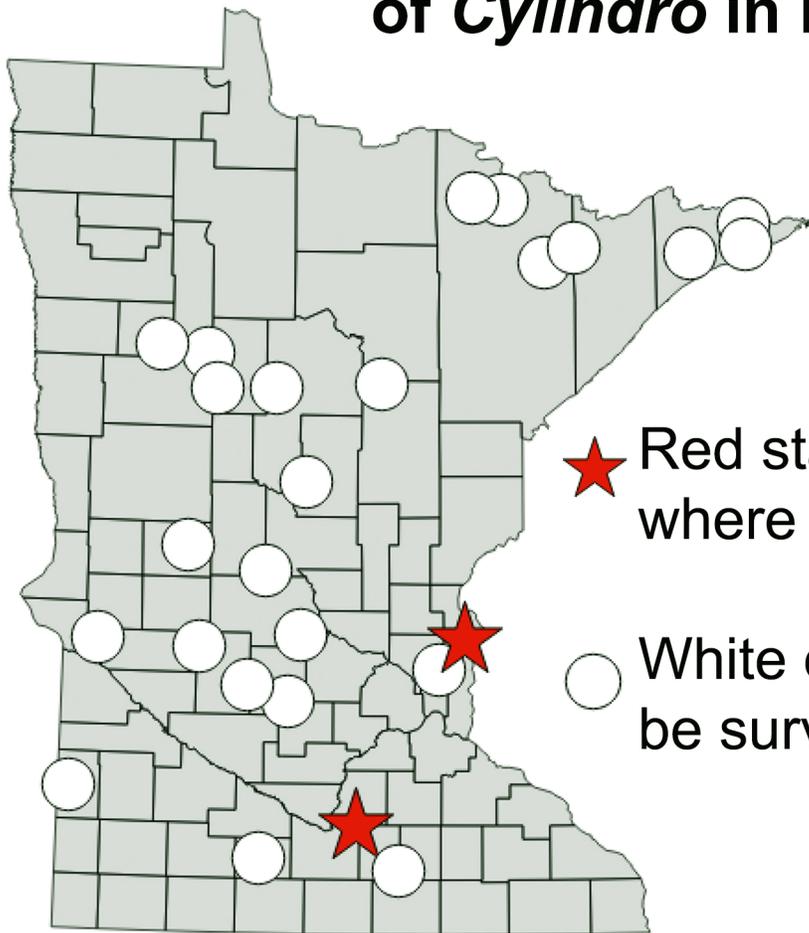
| BUDGET ITEM | AMOUNT |
|--|-------------------|
| Personnel: | \$ 143,141 |
| Heathcote, Associate Scientist: Phyto & Cylindro toxins; 33% FTE for 2 yrs; Salary=71%, Benefits=29% (\$56,300 over 2 years); this is a grant-funded position | |
| Edlund, Senior Scientist: Phyto & Cylindro toxins; 33% FTE for 2 yrs; Salary=71%, Benefits=29% (\$64,600 over 2 years); this is a grant-funded position | |
| Field and Laboratory Technician: Field work and lab analyses; 25% FTE for 2 yr; Salary=71%, Benefits=29% (\$22,241 over 2 years); this is a temporary position | |
| Professional/Technical/Service Contracts: | \$ 1,200 |
| Production of full-length article on project by Greg Seitz (subcontractor) (\$1,200) | |
| Equipment/Tools/Supplies: | \$ 33,900 |
| Field and laboratory supplies: including bottles, reagents, calibration solutions, core tubes, sample cups (\$2,700) | |
| Cyanotoxin ELISA kits: Cylindrospermopsin (26 @ \$600 = \$15,600) Microcystin (26 @ \$600 = \$15,600) | |
| Travel: | \$ 11,735 |
| Field travel to 24 lakes for monitoring Hotel: 2 persons for 10 nights @ \$76.50 = \$1,530 Per diem: 2 persons for 10 days @ \$51 = \$1,020 Mileage & gas: 4,000 miles @ \$0.67 = \$2,680 | |
| Field travel to 24 lakes for monitoring Hotel: 2 persons for 15 nights @ \$76.50 = \$2,295 Per diem: 2 persons for 15 days @ \$51 = \$1,530 Mileage & gas: 4,000 miles @ \$0.67 = \$2,680 | |
| Additional Budget Items: | \$ 53,024 |
| Lab analysis of water samples: TN/TP: 24 @ \$36 DIN/SRP: 24 @ \$36 DOC: 24 @ \$20 DIC: 24 @ \$15 CYN toxin: 24 @ \$50 MC-LR toxin: 24 @ \$44 Lab analysis of sediment samples: 210-Pb (dating): 14 @ \$2,500 loss-on-ignition: 14 @ \$800 (\$11,200) QA/QC of ELISA cylindrospermopsin sediment samples via HPLC (inter-lab comparison via University of Minnesota or competitive bid) (\$2,000) | |
| TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST = | \$ 243,000 |

V. OTHER FUNDS

| SOURCE OF FUNDS | AMOUNT | Status |
|--|------------|---------|
| Other Non-State \$ To Be Applied To Project During Project Period: | N/A | N/A |
| Other State \$ To Be Applied To Project During Project Period: | \$ - | |
| In-kind Services To Be Applied To Project During Project Period: | | |
| Indirect costs at 40.83% waived by the Science Museum of Minnesota | \$ 99,597 | Secured |
| Past and Current ENRTF Appropriation: | | |
| M.L. 2016-186-2-04a: Tracking and Preventing Harmful Algal Blooms | \$ 500,000 | |
| M.L. 2015-76-2-10 "Tracking and Preventing Harmful Algal Blooms" | \$ 93,000 | |
| M.L. 2014-226-2-3g: Watershed-Scale Monitoring of Long-Term Best-Management Practice Effectiveness | \$ 900,000 | |
| Remaining \$ From Current ENRTF Appropriation | | |
| \$380,000 remaining from M.L. 2016-186-2-04a "Tracking and Preventing Harmful Algal Blooms" | \$ 380,000 | Unspent |
| Other Funding History: | | |

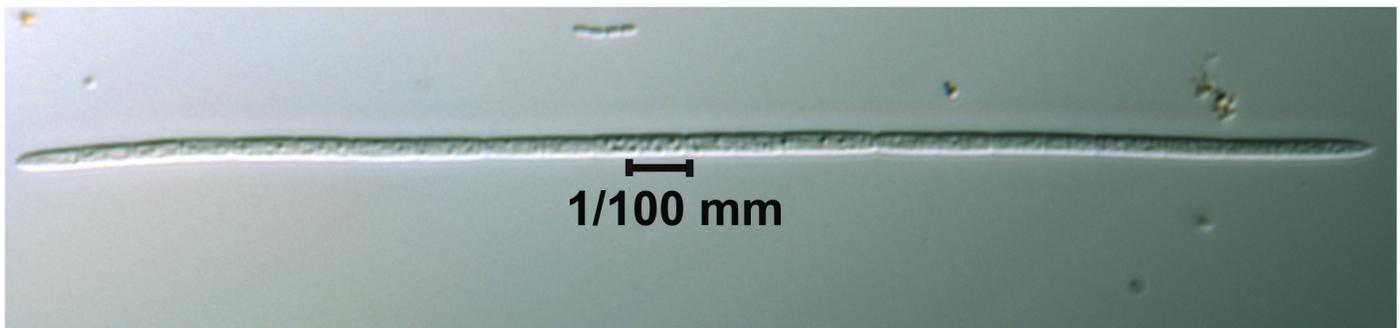
Cylindro: Minnesota's microscopic lake invader

What is the range, abundance, and toxicity of *Cylindro* in Minnesota?



★ Red stars show lakes where *Cylindro* has been found

○ White dots show other lakes to be surveyed in this study



Cylindro (pictured above) may not look like much, but it produces 4 distinct toxins that are harmful to humans and animals



Environment and Natural Resources Trust Fund (ENRTF)

2018 Main Proposal

Project Title: Determining Minnesota's risk of a toxic algal invader - *Cylindrospermopsis*

Project Manager Qualifications

Adam J. Heathcote

1. **Education**

- B.Sc. 2005 Iowa State University, Ames, IA, USA (Animal Ecology)
Ph.D. 2013 Iowa State University, Ames, IA, USA (Ecology and Evolutionary Biology)

2. **Positions**

- 2016-Present Associate Scientist, St. Croix Watershed Research Station
2015-2016 Assistant Scientist, St. Croix Watershed Research Station
2013-2014 Postdoctoral Fellow, Université du Québec à Montreal

3. **Research Expertise**

My research involves assessing how anthropogenic drivers influences the rate of eutrophication in lakes and the coinciding impact on ecosystem function (i.e., nutrient cycling, energy transfer, community structure). I also study the effects of biodiversity on ecosystem functioning between trophic levels in plankton communities, specifically the role Cyanobacteria play in disrupting aquatic food webs. Because these issues are multi-dimensional problems, I focus on the use multivariate statistical techniques to disentangle relationships between complex ecological data and environmental gradients

4. **Recent Publications (previous 2 years)**

- Cael BB, Heathcote AJ, Seekell DA. 2017. The volume and mean depth of Earth's lakes. *Geophys. Res. Lett.* 44 (1): 209-218.
Heathcote AJ, et al. 2016. Biomass pyramids in lake plankton: influence of Cyanobacteria size and abundance. *Inland Waters* 6 (2): 250-257.
Filstrup CT, Heathcote AJ, Kendall DL, and Downing JA. 2016. Phytoplankton taxonomic compositional shifts across nutrient and light gradients in temperate lakes. *Inland Waters* 6 (2): 234-249.
Heathcote AJ, et al. 2015. Large increases in carbon burial in northern lakes during the Anthropocene. *Nature Communications* 6: 10016.
Heathcote AJ, et al. 2015. Predicting bathymetric features of lakes from the topography of their surrounding landscape. *Can. J of Fish. and Aquat. Sci.* 72 (5): 643-650.

5. **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. Its mission is to invite learners of all ages to experience their changing world through science. The St. Croix Watershed Research Station the environmental research center of the SMM with the mission to foster, through research and outreach, "a better understanding of the ecological systems of the St. Croix River basin and watersheds worldwide." 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.