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

Project Title: **ENRTF ID: 096-B**

Creating a Algal Toxin Alert Network for Central and Upper Minnesota

Category: B. Water Resources

Total Project Budget: $ 154,630

Proposed Project Time Period for the Funding Requested: 2 years, July 2018 to June 2020

Summary:

The goal of this project is to create a rapid algal toxin detection network for portions of northern and central Minnesota, with the potential for low cost statewide expansion.

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Location

Region: Central, Northeast

County Name: Benton, Koochiching, Sherburne, St. Louis, Stearns

City / Township:

Alternate Text for Visual:

Figure 1. Modified from Heiskary, Lindon, and Anderson 2014. Map of 2012 microcystin concentrations. Based on pelagic (index) samples. Black boxes represent regions covered in this proposal. Northern laboratories where sampling is not common and central laboratory where hotspot lakes are frequent.

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

PROJECT TITLE: Creating a Algal Toxin Alert Network for Central and Upper Minnesota

I. PROJECT STATEMENT

The goal of this project is to create a rapid algal toxin detection network for portions of northern and central Minnesota, with the potential for low cost statewide expansion. Minnesota's freshwater systems are a vital resource for recreation, domestic use and consumption. The largest algal toxin threat in freshwater systems comes from blue-green alga (cyanobacteria) blooms (Carmichael 2001). Most documented cases of cyanotoxin-induced human illness were contracted through swallowing or aspirating the toxin (Chorus et al. 2000). Monitoring is one method implemented to reduce this risk of human illness (Carmichael 2001). However, monitoring programs to inform freshwater users of cyanotoxin risks contain inherent weaknesses, including the transportation and analysis time lag and the unpredictable nature of cyanobacteria and toxin production that create gaps in the overall effectiveness of the methods for rural areas. Cyanobacteria blooms and toxin production can flourish and disappear rapidly, in as little as seven days or less (Ouahid et al. 2005). Rural areas, where it is necessary to ship samples to a laboratory to detect cyanobacteria and cyanotoxin potential, run the risk of inaccurate risk assessment. Receiving results from a laboratory may take days to weeks. In this time a cyanobacteria bloom may thrive, die out, and bloom again. In these cases the time lag and nature of cyanobacteria generates inaccuracies in assessing human health risk when the water system in question is used on a daily basis.

We will reduce these risks by exploiting expertise within an existing networked organization (select Minnesota State schools) and by taking advantage of new low cost technologies for algal toxin detection. The new technology will allow detection of toxins within minutes of sample submission. All submitted samples will be enumerated to document algal community structure and molecular profiles will be archived. This will allow data base creation targeted at detailing long-term trends and toxin production patterns. Provide information and programming focused on toxin mitigation and removal in rural settings.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Establish Rapid Toxin Detection Centers **Budget: $ 30,000**

Three regional centers will be initially established in St. Cloud (St. Cloud State University), Ely (Vermillion Community College), and International Falls (Rainey River Community College). Each partner is in a region where toxic algal blooms are becoming more common and has an existing active water quality laboratory on site. All partners also have a close relationship with local and regional groups (DNR, MPCA, and municipal water treatment plants), lake associations, and federal agencies (US Park Service and US Forestry Service). These relationships will facilitate public awareness and direct clients to the laboratories. Toxin detection services will be done on the day of sample delivery with report returned to client within 12 hrs of sample submission. A small ($25) fee will be collected to discourage abuse of the service. This fee represents 1/3 of the actual cost. Funds will be used to support the program through additional acquisition of supplies.

Outcome	Completion Date
1. Equip laboratories and train personnel in regional centers (Julius and Stepanek)	01-AUG-2018
2. Notify State, Federal, and lake associations that service is now available (All)	01-AUG-2018
3. Quantify at least 25 "at risk" Water Samples (All)	01-NOV-2018
4. Target potential new regional centers (All)	01-MAR-2019
5. Identify sample analysis price point to allow program sustainability beyond 2019 (Julius, Tedrow, Sjerven)	06-JUN-2019

Activity 2: Establish Central Laboratory for Community Composition and Molecular Archival and Analysis **Budget: $ 123,130**

Despite considerable prior research, specific causes and prediction of toxic algal blooms remains unclear. We hope to assist in understanding these patterns by centralizing and enhancing data collected in this project. St. Cloud State has a well-established algal biology laboratory with culturing, microscopy, and molecular characterization infrastructure. An automated counting system (Flowcam) is requested to enhance the laboratory capabilities and funding for a graduate student is requested to assist in activities is requested. All samples submitted to the regional centers will be enumerated with the new Flowcam system and have DNA extracted and archived via the existing laboratory infrastructure. Enumeration and extraction will occur within 24 hours of sample receipt. These data will be maintained and analyzed over the next decades to assisting in predicting and understand toxic bloom dynamics.

Outcome	Completion Date
1. Install Flowcam and establish sample screening protocols (Julius, Stepanek, Fink)	01-AUG-2018
2. Quantify at Risk Samples (>75 samples) ((Julius, Stepanek, Student)	01-NOV-2018
3. Analyze Seasonal Patterns (2018) (Julius, Stepanek, Fink)	01-JAN-2019
4. Analyze Seasonal Patterns (2019) (Julius, Stepanek, Fink)	01-JAN-2020

Activity 3: Provide programming focused on toxin mitigation in rural settings. **Budget: $ 1,500**

Detection is not enough. Once an individual finds that water is unsafe, information must be provided concerning how to deal with the problem. St. Cloud State has completed prior research in conjunction with Voyageur's National Park concerning this subject (Lindgren, 2008 *Thesis*). This information will be summarized in pamphlet form and workshops will be held regionally explaining how to construct toxin filtering systems.

Outcome	Completion Date
1. Create and disseminate toxin pamphlets	01-NOV-2018
2. Conduct workshop at least once in each regional area	01-JAN-2019

III. PROJECT STRATEGY

- Matt Julius, Professor, Biology, St. Cloud State University (SCSU), St. Cloud, MN, PI: Algal Ecology, Evolution, and Identification.
- Joshua Stepanek, Assistant Prof., Biology, SCSU, St. Cloud, MN, Collaborator: Applied Algal Biomass Production.
- Ryan Fink, Assistant Prof., Biology, SCSU, St. Cloud, MN, Collaborator: Public health microbiology
- O'Neil Tedrow, Environmental Scientists Vermillion Technical and Community College, Ely, MN, Collaborator: Regional Water Quality Expert
- Kelly Sjerven Environmental Scientists, Rainey River Community and Technical College, International Falls, MN, Collaborator: Regional Water Quality Expert.

B. Project Impact and Long-Term Strategy

The toxin detection network created by this project will be coordinated by Julius at St. Cloud. The costs of adding additional detection laboratories is minimal ($10,000 equipment plus supplies for detection). Overtime the project should expand to a statewide basis. Cost per sample is minimal ($75 for a complete toxin assessment). A fee based service will be developed allowing addition of new partners and minimizing future state support. This expansion will allow the data base to expand strengthening the ability to predict and potentially prevent future toxic algal blooms.

C. Timeline Requirements

The proposed project will be completed over a two-year timeline.

2018 Detailed Project Budget

Project Title: *Creating a Algal Toxin Alert Network for Central and Upper Minnesota*

IV. TOTAL ENRTF REQUEST BUDGET 2 years

BUDGET ITEM	AMOUNT
Personel	
Salary for a graduate student over the two year grant period. Student will assist in sample coordiantion between laboratories and manage database at St. Cloud. The will work under the direct supervison of Julius at St. Cloud	$ 20,000
Professional/Technical/Service Contracts: *None*	$ -
Equipment/Tools/Supplies:	
3 Handheld Toxin Strip Readers for Quantifying Algal Toxin Assay Strips. One system for each partner instituions ($2,500 each)	$ 7,500
300 Test Strips for Algal Toxin 1 (Microcystin). 100 strips for each lab ($2,500 each)	$ 7,500
300 Test Strips for Algal Toxin 2 (Cylindrospermopsin). 100 strips for each lab ($2,500 each)	$ 7,500
300 Test Strips for Algal Toxin 3 (Anatoxin-a). 100 strips for each lab ($2,500 each)	$ 7,500
FlowCam Digital Algal Quantification System with Cyanobacteria Detection System	$ 103,130
Travel	
Five workshops at non-St Cloud Laboratories @ $300 per workshop. St. Cloud workshops at no cost.	$ 1,500
Additional Budget Items: *None*	$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 154,630

V. OTHER FUNDS

SOURCE OF FUNDS	
Other Non-State $ To Be Applied To Project During Project Period: N/A	$ -
Other State $ To Be Applied To Project During Project Period: N/A	$ -
In-kind Services To Be Applied To Project During Project Period: Molecular quantification and archiving of genetic informaion for use in regionwide analysis in years one and two.	$ 20,000
Past and Current ENRTF Appropriation: N/A	$ -
Other Funding History: N/A	$ -

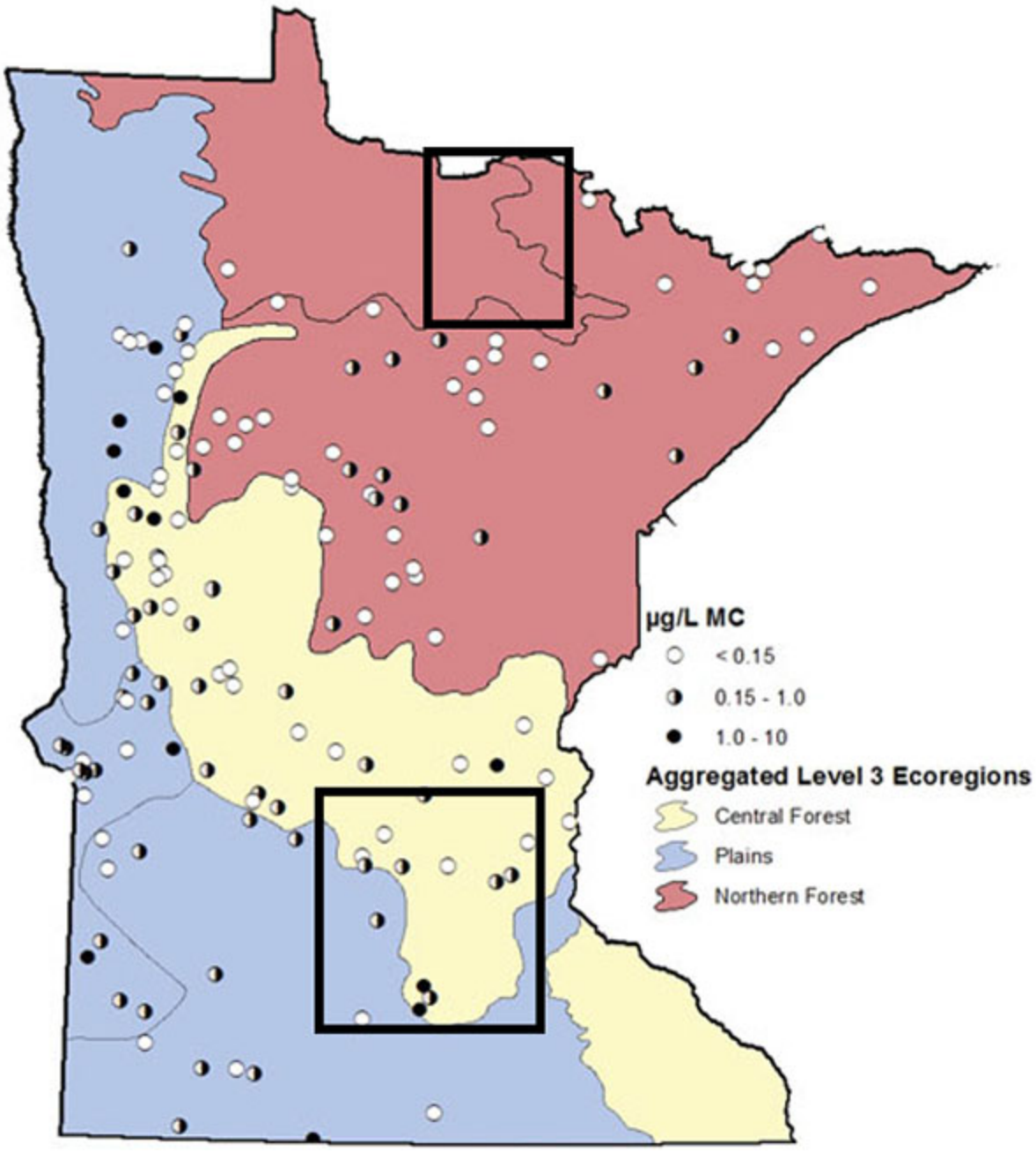

Figure 1. Modified from Heiskary, Lindon, and Anderson 2014. Map of 2012 microcystin concentrations. Based on pelagic (index) samples. Black boxes represent regions covered in this proposal. Northern laboratories where sampling is not common and central laboratory where hotspot lakes are frequent.

Matt Julius Project Manager

Dr. Matt Julius received his Ph.D. from the University of Michigan in 2000. After leaving Michigan in 2000 he accepted a professorship at St. Cloud State University in central Minnesota, U.S.A. He was promoted to associate professor in 2005 and full professor in 2008. His primary research interests involve the classification and biology of diatoms (a group of microscopic algae), with focus on cladistic analysis utilizing morphology of fossil and extant species. While these studies continue to be his focus of choice, he maintains an active research presence in aquatic toxicology and functional morphological analysis. He has authored and co-authored several papers with manuscripts appearing in many phycology focused publications along with non-algae based journals including *Aquatic Toxicology* and the *Journal of Zoology.* He was/is also an associate editor for *Phycological Research* and an associate editor for *Diatom Monographs.* Julius is keenly interested in applying his work with cladistics, evolution, and diatoms to those interested within and outside of the diatom community. In 2013 he served as a Japanese Society for the Promotion of Science Visiting Fellow and in 2015 he was a World Academy of Sciences Visiting Expert in Nigeria. He has developed cladisitic exercises for the undergraduate classroom and is an active participant with the SimRiver water education project (http://www.u-gakugei.ac.jp/~diatom/en/index.html). His long-term research goals are largely focused on his biological knowledge to identify useful algae for applied applications.

Organizational Description

Three partnering institutions are working together lead by the Phytoplankton laboratory at St. Cloud State University. The phytoplankton laboratory consists of four sub-laboratory components. 1) The *Phytolab* which is dedicated to the visualization and identification of algal species. 2) The *Biomass Laboratory* which is dedicated to the production of useful algal biomass for applied nanomaterial research. 3) The *Anaerobic Digestion Facility* which actively converts campus biomass was to electricity. 4) The *Molecular and Biochemical Characterization Laboratory* which uses molecular tools to characterize species and extracts biological components for various research projects. The facility represents one of the most comprehensive algal laboratories in North America. It is well suited to lead and develop the detection network proposed here.