



Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-372

Proposal Title: Providing Critical Water Quality Information: Harmful Algal Blooms

Project Manager Information

Name: Pamela Anderson

Organization: Minnesota Pollution Control Agency

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Project Basic Information

Project Summary: Provide for Minnesota's lake users, near real-time Harmful Algal Bloom risk warnings on lakes to reduce the occurrence of human and pet illness or death from toxic algae.

Funds Requested: \$657,000

Proposed Project Completion: 2024-06-30

LCCMR Funding Category: Foundational Natural Resource Data and Information (A)

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Harmful Algal Blooms (HABs), which produce potent toxins that can make people and pets sick or die, are increasing throughout Minnesota and are now found in lakes where they have never occurred before. Increased nutrient loads from land use intensification and warming temperatures from climate change are the most likely causes of increased HAB toxicity. The best way to keep people and pets safe is to make people aware when and where HABs are likely to occur on their favorite lakes, so they can make informed choices regarding recreation. Minnesota has over 4,000 lakes that are publicly accessible for fishing and recreation, which makes this a difficult task. Currently, the Minnesota Pollution Control Agency (MPCA) and other agencies receive numerous calls each year related to HABs. There is a clear expectation from the public that the state can forecast or predict when HABs will occur, and they plan to use this data to inform their recreational activities. Additionally, some of these lakes are sources of drinking water for municipalities. Minnesota needs the data to accurately quantify risk of toxic HABs across the entire state, and an online system to get that information into the peoples' hands.

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.

This project will use state-of-the-art remote sensing techniques and water temperature modeling informed by lake sampling to predict the risk of HABs for 4,000+ Minnesota lakes. Models will use remotely sensed water quality data (water clarity, chlorophyll, phycocyanin, color) and modeled lake temperature to calculate HAB risk (likelihood of occurrence) in near real-time for each lake.

We will leverage: the MPCA and other existing monitoring programs to collect lake water samples to characterize cyanobacteria abundance, composition, and toxin concentrations to identify lake conditions that lead to toxin production; an automated water quality monitoring system developed in LCCMR project (ML2018 Ch 214 Art4 Sec2 Subd 03b E8181LM) that provides historic and current water quality data; and lake temperature models developed by the US Geological Survey for 4000+ Minnesota lakes which will be automatically updated with recent weather data.

Using these data sources, the likelihood of HABs occurring will be calculated daily for each lake and displayed on the LakeBrowser <https://lakes.rs.umn.edu/>, which is connected to the DNR LakeFinder <https://www.dnr.state.mn.us/lakefind/index.html>, to warn users of potential risks for each lake. Annual summaries will be added to the Minnesota Natural Resources Atlas.

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?

LakeBrowser, an online interactive map for exploring Minnesota lake water quality data, will be frequently updated with new water quality data and HAB probability information. To assist with natural resources planning, annual summaries will also be displayed on the Minnesota Natural Resources Atlas to help agencies place HAB risk into broader management contexts. This vital information is needed to keep people and pets safe from toxic HABs and to make more informed choices about recreational activities, while giving agencies the necessary statewide data to address public concerns about HABs and to develop proactive management strategies to mitigate them.

Activities and Milestones

Activity 1: Water quality sampling and analyses to measure factors that predict HAB risk to update HAB probability models.

Activity Budget: \$280,553

Activity Description:

We will collect water samples monthly during May through September from 200 lakes total during Years 1 and 2 to measure HAB abundance (phycocyanin pigment) and composition (microscope analyses) and toxin concentrations (microcystin, anatoxin-(a)). In addition to variables measured during routine lake monitoring by MPCA (phosphorus, chlorophyll a, water clarity), we will also analyze lake color and dissolved organic carbon (DOC) due to their influences on underwater light climate and HABs. Sampling events that coincide with cloud-free satellite passes will be prioritized for analyses (see Activity 2). Using the water quality and temperature measurements we will determine the factors that contribute to toxic HABs in lakes. The identified factors will then be used to develop a model that can predict HAB risk.

Activity Milestones:

Description	Completion Date
Collect and analyze water quality samples from 100 lakes in Year 1 (500 total samples)	2022-03-31
Collect and analyze water quality samples from 100 lakes in Year 2 (500 total samples)	2023-03-31
Statistical analyses to identify conditions responsible for toxic harmful algal blooms	2023-12-31

Activity 2: Enhance automated water quality monitoring system with indicators of HABs and near real-time modeled lake temperature for 4000+ lakes.

Activity Budget: \$316,447

Activity Description:

We will add phycocyanin (pigment indicating HAB abundance) and modeled lake temperature to the UMN supercomputer automated water quality monitoring system. Because satellite overpasses may not coincide with clear sky conditions (cloud obscured), we can fill in these time gaps to identify HAB-prone lakes using historic and the most recently available satellite derived water quality data. These characteristics along with lake temperature can be used to determine the probability of HABs using the criteria determined in Activity 1. The USGS has created lake temperature models for 4000+ lakes in Minnesota using historic weather data. We would run those models on UMN supercomputers and link them to weather data from the National Weather Service to predict lake temperature for 4000+ lakes in near real-time. New satellites collect data that can be used to measure the phycocyanin and temperature. Combination of the remotely sensed water quality and temperature data with the modeled lake temperature will allow us to apply the criteria determined in Activity 1 to calculate HAB risk for 4000+ lakes on a daily basis.

Activity Milestones:

Description	Completion Date
Analysis of field and satellite data to develop predictive relationships to permit monitoring of phycocyanin	2022-06-30
System to automatically model lake temperature for 4000+ lakes informed by real-time weather data	2023-06-30
Method to calculate HAB probability daily for 4000+ lakes	2024-03-31

Activity 3: Adapt LakeBrowser with HAB risk capability to help protect people from toxins

Activity Budget: \$60,000

Activity Description:

The online HAB risk tool will be freely available to Minnesotans through the popular UMN LakeBrowser (www.lakes.rs.umn.edu) and through its connection to the Minnesota Department of Natural Resources Lake Finder (<https://www.dnr.state.mn.us/lakefind/index.html>). Underlying computer code will be updated to include HAB risk maps and to provide near real-time information through automated updates based on the most current satellite imagery and weather data. Additionally, annual summaries displayed on the Minnesota Natural Resources Atlas will help state and regional agencies visualize HAB risk in relation to community demographics, built infrastructure, and recreational resources, thereby helping inform decision-making regarding natural resources management and planning. We will work with end users to improve data visualization and the user interface.

Activity Milestones:

Description	Completion Date
Add summarized harmful algal bloom to Minnesota Natural Resource Atlas	2024-06-30
Create flagging system to highlight with high harmful algal bloom risk	2024-06-30
System to update LakeBrowser with daily harmful algal bloom risk predictions	2024-06-30

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Leif Olmanson	Department of Forest Resources, University of Minnesota	Olmanson will lead the remote sensing and temperature modeling and oversee modifications to the LakeBrowser.	Yes
Dr. Samantha Oliver	Upper Midwest Water Science Center, United States Geological Survey	Oliver will provide guidance in implementing the lake water temperature models on UMN supercomputers.	No
Tracy Lund	Minnesota Department of Health	Lund will provide guidance on user interface for the LakeBrowser and how data can be utilized for drinking water protection.	No
Marty Rye, P.E.	Superior National Forest, United States Forest Service	Rye will help with collection of additional water samples for this project from Superior National Forest Lakes, and will share concurrent water quality monitoring data collected during routine USFS monitoring.	No
Dr. David Porter	Minnesota Supercomputer Institute, University of Minnesota	Porter will implement the new satellite water quality and temperature model to the existing water quality monitoring system. Will implement USGS lake temperature models with current weather data.	Yes
Dr. Christopher Filstrup	Natural Resources Research Institute	Filstrup will lead efforts to characterize algae and cyanobacteria composition in lakes, including microscopic quantification of species and total cyanobacteria amount (phycocyanin), as well as dissolved organic carbon (DOC) analyses. He will lead statistical analyses to identify drivers of cyanobacteria toxicity in Minnesota lakes.	Yes

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?

Our project creates a cost-effective, statewide method for mapping risk of toxic HABs in lakes to help reduce exposure of people and pets to cyanobacteria toxins. Semi-automated computer code will routinely acquire the latest satellite imagery and weather data to quantify HAB risk at minimal cost to project partners. Information will be freely available to all through the popular UMN LakeBrowser, which can be maintained into the future. Additionally, cyanobacteria-related water quality analyses can be targeted to high risk lakes in the future through the MPCA Lake Monitoring Program at minimal cost.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Forest and Bioeconomy Research	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 03q	\$2,200,000
Providing Critical Water-Quality Information for Lake Management	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 03b	\$250,000

Assessment of Surface Water Quality With Satellite Sensors	M.L. 2016, Chp. 186, Sec. 2, Subd. 04i	\$345,000
Minerals and Water Research	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 03r	\$883,000

Project Manager and Organization Qualifications

Project Manager Name: Pamela Anderson

Job Title: Manager

Provide description of the project manager’s qualifications to manage the proposed project.

Pam will oversee the overall management of the project and has had experience managing several LCCMR projects during her tenure at MPCA. She has over 16 years of experience working directly with citizens, river and lake water quality and assessments, and harmful algal blooms. She has responded to hundreds of calls during her tenure from concerned citizens looking for answers on where they can recreate or take their pets without exposure to harmful algal blooms. She has responded to dog deaths, and worked collaboratively with the Minnesota Department of Health to help determine environmental causes of the deaths and worked to prioritize monitoring and assessment of those waters. Pam has managed several projects with the University of Minnesota during that tenure, including the initial work to collect data to calibrate the satellite imagery to develop the initial LakeBrowser. This work included managing budgets, meeting LCCMR reporting requirements, and project oversight. She is well versed in budget oversight and reporting, having developed and managed unit and program budgets for the past 7 years.

Organization: Minnesota Pollution Control Agency

Organization Description:

The Minnesota Pollution Control Agency (MPCA) mission is to protect and improve the environment and human health. The MPCA monitors environmental quality, offers technical and financial assistance, and enforces environmental regulations. The agency finds and cleans up spills or leaks that can affect our health and environment. Staff develop statewide policy, and support environmental education.

Specifically related to this project, the MPCA operates statewide lake and stream water quality monitoring programs. Historically, MPCA has partnered with the University of Minnesota to utilize agency collected water quality data to calibrate remote sensed imagery to show clarity on lakes across Minnesota. MPCA also maintains, in partnership with the Minnesota Department of Health, web pages devoted to harmful algal blooms to help inform the public of ways to reduce exposure and risk, operates phone and email reporting of blooms, human illness, and animal illness and/or death, and coordinates an interagency team devoted to coordinating work and efforts surrounding harmful algal blooms.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Student workers, Minnesota Pollution Control Agency		field staff to assist agency staff with water monitoring			7%	0.46		\$18,000
Christopher Filstrup, UMD NRRI		Researcher			26.7%	0.45		\$48,060
Elaine Ruzycki, UMD NRRI		Lab analysis			26.7%	0.27		\$19,689
Beth Bernhardt, UMD NRRI		Lab analysis			24.1%	0.27		\$20,266
Leif Olmanson, UMN		Researcher			26.7%	1.2		\$114,534
David Porter, UMN		Consultant			26.7%	0.6		\$100,283
Peter Wiringa, UMN		Geospatial Analyst			26.7%	0.3		\$31,101
Research Fellow TBD, UMN		Remote sensing coding, database development and Lake Browser coding			26.7%	1.5		\$115,529
							Sub Total	\$467,462
Contracts and Services								
University of Minnesota Remote Sensing Laboratory	Internal services or fees (uncommon)	Access to remote sensing/GIS software and computers for model development at the University of Minnesota.				-		\$3,000
University of Minnesota Supercomputing Institute	Internal services or fees (uncommon)	Access to supercomputer servers to process and store data.				-		\$9,000
Minnesota Department of Health	Professional or Technical	Lab analysis for 1000 water quality samples and 400 algal toxin samples from 200 lakes. The results will calibrate the satellite imagery.				-		\$157,000

	Service Contract	Minnesota Pollution Control Agency is doing the sampling; they use the Minnesota Department of Health to analyze samples through an interagency agreement.						
							Sub Total	\$169,000
	Equipment, Tools, and Supplies							
	Tools and Supplies	400 bottles, slides, and associated vials of preservative, UMD NRRI	This is necessary to collect, properly preserve and to view the algal samples for composition analysis.					\$1,000
	Tools and Supplies	1000 sets of bottles, filters, syringes, necessary reagents, UMD NRRI	Supplies for dissolved organic carbon and phycocyanin analysis					\$10,000
							Sub Total	\$11,000
	Capital Expenditures							
							Sub Total	-
	Acquisitions and Stewardship							
							Sub Total	-
	Travel In Minnesota							
	Miles/ Meals/ Lodging	Meals for student workers (70 dialy per diems over 2 field seasons), MPCA	Student workers will accompany agency staff to collect water quality samples. This will include funds to cover their meals.					\$2,538
	Conference Registration Miles/ Meals/ Lodging	1 conference (in state) per year, UMN/UMD	Present results of LCCMR funded work.					\$2,100
	Miles/ Meals/ Lodging	Mileage for field work, UMN/UMD	Field work to perform in situ spectroradiometer measurements with water quality samples for model development					\$900
							Sub Total	\$5,538

Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
		Shipping of samples from MPCA to NRRI; 20 weekly shipments for 5 months in years 1 and 2, estimated at \$100 per shipment	MPCA is collecting the water quality samples based out of St. Paul. NRRI is conducting the DOC and algal composition work out of its Duluth lab. MPCA will need to ship samples to Duluth for analysis.					\$4,000
							Sub Total	\$4,000
							Grand Total	\$657,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	-
Non-State				
			Non State Sub Total	-
			Funds Total	-

Attachments

Required Attachments

Visual Component

File: [2831cee8-48b.pdf](#)

Alternate Text for Visual Component

Visual contains images of harmful algal blooms on Minnesota lakes. Includes example image of a statewide map of harmful algal bloom risk, with categories ranging from no risk to danger. Depicts lake user looking this information up online to make decisions about where to recreate.

Optional Attachments

Support Letter or Other

Title	File
Minnesota Department of Health Support Letter	40399921-112.pdf
United States Geological Survey Support Letter	1fae93e9-98d.pdf
United States Forest Service Support Letter	6c9243c5-0cf.pdf
Metropolitan Council Environmental Services Support Letter	a2c68fa5-5d2.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

Does your project include research?

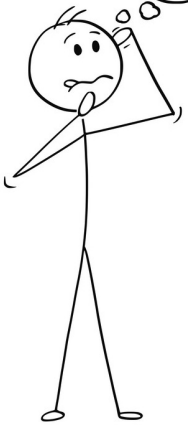
Yes

Does the organization have a fiscal agent for this project?

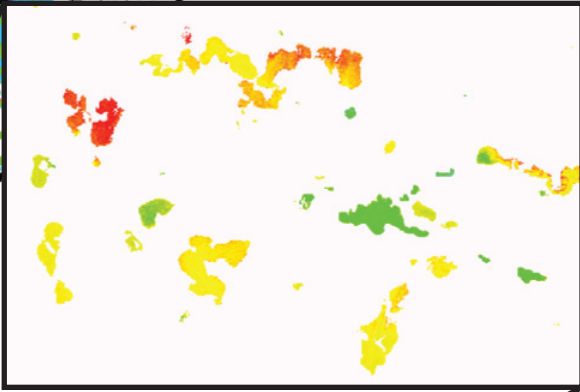
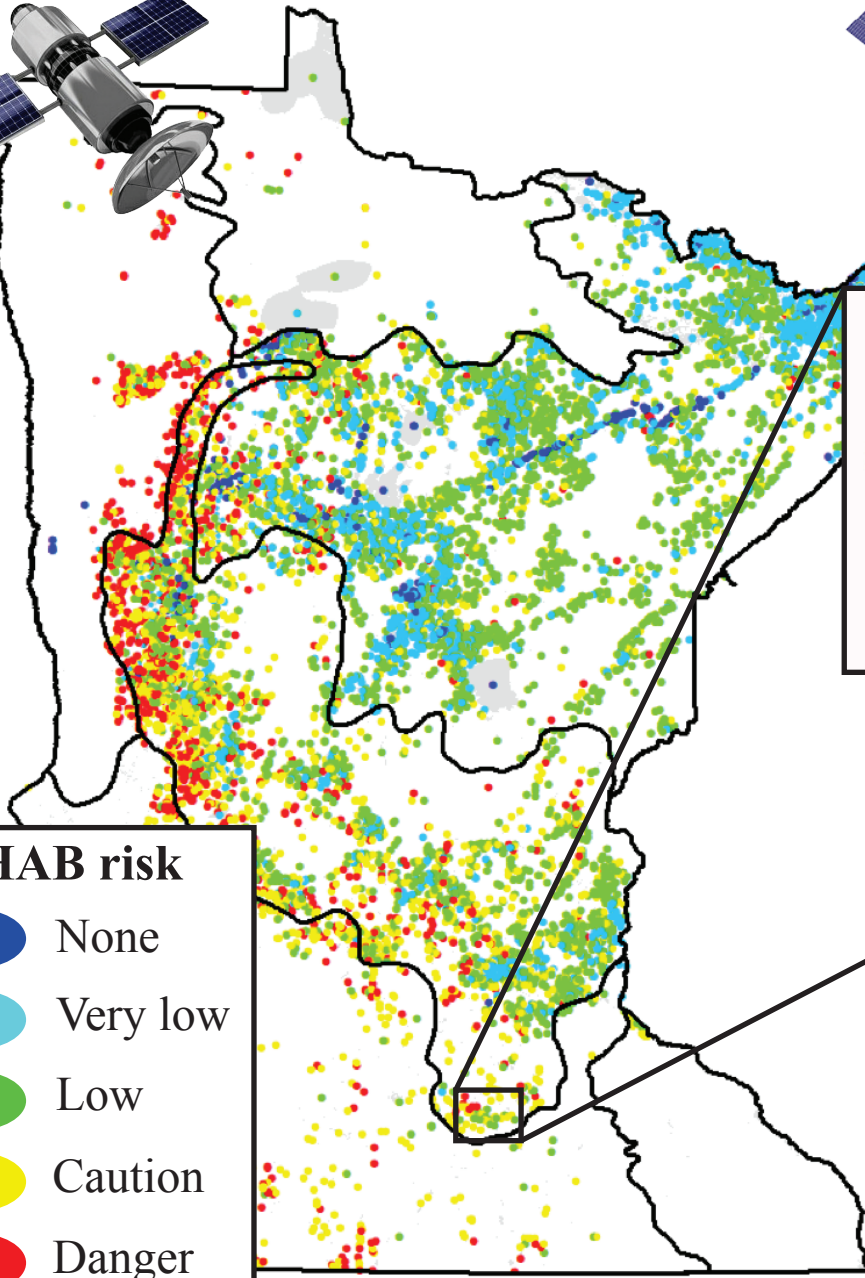
No

Providing Critical Water Quality Information: Harmful Algal Blooms

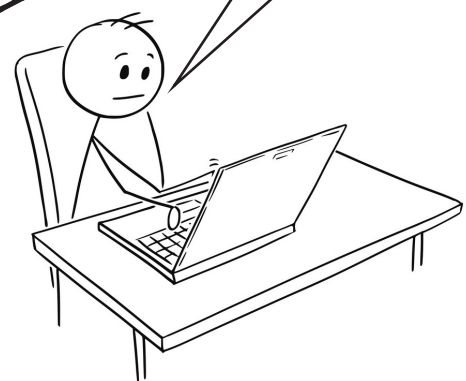
Is it OK to swim today?



Too bad someone can't track these HABs from space. Oh, they can? What are they waiting for!



I'm so glad they added HAB risk to the MN LakeBrowser website! What a great idea!



HAB risk

- None
- Very low
- Low
- Caution
- Danger

