

**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 qualiyt 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 LakeBrower 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. Ineli gible** | **% Bene fits** | **# FTE** | **Class ified 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** |  |  |  |  |  |  |  |  |
| Univerity 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 Service Contract | Lab analysis for 1000 water quality samples and 400 algal toxin samples from 200 lakes. The results will calibrate the satellite imagery. Minnesota Pollution Control Agency is doing the sampling; they use the Minnesota Department of Health to analyze samples through an interagency agreement. |  |  |  | - |  | $157,000 |
|  |  |  |  |  |  |  | **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** |

### **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](https://lccmrprojectmgmt.leg.mn/media/map/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](https://lccmrprojectmgmt.leg.mn/media/attachments/40399921-112.pdf) |
| United States Geological Survey Support Letter | [1fae93e9-98d.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/1fae93e9-98d.pdf) |
| United States Forest Service Support Letter | [6c9243c5-0cf.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/6c9243c5-0cf.pdf) |
| Metropolitan Council Environmental Services Support Letter | [a2c68fa5-5d2.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/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