

**Environment and Natural Resources Trust Fund**

# 2022 Request for Proposal

## **General Information**

**Proposal ID:** 2022-102

**Proposal Title:** Public portal for algae blooms in lakes

## **Project Manager Information**

**Name:** Pamela Anderson

**Organization:** Minnesota Pollution Control Agency

**Office Telephone:** (651) 757-2190

**Email:** pam.anderson@state.mn.us

## **Project Basic Information**

**Project Summary:** Provides a public portal for lake users as well as researchers and resource managers showing and predicting the locations of harmful algae blooms.

**Funds Requested:** $846,000

**Proposed Project Completion:** June 30 2025

**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.**

Summer in Minnesota means a day at the lake fishing, swimming and recreating. With warming temperatures, longer open water seasons, and more intense storms delivering more nutrients to our lakes, harmful algal blooms (HABs) are projected to increase. In addition to being a public health threat due to their potent toxins, HABs can create low oxygen levels that contribute to fish kills and reduce fish habitat within a lake. Current temperature and water quality data are critical to predicting and addressing HABs and to aid lake and fisheries management. This project will enhance the existing online system to provide additional information for Minnesotans and local public health agencies of when and where HABs are likely to occur on recreation and drinking water source lakes. It will additionally fill a void for high resolution data to inform lake management, including watershed protection and conservation of fish habitat.

**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 update the existing LakeBrowser (https://lakes.rs.umn.edu/) to forecast lake temperature and the likelihood of HABs for Minnesota’s recreational lakes.  
  
This project will use remote sensing and water temperature modeling informed by lake sampling and in-lake monitoring buoys to predict the risk of HABs for 4,000+ Minnesota lakes. Models will use remotely sensed temperature and water quality data (water clarity, chlorophyll, phycocyanin, color) to inform modeled lake temperature to calculate HAB risk near real-time for each lake.   
  
This project leverages:  
• The Pollution Control Agency and other existing monitoring programs to collect lake water samples to characterize nutrients, cyanobacteria abundance, composition, and toxin concentrations to identify lake conditions that lead to toxin production;   
• an automated water quality monitoring system developed in a 2018 LCCMR project that provides historic and current water quality data;   
• lake temperature models developed by the US Geological Survey for 4000+ Minnesota lakes which will be automatically updated with recent remotely sensed water quality, temperature and real-time and forecast weather data; and   
• a molecular (DNA/RNA) tool being developed for a MN Sea Grant project to rapidly and inexpensively assess toxic HABs.

**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 and temperature data along with HAB risk levels. To assist with natural resources planning, annual summaries will be published to the Minnesota Natural Resources Atlas to help agencies characterize HAB risk. High frequency data provides resource managers and lake associations the information needed to fill gaps between sampling events and helps identify waters for prioritization and implementation actions on the ground and to aid resource managers in understanding lake processes and how they relate to fish populations and aquatic habitat.

## **Activities and Milestones**

### **Activity 1: Water quality monitoring to measure factors that predict HAB risk to update HAB forecast and temperature models.**

**Activity Budget:** $466,792

**Activity Description:**We will collect water samples monthly (May-September) from 200 lakes total during Years 1 and 2 to measure HAB abundance (phycocyanin pigment) and toxin concentrations (microcystin, anatoxin-(a)). In addition to variables measured during routine MPCA lake monitoring (phosphorus, chlorophyll a, water clarity), we will analyze lake color and dissolved organic carbon (DOC) due to their influences on underwater light climate and HABs. Molecular approaches (DNA/RNA) will be used to measure HAB composition and identify presence of toxin genes on a subset of lake samples (200 total samples in each of Years 1 and 2). Sampling events that coincide with cloud-free satellite passes will be prioritized for analyses (see Activity 2). In addition to the 200 lakes, we will deploy monitoring buoys (15-minute interval; temperature, dissolved oxygen, chlorophyll a, turbidity) and frequently sample (10 events in year 1 and 2 for nitrogen, phosphorus, chlorophyll a, phycocyanin, water clarity, color, DOC, molecular samples) 2 Sentinel lakes with known HAB occurrences to provide high resolution data to improve HAB forecast and temperature models. We will utilize additional buoy data from other partners, such as the Science Museum of Minnesota St. Croix Research Station and the United States Forest Service.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Collect and analyze water quality samples from 100 lakes in Year 1 (530 total samples) | March 31 2023 |
| Collect and analyze water quality samples from 100 lakes in Year 2 (530 total samples) | March 31 2024 |
| Statistical analyses to identify conditions responsible for toxic harmful algal blooms | December 31 2024 |

### **Activity 2: Update automated water quality monitoring system with indicators of HABs and new satellite products.**

**Activity Budget:** $219,208

**Activity Description:**We will add Landsat 9 (launch Sep 2021) data to the automated water quality monitoring system and update the code for new Sentinel 2 products. Using the field data collected in Activity 1 we will develop methods for measurement of phycocyanin (pigment indicating HAB abundance) and remotely sensed temperature using Landsat 8 and 9 and add those capabilities to the automated water quality monitoring system.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Add Landsat 9 data and update automated water quality monitoring system for new Sentinel products | June 30 2023 |
| Analysis of field and satellite data to develop predictive relationships to permit monitoring of phycocyanin | June 30 2024 |
| Analysis of field and satellite data to develop predictive relationships to permit monitoring of temperature | June 30 2024 |
| Add temperature and phycocyanin to the automated water quality monitoring system | December 31 2024 |
| Update system with biweekly clarity, algae, color, temperature and phycocyanin from the past 7 years | June 30 2025 |

### **Activity 3: Develop near-real time and forecast-modeled temperature and adapt LakeBrowser to display HAB risk**

**Activity Budget:** $160,000

**Activity Description:**To fill in temperature between satellite overpasses and when clouds may obscure measurements, we will automate lake temperature models that the USGS has created for 4000+ lakes in Minnesota using historic weather data. We would run those models on UMN supercomputers and link them to real-time and forecast weather data from the National Weather Service to predict and forecast lake temperature for 4000+ lakes in near real-time. Remotely sensed water quality and temperature data (Activity 2) combined with the modeled lake temperature will allow us to apply the criteria determined in Activity 1 to predict and forecast HAB risk for 4000+ lakes on a daily basis.  
  
Underlying computer code will be adapted to include HAB maps and to provide near real-time and forecast information through automated updates based on the most current satellite imagery and weather data. The online HAB 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). We will work with end users to improve data access and the user interface of the LakeBrowser and add annual summaries

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| System to automatically model lake temperature for 4000+ lakes utilizing real-time and forecasted weather data | June 30 2024 |
| Develop and implement method to calculate HAB probability risk for 4000+ lakes | March 31 2025 |
| System to update LakeBrowser with daily temperature and harmful algal bloom risk predictions | June 30 2025 |
| Create flagging system to highlight with high harmful algal bloom risk | June 30 2025 |
| Add summarized harmful algal bloom risk to Minnesota Natural Resource Atlas | June 30 2025 |

## **Project Partners and Collaborators**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Organization** | **Role** | **Receiving Funds** |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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. Cody Sheik | Large Lakes Observatory, University of Minnesota, Duluth | Sheik will lead efforts to characterize algal composition and presence of toxin genes using molecular (DNR/RNA) approaches. | Yes |
| Dr. Heidi M. Rantala | DNR Fisheries Research Scientist | Rantala will provide guidance and input on how the products of this work will be most useful to fisheries staff in management, habitat, and research. | No |

## **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?**Semi-automated computer code will routinely acquire the latest satellite imagery and weather data to quantify HAB risk. Information will be freely available to all through the UMN LakeBrowser. Maintenance to the UMN LakeBrowser and any updates to data processing would be funded through small contracts with state agencies as needed. The MPCA and Minnesota Department of Health will communicate and promote the use of the new risk information to lake users and drinking water professionals. Minnesota Department of Natural Resources will use these data in projects that assess fish habitat and drivers of fish population metrics, and guide lake protection.

## **Other ENRTF Appropriations Awarded in the Last Six Years**

|  |  |  |
| --- | --- | --- |
| **Name** | **Appropriation** | **Amount Awarded** |
| Assessment of Surface Water Quality With Satellite Sensors | M.L. 2016, Chp. 186, Sec. 2, Subd. 04i | $345,000 |
| Providing Critical Water-Quality Information for Lake Management | M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 03b | $250,000 |
| Forest and Bioeconomy Research | M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 03q | $2,200,000 |
| 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 |  | Project Coordinator |  |  | 26.7% | 0.18 |  | $19,223 |
| Jerry Henneck, UMD NRRI |  | Researcher 4 |  |  | 24.1% | 0.24 |  | $21,349 |
| Beth Bernhardt, UMD NRRI |  | Researcher 3 |  |  | 24.1% | 0.24 |  | $17,631 |
| Leif Olmanson, UMN |  | Researcher |  |  | 26.7% | 1.2 |  | $111,198 |
| David Porter, UMN |  | Consultant |  |  | 26.7% | 0.6 |  | $100,283 |
| Peter Wiringa, UMN |  | Geospatial Analyst |  |  | 26.7% | 0.39 |  | $40,563 |
| Research Fellow TBD, UMN |  | Remote sensing coding, database development and Lake Browser coding |  |  | 26.7% | 1.5 |  | $112,164 |
| Cody Sheik, UMD LLO |  | LLO Molecular Lead |  |  | 26.7% | 0.12 |  | $17,895 |
| Zachary Wagner |  | Researcher 2 |  |  | 24% | 0.12 |  | $7,223 |
| Graduate Student |  | sampling and data processing |  |  | 32.6% | 0.56 |  | $42,844 |
| Undergraduate Student |  | Data collection |  |  | 0% | 0.74 |  | $18,720 |
|  |  |  |  |  |  |  | **Sub Total** | **$527,093** |
| **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 1060 water quality samples and 460 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. |  |  |  | 0 |  | $152,039 |
| University of Minnesota Duluth | Internal services or fees (uncommon) | Water quality analytical fees: fees to analyze DOC and phycocyanin in all lakes, and water chemistries in buoy lakes |  |  |  | 0 |  | $16,920 |
| University of Minnesota DNA sequencing | Internal services or fees (uncommon) | Sequence molecular data for phytoplankton |  |  |  | - |  | $35,196 |
|  |  |  |  |  |  |  | **Sub Total** | **$216,155** |
| **Equipment, Tools, and Supplies** |  |  |  |  |  |  |  |  |
|  | Tools and Supplies | Lake buoy construction materials | To build buoys and temperature strings needed for housing sensors; data needed to build temperature models and HAB forecasts |  |  |  |  | $8,838 |
|  | Tools and Supplies | Field filtration and phytoplankton sampling | bottles, filters, and reagents for phytoplankton analysis |  |  |  |  | $25,756 |
|  | Tools and Supplies | Lab supplies | Reagents and lab supplies for molecular sample and water quality analyses |  |  |  |  | $26,456 |
|  |  |  |  |  |  |  | **Sub Total** | **$61,050** |
| **Capital Expenditures** |  |  |  |  |  |  |  |  |
|  |  | Hydrolab DS5 sonde with sensors for temperature, conductivity, pH, DO, turbidity and chloropyll-a (2 units) | To collect high frequency data to build temperature models and HAB forecasts |  |  |  |  | $27,164 |
|  |  |  |  |  |  |  | **Sub Total** | **$27,164** |
| **Acquisitions and Stewardship** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Travel In Minnesota** |  |  |  |  |  |  |  |  |
|  | Miles/ Meals/ Lodging | Meals for student workers (70 daily 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 |  |  |  |  | $5,900 |
|  |  |  |  |  |  |  | **Sub Total** | **$10,538** |
| **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** | **$846,000** |

### **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** |  |  |  |  |
| In-Kind | Game and Fish Fund 97A.055 | Dr. Rantala will provide guidance and input on how the products of this work will be most useful to fisheries staff in management, habitat, and research. | Secured | $2,040 |
|  |  |  | **State Sub Total** | **$2,040** |
| **Non-State** |  |  |  |  |
| In-Kind | UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs. | Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs) | Secured | $168,369 |
| In-Kind | United States Forest Service | Rye will share concurrent water quality monitoring and lake temperature data collected during routine USFS monitoring. | Secured | - |
|  |  |  | **Non State Sub Total** | **$168,369** |
|  |  |  | **Funds Total** | **$170,409** |

## **Attachments**

### **Required Attachments**

#### ***Visual Component***

File: [c85e302c-e55.pdf](https://lccmrprojectmgmt.leg.mn/media/map/c85e302c-e55.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....

### **Optional Attachments**

#### ***Support Letter or Other***

|  |  |
| --- | --- |
| **Title** | **File** |
| Minnesota Department of Natural Resources Support Letter | [b0126e04-6b1.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/b0126e04-6b1.pdf) |
| Metropolitan Council Environmental Services Support Letter | [9e6253f9-c63.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/9e6253f9-c63.pdf) |
| United States Forest Service Support Letter | [d17e1dc7-39b.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/d17e1dc7-39b.pdf) |
| United States Geological Survey Support Letter | [70fd3e89-987.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/70fd3e89-987.pdf) |
| Minnesota Department of Health Support Letter | [5eef59f8-dd3.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/5eef59f8-dd3.pdf) |

## **Administrative Use**

**Does your project include restoration or acquisition of land rights?**   
 No

**Does your project have potential for royalties, copyrights, patents, or sale of products and assets?**   
 No

**Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?**   
 N/A

**Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?**   
 N/A

**Does your project include original, hypothesis-driven research?**   
 Yes

**Does the organization have a fiscal agent for this project?**   
 No