Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-156

Proposal Title: Biocontrol of Harmful Algal Blooms

Project Manager Information

Name: Beatriz Baselga Cervera

Organization: U of MN - College of Biological Sciences

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Project Basic Information

Project Summary: Harmful algal blooms threaten Minnesota's environment, economy, and health. Our project combines student sampling, advanced genomic sequencing, and laboratory research to find cyanotoxins-degrading bacteria and cyanophages, biocontrol alternatives to blooms.

ENRTF Funds Requested: $483,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Water (B)

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?

During the Project and In the Future

Narrative

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

Algal blooms are natural ecosystem processes, but harmful algae blooms (HABs) are becoming more frequent in Minnesota's lakes and ponds due to nutrient pollution and warming waters. HABs threaten wildlife, recreation, and public health worldwide. These overgrowths pose ecological and water supply risks by depleting oxygen in the water, sometimes killing fish and other aquatic life, creating unpleasant odors, and, in some cases, producing cyanobacterial toxins. Concretely, cyanotoxins are considered emerging contaminants with diverse chemical structures and toxic effects that can range from mild illness to severe poisoning or death in animals and humans. Although there are currently no comprehensive regulatory limits, these toxins appear on the Minnesota Pollution Control Agency and U.S. Environmental Protection Agency's Candidate Contaminant List for drinking water. In Minnesota, managing cyanotoxins in lakes, reservoirs, and drinking water sources is an important priority for freshwater protection and treatment. Traditional management strategies focus on monitoring, watershed nutrient reduction, and water treatment processes that remove or inactivate cyanobacteria and their toxins. However, treatment remains challenging because cyanobacteria distribution varies with environmental conditions, toxins can be released when cells rupture, dissolved toxins are difficult to remove, and some treatments may unintentionally alter water chemistry and harm aquatic life.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

Our proposed solution is to harness naturally occurring microbial communities in Minnesota's lakes to better understand and identify potential biological control agents for managing cyanobacterial blooms and their toxicity. Through targeted bioprospecting, this project will isolate and characterize cyanophages, viruses that specifically infect cyanobacteria, and bacteria capable of degrading cyanotoxins. By infecting and lysing cyanobacterial cells, cyanophages can disrupt bloom development and reduce toxin production. Cyanotoxin-degrading bacteria can break down cyanotoxin into non-toxic compounds, providing a biological mechanism for detoxifying polluted waters. Both cyanophages and cyanotoxin-degrading bacteria are common components within HABs, yet they exhibit high degrees of specificity regarding the host cyanobacteria strains they infect or the toxins they degrade. Together, cyanophages and toxin-degrading bacteria represent promising, environmentally friendly alternatives to chemical or mechanical bloom mitigation strategies. This project will also expand exploration of microbial and viral diversity associated with HABs in Minnesota's lakes and ponds, improving understanding of natural ecosystem processes that influence bloom formation and decline. The dynamics underlying HABs are influenced by shifting environmental factors, including nutrient pollution, changing weather patterns, and potential pressures from invasive species, making this research valuable for understanding the direction in which they are evolving.

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?

Bioprospecting Minnesota's freshwater resources will increase our knowledge of the biological diversity and provide biological alternatives to manage HABs. To achieve this:

i) will survey, sample, and analyze microbial community composition and cyanotoxin occurrence in HABs across Minnesota. Strengthening ecology knowledge and awareness of the importance and vulnerability of Minnesota's freshwater resources.

ii) isolate and characterize cyanotoxins-degrading bacteria and cyanophages that infect bloom-forming cyanobacteria. These organisms will be evaluated for their potential as biological control agents that could help reduce bloom intensity or toxicity.

iii) mentor students on water resource challenges for careers in science, environmental policy and resource management.

Activities and Milestones

Activity 1: Monitor, sample, and characterize Harmful Algae Blooms (HABs)

Activity Budget: $152,000

Activity Description:
Freshwater samples will be collected during and after HABs in the 2028 and 2029 seasons across Minnesota. Sampling will include ponds and lakes monitored by existing programs, urban and rural lakes south and north of the Twin Cities, and northern lakes surveyed with support from the Itasca Biological Station, informed by previous data. From bloom samples, algae, cyanobacteria, bacteria, and other microorganisms will be identified and quantified using optical microscopy. Cyanobacteria blooms, or blue-green algae, will be prioritized for analyses and cyanophage discovery. The presence of cyanophages will be assessed using cyanobacteria strains previously isolated and cultured from Minnesota lakes. Cyanotoxins will be measured semi-quantitatively using commercial ELISAs for toxins such as Microcystin-LR and Nodularin. HABs positive for cyanotoxins will be used to isolate cyanotoxin-degrading bacteria. DNA sequencing, including metagenomics, will support identification of cyanobacteria blooms and associated toxicity genes, while water chemistry will be analyzed as appropriate. Collaborations with partners will provide real-time HAB information, reducing the need for extended travel. This project aims to map the distribution, diversity, and toxicity of cyanobacteria HABs across Minnesota and provide foundational data for isolating cyanophages and cyanotoxin-degrading bacteria. Results will inform public health guidance, lake management, and future research.

Activity Milestones:

Description	Approximate Completion Date
Protocol development (e.g., sampling, safety, molecular, microbiology and data curation) in laboratory meetings	April 30, 2028
Faculty and students will collect HABs samples across Minnesota (2 sessions)	November 30, 2029
Students and Technical staff will be trained to identify and characterize cyanobacterial blooms.	November 30, 2029
compile/disseminate findings and protocols.	November 30, 2029
Faculty, students, and staff will carry out chemical and Toxicity assays	November 30, 2029

Activity 2: Isolate, identify, and characterize cyanophages from Minnesota's HABs

Activity Budget: $170,000

Activity Description:
The increasing frequency and diversity of harmful algal blooms (HABs), in terms of appearance, toxicity, and environmental impact, underscores the urgent need for alternative management strategies. Cyanobacteria, commonly known as blue-green algae, are the primary drivers of HABs in freshwater systems both in Minnesota and worldwide. These organisms produce a wide range of cyanotoxins, which can be harmful or highly toxic to humans, pets, and wildlife. Cyanophages, viruses that specifically infect and lyse cyanobacteria, are promising biocontrol agents for managing HABs. This project focuses on isolating and characterizing cyanophages from HAB samples, using established protocols such as plaque assays and PCR-based molecular detection to determine host range and efficacy. Faculty, technical staff, and students at the University of Minnesota (UMN) will employ advanced molecular and microbiological techniques to enhance the cultivation of bacteriophages. Through systematic laboratory screening, we aim to identify cyanophages with potential as targeted biocontrol agents against bloom-forming cyanobacteria. The project will also identify phage genes critical for cyanobacteria control and expand understanding of phage biodiversity in MN HABs. Findings from this research will be integrated into relevant UMN courses, providing hands-on learning experiences while advancing sustainable HAB management strategies.

Activity Milestones:

Description	Approximate Completion Date
Research students and staff will be trained in phage isolation and characterization.	May 31, 2028
Students will be trained by research staff and faculty on growing cyanobacterial cultures and cyanophages	May 31, 2028
Experiments to identify the cyanophages' host range and lysis capacity	November 30, 2029
Cyanophages and genes of interest identification by a graduate student and faculty	March 31, 2030
Collaborative mentorship of the scientific writing of a manuscript and dissemination by students and faculty	June 30, 2030

Activity 3: Isolate, identify, and characterize cyanotoxins-degrading bacteria from Minnesota's HABs

Activity Budget: $161,000

Activity Description:

HABs are an urgent threat that demands a multi-faceted approach, producing cyanotoxins that range from mild irritants to potentially fatal compounds, depending on exposure route (ingestion, inhalation, or skin contact). These toxins are highly persistent and heat-stable, making conventional treatment methods, such as activated carbon or advanced oxidation, expensive and limited in effectiveness. We propose isolating cyanotoxin-degrading bacteria directly from toxin-positive HABs using a combination of traditional microbiology (agar plating, serial dilution) and cutting-edge iChip technology to access previously unculturable microbes. Candidate strains will be evaluated through targeted biodegradation and toxicology assays under diverse conditions, including varying toxin concentrations and exposure to filtered HAB samples or spent cyanobacterial media. Molecular and genomic analyses will identify key genes and pathways enabling cyanotoxin breakdown, guiding selective culture enhancement to maximize biodegradation potential. All promising isolates will be preserved, with top candidates deposited in microbial collections for future research and application. This project integrates hands-on, providing students with experience in microbial isolation, genomics, and environmental biotechnology. By combining innovative microbial discovery with applied biodegradation strategies, this work aims to generate novel strategies for sustainable cyanotoxin removal.

Activity Milestones:

Description	Approximate Completion Date
Faculty and graduate student will complete microbial functional and biodiversity analyses.	June 30, 2029
Undergraduates will be trained in bacterial isolation and characterization	September 30, 2029
Students will be trained in bacterial isolation and characterization	November 30, 2029
Faculty, staff, and students will complete biodegradation and toxicity assays to identify potential biodegrading bacteria	December 31, 2029
Faculty and gradaute student will complete microbial functional and biodiversity analyses (analysing sequences)	December 31, 2029
Students and staff will complete toxicity and biodegradation assays supervised by faculty	December 31, 2029
Collaborative mentorship of the scientific writing of a manuscript and dissemination by students and faculty	June 30, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
John Manske	Ramsey County Environmental Services, Lake Management	John Manske provided information on the last 3 years of chemistry and zooplankton data from lakes located in Ramsey County Areas	No
Jonnathan Schilling	Director of Itasca Biological Station and Laboratories (IBSL)- University of Minnesota	Dr. Schilling, as the Director of IBSL, will provide access to the properties and laboratory facilities, facilitate communication and permits with Itasca State Park, and support the identification of sampling locations.	No
Michael Travisano	Prof. Ecology, Evolution, and Behavior, University of Minnesota	Travisano's lab will provide facilities and equipment to run specific microbial analyses (i.e., Coulter Counter Multisizer). He will support the experimental aspect of the proposal.	No
Caitlin Potter	Cedar Creek Ecosystem Science Reserve (CCESR), University of Minnesota	Associate director of CCESR, providing permissions and support for sampling and bioprospecting, facilitating access to Cedar Creek buildings and equipment, and supporting Dr. Baselga Cervera in her mentoring efforts, including by integrating her and her research into our ongoing summer undergraduate professional development programming.	No
Jacques Finlay	Ecology, EVolution and Behavior Department, UMN	Access to data and alerting Dr. Baselga Cervera team if a bloom occurs in any of the lakes they monitor across the Minneapolis-St. Paul Metropolitan Area (MSP) Long Term Ecological Research Program.	No

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

i) Data and Findings Sharing at the State Level:

This project will actively communicate findings and data to partners, scientific venues, local and state stakeholders, and public audiences in Minnesota. Stakeholders (including the Minnesota Pollution Control Agency, Minnesota Department of Health, Minnesota DNR, watershed districts, and local environmental organizations) will be engaged through direct data sharing and presentations in local venues (e.g., UMN Water Network or Freshwater Society events). These efforts will ensure that research outcomes, such as microbial community data, cyanophage diversity, and cyanotoxin-degrading bacteria, are accessible to those responsible for managing HABs and freshwater resources. We will also provide technical reports and data summaries tailored to the needs of freshwater managers.

ii) Scientific and Research Dissemination:

Research products will be preserved and published in scientific venues. Cyanophages and cyanotoxin-degrading bacteria identified as promising biocontrol agents will be maintained in the lab and deposited in microbial collections for future research and application. DNA sequencing, metagenomic analyses, and water chemistry data will be archived in publicly accessible repositories (e.g., NCBI), enabling other researchers and practitioners to utilize these resources for ongoing

monitoring, research, and mitigation efforts. Furthermore, if any specific biodegradation pathway or cyanophage isolate demonstrates potential as a biocontrol agent, we will actively seek additional funding, industry partnerships, and opportunities for practical testing.

iii) Education and Workforce Development:
Undergraduate and graduate students involved in the project will gain hands-on experience in field sampling, microbiology, genomics, and biocontrol strategies. Project findings will be integrated into University of Minnesota courses, giving students opportunities to engage directly with pressing freshwater resource challenges and to connect with environmental policy and resource management practices.

iv) Public Audience Engagement:
We will collaborate with the CBS Marketing and Communications Office to connect with local media and highlight the importance of HAB management and environmentally friendly strategies for protecting lakes, ponds, and public health. Additional public engagement will occur at venues such as the Itasca Biological Station and the CBS State Fair booth.

v) Acknowledgement and Dissemination Costs:
Project outputs, including publications, presentations, and digital media, will acknowledge support from the Environment and Natural Resources Trust Fund (ENRTF), using the ENRTF logo and attribution language according to guidelines. Dissemination costs are not included in the project budget; however, the project team will leverage resources from the University of Minnesota and partner organizations (e.g., no-cost journal publication or CBS Marketing and Communications support) to support these activities.

By widely sharing research results, mentoring students, and preserving microbial collections, this project will foster knowledge transfer, maximize both immediate and long-term impact, promote improved freshwater resource management, and support the sustainable protection and conservation of Minnesota's aquatic ecosystems.

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 work be funded?
The results will be communicated beyond scientific venues (i.e., UMN Water Network, local/regional conferences, and peer-reviewed publications) with stakeholders, specifically the Minnesota Pollution Control Agency watershed districts, and scientific/engineering researchers. through direct communication and data sharing. My lab has the infrastructure to train undergraduates and a graduate student, as mentioned in this proposal. Lessons and protocols will be integrated into our future research. and teaching. If a promising biocontrol agent is identified, we will actively pursue additional funding to support expanded testing and development.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Safeguarding Bees While Monitoring Pollinators and Nesting Habitats	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 03u	$590,000

Project Manager and Organization Qualifications

Project Manager Name: Beatriz Baselga Cervera

Job Title: Assistant professor

Provide description of the project manager's qualifications to manage the proposed project.
Beatriz Baselga Cervera is a principal investigator of ecological ideas at the School of Biology at the University of Minnesota. For the past thirteen years, Beatriz has investigated freshwater microbial communities. Her doctoral degree focused on the study of the rapid adaptation of microalgae and bacterial communities in mining ponds. During her postdoctoral work, she investigated the adaptation in microalgae, cyanobacteria, and yeast to pollutants and other selective pressures. Her lab focuses on the integration of experiments and field observations to address biological diversity, toxicology, pollution and ecological questions of freshwater microbial communities. She is the main author of multiple publications in scientific journals (i.e., Journal of Phycology, Aquatic Toxicology, Scientific Reports or Ecotoxicology), two patents, and participated in several scientific projects (i.e., "Cyanotoxin Bioremediation with Microbes" or "Selection and adaptation of a toxicity test for microcystin: assistance at early warming levels".). Her expertise spans project management, experimental design, data collection, dissemination, mentoring, and funding acquisition. In the present proposal, she will act as the principal investigator as well as the aquatic microbiologist, and she will coordinate the different partnerships, hire the research personnel, and lead the experimentation and other necessary operations.

Organization: U of MN - College of Biological Sciences

Organization Description:
This project is a collaboration of twoentities at the University of Minnesota College of Biological Sciences: Ecology, Evolution, and Behavior (EEB) Department researchers and Itasca Biological Station and Laboratories (IBSL)), with strengths in environmental, natural, ecological, monitoring and experimental Lakes studies. The University of Minnesota EEB Department will manage this project and it will be formally housed in the Baselga-Cervera laboratory. EEB department will provide office and laboratory space, laboratory operation and maintenance services, administrative support, investigation centers support and special rates, and access to several world-renowned experts in the field of ecology.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Principal Investigator-Baselga Cervera		Overall project coordination, lab, and field experimental design, running, coordination, and managing the sampling, training students with high-skilled laboratory techniques, results curation, overseeing results analyses and data management, and developing dissemination materials.			36.6%	0.36		$68,000
Research Specialist		Assist in fieldwork, lab work, data entry, curation, labeling, sample preparation, support with any laboratory analyses and long-term sample storage. Support sampling years 1 person for 3 years. Position part-time (20h/week).			32.3%	1.5		$103,000
Undergraduates		Undergraduate research; 2 students per summer, the first two years hired by the UMN> hired by UMN. Assist with lab, field work, strain isolations, DNA extractionsn and set-up, and enter data.			8%	1		$35,000
Graduate Student		Coordinate field work on the ground and DNA extractions. high-level technical bioinformatics analysis. Benefits include Fringre (24.2%) and Tuition per 3 years ($32000)			24.2%	0.5		$120,000
							Sub Total	**$326,000**
Contracts and Services								
U of M genomics center	Internal services or fees (uncommon)	Identification and characterization of bacteriophages and biodegradation bacterial strains from algae blooms.				0		$60,000
U of M Research Analytical laboratory	Internal services or fees (uncommon)	Including: Nitrate/Nitrite, total phosphorous, solids, and 27 elements, including sulphur and iron, and other chemical values and service, approx. $166 per sample internal rate. Total: $10,000 per 60 samples. Plus Cyanotoxins analyses approx. $110 sample. Total: $7000 per 60 samples				0		$17,000

							Sub Total	**$77,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	Chemical reagents	Chemical reagents used to prepare media for the isolation and growth of microorganisms and bacteriophages include standard consumables such as peptones, yeast extracts, agar, sodium chloride, and various buffer systems (e.g., Tris-HCl, phosphate buffers). For the characterization of bacteria capable of degrading cyanotoxins, specific commercial toxins, including microcystin variants.					$10,000
	Tools and Supplies	DNA sequencing lab supplies	DNA sequencing is necessary to identify microbial strains and phages from lake samples (>200 samples across 3 years)					$20,000
	Tools and Supplies	Microbiological lab supplies consumables	Microbiological culturing and manipulating consumables for freshwater microbes and bacteriophages. Key consumables include: pipette tips, gloves, test tubes, petri dishes, syringes, cell culture plates, falcons, and cuvettes					$20,000
	Tools and Supplies	Cyanotoxins commercial ELISAs	To analyze and quantify cyanotoxins in the water of more than 100 bloom samples across the state that present toxin-producing cyanobacteria species (approximately 10 Elisa tests for at least two cyanotoxins. Total: 20 tests for $500 each). Given that samples need to be triplicated, we can approx. 25 samples per ELISA).					$10,000
							Sub Total	**$60,000**
Capital Equipment								

							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Mileage reimbursement for a subset of fieldwork examples at .725/mile (IRS standard rate). (a)Twin Cities metro lakes (16 miles sampling roundtrip= $12). (b) Close to metro: 70 miles sampling roundtrip=$51) (c) Further metro: 460 miles sampling roundtrip =$350). Overnight lodging and meals at approved rates to cover locations more than 300 miles away from the city for 1 faculty member, a researcher/graduate student, and one or two undergraduates over two summers.	For surveying and sampling MN lakes and urban lakes.					$20,000
							Sub Total	**$20,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$483,000**

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				
In-Kind	INDIRECT - 54% MTDC	Indirect costs associated with this proposal at 54% MTDC	Potential	$243,000
			Non State Sub Total	**$243,000**
			Funds Total	**$243,000**

Total Project Cost: $726,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 1dd1a1ae-c81.pdf

Alternate Text for Visual Component

A)Candidate cyanotoxin-degrading bacterial colonies cultured onplates supplemented with the cyanotoxin microcystin-LR. Samples were inoculated from a HAB maintained in laboratory culture. (B) The halos represent plaques of cyanophages lysing the cyanobacteria cells (green lawn). A sample was collected for the phage cocktail in late August 2025 from Medicine Lake....

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
Regents of the University of Minnesota-Letter	98e90c4e-861.pdf
Letter of Support from ITASCA Biological station	240fa8b2-9c5.pdf
Support Letter CCESR directo	7d61ffd9-1fc.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

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?

Yes, Sponsored Projects Administration

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing $10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

University of Minnesota and Dr. Michael Travisano (Scientific Partner)

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A