

Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-224

Proposal Title: Using Lichens to Monitor Atmospheric Microplastics and Nitrogen

Project Manager Information

Name: Natalia Mossmann Koch Organization: U of MN - College of Biological Sciences Office Telephone: (612) 512-4646 Email: nkoch@umn.edu

Project Basic Information

Project Summary: This project will use lichens and mosses as low-cost monitors of microplastics and nitrogen air pollution across Minnesota, in addition to expanding the previous monitoring program focused on heavy metals.

ENRTF Funds Requested: \$500,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Fish and Wildlife (D)

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.

Air quality monitoring can be costly and difficult to deploy at large scales. In a current ENRTF-funded project (2023-152), we have been using lichens as a cost-effective way to monitor airborne heavy metals across Minnesota. Lichens and mosses have proven to be successful monitors of air quality, due to their sensitivity to changes in the atmospheric composition. The success of this past work on heavy metals motivates us to propose a new project to address additional pollutants of growing concern for Minnesotans, microplastics and nitrogen, building on our established sampling network and community relationships. Microplastics are widely distributed in different ecosystems. Recently, studies have identified disturbing amounts of microplastics in human bodies (including our brains!), yet monitoring is still very limited. There are also other chemicals in air pollution that we have a lot to learn about, such as NO2 and NH3, which can be toxic to humans and wildlife and a threat to biodiversity and ecosystems resilience. Although the few monitored sites for NO2 in MN are within the standards, a recent study that included data from Minnesota showed that greater long-term exposure to air pollution, including NO2, was associated with a higher risk of blood clotting diseases.

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.

We will use lichens and mosses to monitor microplastic and nitrogen air pollution across Minnesota. We will leverage the sites that we have established since 2023 for heavy metal monitoring for this new purpose and expand the network to include more urban areas (and neighboring natural areas). We will apply a combination of laboratory experiments (to develop better protocols), transplants of lichens and mosses from control natural areas into urban areas (to assess accumulation of pollutants), and lichen surveys (reflecting long-term effects on lichen biodiversity). To monitor microplastics, existing protocols will be tested and improved, and then a network across Minnesota will be monitored. For nitrogen monitoring, we will use a combination of experiments, transplants, and field sampling to test the applicability and effectiveness of using nitrogen isotopic signatures (δ 15N) with total nitrogen deposition. We also aim to expand our current monitoring of heavy metals to new urban areas, building on our previous work mapping air quality by expanding both the type of pollutants monitored and the number of sites. Improving the geographical coverage of air quality monitoring is of high importance to protect and manage wildlife and greatly increase our understanding of the air that we breath in Minnesota.

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?

The main outcome will be to generate an initial map of atmospheric microplastic distribution (the first in the U.S). and a map of the distribution of nitrogen air pollution across different urban areas in Minnesota, including areas where no detailed information on air quality is currently available. This information could be used to improve and direct efforts on public health, and management and protection of Minnesota natural resources. We will share our findings and in different outreach activities building on strong, established partnerships that have included events with the Minnesota Master Naturalists, the Bell Museum, and the Minnesota StarTribune.

Activities and Milestones

Activity 1: Using lichens and mosses to monitor microplastic air pollution in urban areas across Minnesota

Activity Budget: \$153,000

Activity Description:

Because microplastics are easily dispersed in the air, they can be trapped in living organisms such as liches and mosses. These organisms have been shown to be great biomonitors of air pollution, so they show promise to also monitor the presence of microplastics in the air that we breath. Recently, lichens and mosses have also been shown to entrap microplastics deposited on their surface. However, up until now, there are no studies testing the presence of microplastics on natural growing lichens in the U.S., despite the potential of using these organisms for that goal. To accomplish that, we will first develop a protocol to better analyze microplastics particles captured by lichens and mosses using laboratory experiments based on published protocols for lichens and the expertise of other researchers at the UMN studying microplastics in other samples. After that, natural living individuals from at least one species of moss and one species of lichen will be collected from six sites of at least three different urban areas across MN and analyzed using this protocol.

Activity Milestones:

Description	Approximate Completion Date
Develop a protocol to measure microplastics using lichens and mosses	June 30, 2027
Request permits	June 30, 2027
Test the protocol in the laboratory with experiments	September 30, 2027
Sample lichens and mosses in the metro areas of at least three cities across MN	December 31, 2027
Analyze data	December 31, 2028
Completion of final products of research, such as final reports and peer-reviewed journal articles	January 31, 2029
Dissemination and outreach. At least 6 activities, starting beginning of Year 2	May 31, 2029

Activity 2: Mapping atmospheric urban nitrogen pollution across Minnesota

Activity Budget: \$179,000

Activity Description:

Monitoring nitrogen atmospheric pollution at a regional scale is usually costly and requires the use of monitoring stations comprising expensive, specialized collectors. Currently, Minnesota has regular monitoring of some nitrogen compounds in a few sites, but there is no detailed mapping across the state. Lichens can be a great tool for monitoring the loads of nitrogen, because either the gaseous (NOx) or the particulate (NHX) forms can enter the lichen cells. These compounds will then have different impacts on these organisms, depending on the species tolerance. For this activity, we aim to collect two nitrogen-tolerant lichen species that naturally grow in urban and suburban sites across MN and measure the amount of nitrogen compounds and their isotopic signature (δ 15N) absorbed by the lichens. In those same lichens, we will use non-invasive physiological monitoring approaches (chlorophyll fluorescence) to identify non-destructive predictors of nitrogen pollution. Additionally, we will use previously obtained lichen diversity and composition data from those sites (sampled in previous LCCMR projects by the lead researcher of this project) and sample lichens from the new expanded sites (see activity 3) to test for the existence of long-term effects on lichen communities, based on their known nitrogen tolerance.

Activity Milestones:

Description	Approximate
	Completion Date

Collect natural living lichens across MN in 10 urban areas (6 sites in each one)	December 31, 2027			
Measure lichen physiology, nitrogen and other accumulated pollutants	December 31, 2027			
Compare N deposition results with lichen community data	June 30, 2028			
Analyze data	December 31, 2028			
Completion of final products of research, such as final reports and peer-reviewed journal articles	May 31, 2029			
Dissemination and outreach. At least 6 activities, starting beginning of Year 2	May 31, 2029			

Activity 3: Expanding the urban air quality monitoring in Minnesota with lichens as biomonitors

Activity Budget: \$168,000

Activity Description:

Because we have seen the importance of combining lichen transplants to monitor heavy metals with sampling lichen species composition and diversity across MN in our previous LCCMR project (M.L. 2023, Chp. 60, Art. 2, Sec. 2, Subd. 07d), we aim to now expand this monitoring network to be able to include more cities across Greater Minnesota. In these new sites, we aim to measure the same parameters as measured in the previous sites, including heavy metal absorption by the "Common Greenshield lichen" (Flavoparmelia caperata) and the effects of urbanization on lichen communities, and incorporate these sites in our nitrogen monitoring areas (as described in activity 2). We will achieve this by transplanting lichens from control natural areas (local State Parks) closer to each area, to provide standardized measures of air quality, analyze their physiology and response to pollution, but also sample the lichen diversity of each site and collect natural living species for nitrogen analyses as described above.

Activity Milestones:

Description	Approximate Completion Date
Select areas and request permits	June 30, 2027
Install lichen transplants in 4 urban areas across MN at 7 sites in each area	September 30, 2027
Measure physiology and accumulated pollutants after 6 months	March 31, 2028
Expert surveys of lichen communities surrounding the transplant sites	August 31, 2028
Analyze data from lichen communities and transplants	December 31, 2028
Completion of final products of research, such as final reports and peer-reviewed journal articles	May 31, 2029
Dissemination and outreach. At least 6 activities, starting beginning of Year 2	May 31, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving
	_		Funds
Daniel Stanton	University of Minnesota - College of Biological Sciences	Co-lead, in particular providing equipment and expertise for physiological measurements, as well as helping in the project design and outcomes	No
Emilie Snell- Rood	University of Minnesota - College of Biological Sciences	Collaborator, in particular providing expertise on the effects of pollutants in the environment and helping in the project design.	No
Lee Penn	University of Minnesota - College of Science & Engineering	Collaborator, in particular providing expertise on the analyses of microplastics (Activity 1).	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 work be funded?

The findings and results will be published in peer-reviewed academic journals, as well as written up and shared in public outreach formats. The long-term continuation of the outreach activities will be incorporated into the Urban Long-Term Ecological Research program at the University of Minnesota, led by Dr Sarah Hobbie and Dr Emilie Snell-Rood (a project collaborator), which will also provide a platform for data curation and publicly accessible data storage.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Lichens as Low-Cost Air Quality Monitors in Minnesota	M.L. 2023, , Chp. 60, Art. 2, Sec. 2, Subd. 07d	\$341,000

Project Manager and Organization Qualifications

Project Manager Name: Natalia Mossmann Koch

Job Title: Researcher Associate

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

Dr Koch has extensive expertise (>18yrs) of work with lichen ecology, including particular focus on urban lichen communities. She has led studies of lichens in urban and natural environments in Minnesota and Brazil, including on variation of lichen communities in parks from urban to suburban to rural contexts in Brazil. She has also been developing expertise in the use of physiological measurements of lichens that can provide a non-destructive means of assessing health and stress. More recently she is successfully leading a LCCMR funded project on Lichens as Low-Cost Air Quality Monitors across Minnesota, managing the project's budget, mentoring students, doing field work, identifying lichen species, leading outreach activities and preparing abstracts and reports.

Organization: U of MN - College of Biological Sciences

Organization Description:

Department of Ecology, Evolution and Behavior in the College of Biological Sciences at the University of Minnesota.

Budget Summary

Category /	Subcategory	Description	Purpose	Gen.	% Bono	# 575	Class	\$ Amount
Name				gible	fits	FIL.	Staff?	
Personnel				8				
Project		Lead data collection, analysis and outreach. Dr.			26.8%	3		\$288,000
Leader		Mossman Koch is the project leader and the						
		researcher associate of the project						
Student		Undergraduate student researcher assisting			0%	1.11		\$42,000
worker-		research scientist with laboratory work during						
semester		school semesters						
Student		Field support student researcher			0%	1.02		\$37,000
worker								
(summer)								
Temp &		Undergraduate level researcher to assist the			6.8%	0.56		\$22,000
Casual		research scientist with field work						
Academic		Dr Lee Penn will support with microplastic			26.8%	0.25		\$6,000
Faculty		assessment on lichens and mosses (Y1)						
							Sub	\$395,000
							Total	
Contracts								
and Services								
TBD	Service	Lab services (analyses of pollutant content).				-		\$22,000
	Contract	Analyses of types of microplastics (Activity 1),						
		nitrogen isotopes, total nitrogen and carbon						
		(Activity 2) heavy metal and total nitrogen and						
		carbon contents of transplants (Activity 3).						
							Sub	\$22,000
							Total	
Equipment,								
Tools, and								
Supplies								
	Tools and	Supplies / Instructional Materials	Kits and supplies for outreach activities					\$3,000
	Supplies		including hand lens, grid, etc. \$30/kit					
			for 100 kits.					
	Tools and	Temperature, humidity dataloggers and PM2.5	Purple Air Sensors and power source at					\$10,000
	Supplies	sensors	~\$333 each) to track conditions at the					
			monitoring sites.					
	Tools and	Lab and fieldwork supplies	Collection bags, tools, CO2 cartridges					\$12,000
	Supplies		for physiological measurements, resin					

			bags for nitrogen throughfall			
			measurement, etc.			
					Sub	\$25,000
					Total	
Capital						
Expenditures						
					Sub	-
					Total	
Acquisitions						
and						
Stewardship						
					Sub	-
					Total	
Travel In						
Minnesota						
	Miles/ Meals/	Food and lodging (eg motel/hotel near study sites in	Travel across MN to sample lichens and			\$42,000
	Lodging	Minnesota) for research scientist and assistant	complete field activities			
		during fieldwork (estimate for 2 people for 80 days,				
		considering a daily amount per capita of around USD				
		262.00).				
	Miles/ Meals/	80 days of field work, for two people	Fleet vehicle rental for fieldwork across			\$10 <i>,</i> 000
	Lodging		Minnesota			
					Sub	\$52 <i>,</i> 000
					 Total	
Travel						
Outside						
Minnesota						40.000
	Conference	Travel for research scientist to 1 domestic	Travel for research scientist to present	х		\$2,000
	Registration	conference (Y2)	project findings			
	Miles/ Meals/					
	Lodging					42.000
					Sub	\$2,000
Duinting and					Total	
Printing and						
Publication	Duinting	Drinting anota fan autorach matariala				ć2.000
	Printing	Printing costs for outreach materials	Material for outreach activities			\$2,000
					Sub	\$2,000
					 Total	
Other						
Expenses						

	Equipment servicing and re-calibration in Year 1	Ecophysiological equipment to be used			\$2,000
		recalibration			
				Sub	\$2,000
				Total	<i>Ş</i> 2,000
				Grand	\$500,000
				Total	

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel Outside	Conference	Travel for research scientist to 1	Formal presentation of results at a conference
Minnesota	Registration	domestic conference (Y2)	
	Miles/Meals/Lodging		

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	University of Minnesota	Indirect costs associated with this proposal	Potential	\$269,000
			State Sub	\$269,000
			Total	
Non-State				
			Non State	-
			Sub Total	
			Funds	\$269,000
			Total	

Total Project Cost: \$769,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component File: 453728b1-470.pdf

Alternate Text for Visual Component

Activities and outcomes of the proposal: left, a simplified demonstration of the microplastic laboratory experiment and the natural living species sampling; middle, nitrogen deposition mapping and physiological analyses on lichens; right, example of a lichen transplant, the analyses and lichen diversity sampling; and at the bottom, the summary of outcomes....

Supplemental Attachments

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

Title	File
UMN Approval Letter	0d087b85-00a.pdf
Media coverage of our previous LCCMR funded project	a11eef22-d5d.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?

No

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:

None

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

Yes, I understand