Environment and Natural Resources Trust Fund

M.L. 2023 Draft Work Plan

General Information

ID Number: 2023-074

Staff Lead: Mike Campana

Date this document submitted to LCCMR: January 24, 2023

Project Title: Sinking and Suspended Microplastic Particles in Lake Superior

Project Budget: $412,000

Project Manager Information

Name: ELIZABETH MINOR

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Project Reporting

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: June 30, 2026

Final Report Due Date: August 14, 2026

Legal Information

Legal Citation:

Appropriation Language:

Appropriation End Date: June 30, 2026

Narrative

Project Summary: Microplastics suspended in and sinking within Lake Superior waters will be compared to help determine source and fate. The flux of microplastics from water to sediment will be determined.

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

Since 1950, when large-scale plastics production began, plastics have become increasingly important to our everyday lives. They are found in clothing, building materials, food packaging, medical supply packaging, fishing gear, and car parts. Of the plastic produced worldwide since 1950, ~ 59% is now waste present in landfills or the open environment. As plastics are so prevalent and are often long-lived in the environment, they are being spread from areas of input to remote regions by water currents, wind currents, and animal activity. Plastic pieces (many in the microscopic range that can be easily ingested by animals) are often found in natural waters. The health impacts for those animals ingesting microplastics is an active area of research. This project would investigate plastic-particle types, size ranges, and extents of weathering— in particles suspended in the water column (and thus more likely to impact fish and other organisms in open-lake waters) vs those that sink and are thus most likely to end up in the sediments, impacting animals that live on or feed on the sediments. We will estimate the flux of plastic from the water to the sediments and pinpoint the time of year that most of this flux occurs.

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 measure sinking and suspended plastic particles (>4 mm, >300 µm, >100 µm) in Lake Superior's western gyre by comparing samples from large-volume in situ pumping filtration (suspended particles) at depths from surface water to ~100 m with samples collected in a sediment trap (sinking particles) at 100 m depth. The sediment trap consists of a conical collection surface that deposits sinking particles into a set of rotating tubes, with a new tube put in place every 10 to 20 days. Thus from the sediment trap we not only get physical samples to characterize but a known time frame over which these samples are deposited. We will compare the amount, type, and extent of weathering of microplastics in water column samples with those in the sediment trap to determine predictive factors for the fate of plastic materials in the lake. We will see if there are specific seasons, lake states, or particle types that lead to the sinking and potential burial of plastic particles in sediments. Both suspended and sinking material samples will be analyzed for numbers, shapes (fiber, foam, fragment, etc) and mass of microplastic particles. Microplastic polymers will be identified using specialized equipment (microFTIR or pyGCMS).

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?

This project will provide information on the sources and fate of plastic pollution in Lake Superior. Plastic particles have been identified in the lake's surface waters, fish, and beach sands, but we do not yet know what plastics remain in the water and what get buried in sediments. Surprisingly, plastic density appears a poor predictor of particle location in surface waters vs mid-water column vs sediments. This project will provide insights into factors promoting the sinking of microplastics and help us design effective remediation strategies. It will also inform toxicology studies by providing environmentally-relevant particle loadings and size ranges.

Project Location

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

Region(s): NE

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

Region(s): NE

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Determination of sinking and suspended microplastics in Lake Superior

Activity Budget: $388,270

Activity Description:
Sediment traps have been deployed on cruises funded with non-ENRTF dollars, with installation in August 2021 and recovery/redeployment in August 2022 and August 2023. We request funding to add deployments from August 2023-May 2024, May 2024-October 2024, and October 2024-to May 2025. This will give us two years of sediment trap samples at ~ monthly resolution and 1.6 years at better than monthly resolution at the cost of three sediment trap cruises (May 2024, Oct 2024, and May 2025). On these sediment trap cruises and additional cruises (July 2023, July 2024), we will perform suspended-particle sampling (via McLane pump) at 3 sites within 2 nautical miles of the mooring and at multiple depths (above and below the seasonal thermocline). On the July 2023 and May 2025 cruises we will also collect surface sediments via multicorer from the pumping locations. Sinking-particle samples and sediment samples will be sieved to the same size ranges as the suspended-particle samples. All samples will be oxidized and density separated prior to analysis. The number, size, polymer identification, and extent of weathering of plastic particles will be determined using microFTIR analysis or visual microscopy coupled with pyGCMS (if matrix effects complicate polymer identification using microFTIR).

Activity Milestones:

Description	Approximate Completion Date
Initial testing of sediment trap samples; fine-tuning of microplastic isolation and analysis procedures	February 28, 2024
Preparation and laboratory analysis of the initial suspended-particle and sediment samples	June 30, 2024
Completion of sampling	May 31, 2025
Completion of sample processing and preparation of manuscripts for publication	April 30, 2026

Activity 2: Dissemination of Data to State of MN Partners and the Public

Activity Budget: $23,730

Activity Description:
We will share our results with the interested public via our lab group websites and via Science on Deck presentations, where the R/V Blue Heron, UMD's research vessel, is open to tours by the general public and hosts presentations on scientific issues. We will also present our results at meetings of the Twin Ports Freshwater Folks, a MN-SeaGrant-hosted gathering of researchers, managers, and community members interested in freshwater issues in northeastern MN and western Wisconsin. Results will be shared with partners at the MPCA and MN Department of Health, who are working on risk assessment of microplastics in Minnesota waters via oral presentations and the sharing of data archive links. All data will be archived along with metadata and a brief project description at the Data Repository for U of MN (DRUM), which provides searchable links to archived data for researchers around the world. We request two half-days of funding for the R/V Blue Heron to cover the travel to/from the Duluth Aquarium and the time for the public tours, funding for outreach materials, and salary for the PI to oversee the outreach, data reporting and data archiving.

Activity Milestones:

Description	Approximate Completion Date
Posting project information (including pictures of sampling) on a webpage for the general public	May 31, 2025
Sharing with interested public through Science on Deck	May 31, 2026
Sharing with colleagues at MDH, MPCA, the Fond du Lac Environmental Program and UMN	June 30, 2026
Archiving data in DRUM, a publicly available data repository	June 30, 2026

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Josef Werne	University of Pittsburgh	co-PI via subaward (helping with sediment trap sampling, sample analyses and data interpretation)	Yes
Nancy Schuldt	Water Projects Coordinator, Fond du Lac Environmental Program	interested in the data collected	No
Steve Besser	Statewide Fishing Organization Representative on the Minnesota Clean Water Council	interested in data collected, may assist in sample collection	No
Michael Jacob	Large Lakes Observatory	budgeting and administrative assistance	No
Melissa Maurer-Jones	UMD	coPI	Yes

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.
Our results will be presented at regional or international scientific meetings, such as those held by the Association for the Sciences of Limnology and Oceanography or the American Water Works Association. We will also present our results at meetings of the Twin Ports Freshwater Folks, a MN-SeaGrant-hosted gathering of researchers, managers, and community members interested in freshwater issues in northeastern MN and western Wisconsin. Through this and other mechanisms, our results will be shared with colleagues at the MPCA, the DNR, and the Minnesota Department of Health who have demonstrated interest in the plastic levels in Minnesota waters. Publication of our results in peer-reviewed journals such as Science of the Total Environment, Environmental Science and Technology, or Limnology and Oceanography will allow them to inform research and management on a national to international basis.

The data collected in this project will be archived at the Data Repository for the University of Minnesota (DRUM). The DRUM repository is open-access and provides searchable doi links for data sets.

To share our results with Minnesotans and to help reduce microplastics pollution in Minnesota waters we will give Science on Deck presentations, where the R/V Blue Heron, UMD's research vessel, is parked by the Great Lakes Aquarium (Duluth, MN) for tours by the general public and the hosting of presentations on scientific issues. We will also maintain a website that is focused on sharing project details with the general public.

The Environment and Natural Resources Trust Fund will be acknowledged on project publications, presentations at meetings, electronic media, and other communications using the trust fund logo or attribution language per the ENTRF Acknowledgment Guidelines.

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?

We will share our published data with the interested public through our existing laboratory websites. Seminars/webinars will be used to provide preliminary results to various stakeholders as data becomes available. We will archive the data in a publically available data repository and publish our results in peer-reviewed papers. The data will also be shared with our colleagues at the MPCA and the MN Dept of Health so that they can inform toxicology and risk assessment studies.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Quantifying Microplastics in Minnesota's Inland Lakes	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04d	$200,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
PI		Will oversee the sampling, analyses, reporting, and data archiving			27%	0.18		$32,760
Co-I		Will assist in sampling and analyses, and will oversee the polymer identification and weathering measurements			27%	0.18		$26,900
Technician		Will be responsible for packing for sampling cruises and will perform and teach microplastic isolation and identification protocols.			24%	0.48		$39,999
Summer PhD Grad Student		Will assist in sampling and will perform microplastic isolation approaches and microscopy,			19.1%	0.36		$25,739
Undergrad Researcher		Will assist in analysis of field samples with guidance from the technician. Will prepare the reagents used in microplastics isolation work.			0%	1.23		$26,568
							Sub Total	**$151,966**
Contracts and Services								
University of Pittsburg	Sub award	Co-I Joe Werne from University of Pittsburgh is an expert in sampling sinking sediments for nutrient and carbon flux analyses. His experience with these sampling protocols will enable collection of microplastics flux samples. He will perform total carbon and total sediment mass analyses for placing microplastics amounts in context.		X		0.36		$60,177
UMD-LLO analytical services	Internal services or fees (uncommon)	Lab analyses to identify polymer type in microplastics analysis				0.12		$4,926
							Sub Total	**$65,103**
Equipment, Tools, and Supplies								
	Tools and Supplies	Lab supplies (need to order these for each year of the project, and a small inflation increase is included in years 2 and 3): 4 boxes anodisc filters	The hydrogen peroxide, ferrous chloride, tetrahydrate, and the sodium chloride are reagents used to remove					$24,000

		($3510), 72 petri dishes ($1026), 2 cases hydrogen peroxide ($935), 500g ferrous chloride, tetrahydrate ($501), 1 kg NaCl ($76), 6 boxes of disposable nitrile gloves ($300), 6 boxes of kimwipes ($67), 144 glass sample jars ($1477), 2 pairs forceps ($28)	sample matrix and to isolate the microplastics for analyses. After treatment the reagent solutions plus microplastics are filtered onto anodisc filters, which are made of aluminum oxide and thus are transparent to our microFTIR characterization technique. Gloves, kimwipes, and forceps help in clean sample handling and the samples are stored in the glass jars before processing and petri dishes after filtering.					
							Sub Total	**$24,000**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
							Sub Total	**-**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Printing	Outreach duplicating/copying	Printing costs for materials shared in science on deck outreach					$1,567
							Sub Total	**$1,567**
Other Expenses								
		Blue Heron ship time	Blue Heron Ship time at ~$10,400 per day in 2023. 6.5 days in Period 1 (2 days					$169,364

			for sediment trap deployment-note 1 day is needed for transit time to and from the site, 4 days for water-column in situ pumping, 0.5 days for Science on Deck), and 9.5 days in Period 2 (4 days for sediment trap deployment/recovery of which two days are transit time, 5 days for water column in situ pumping, 0.5 days for Science on Deck). Note that the research cruises are for this ENRTF project only but that the Science on Deck outreach component will be shared with other area researchers.					
							Sub Total	**$169,364**
							Grand Total	**$412,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Contracts and Services - University of Pittsburg	Sub award	Co-I Joe Werne from University of Pittsburgh is an expert in sampling sinking sediments for nutrient and carbon flux analyses. His experience with these sampling protocols will enable collection of microplastics flux samples. He will perform total carbon and total sediment mass analyses for placing microplastics amounts in context.	Werne has over 10 years of experience in sediment trap deployment and organic carbon analyses in deeper-water sites in large lakes and oceans. This expertise is not currently available in Minnesota due to retirements and relocations among that community of researchers. He will be training us in these approaches, thus enhancing the capabilities of Minnesota researchers in the future. Note also that the first deployments of the trap (the ones on non-ENRTF-funded cruises) are provided by his research group at no cost to this project and he is sharing the resulting samples with us.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	University of Minnesota	Unrecovered indirect costs at 55% of 1st $25k for U-Pitt sub, 26% of ship time and 55% of the remaining MTDC project	Secured	$158,137
In-Kind	University of Pittsburg - Joe Werne	6 days of Blue Heron time at $10,400/day plus 26% F&A	Secured	$78,624
			Non State Sub Total	**$236,761**
			Funds Total	**$236,761**

Attachments

Required Attachments

Visual Component

File: a6ac49f1-4af.pdf

Alternate Text for Visual Component

Visual showing the plan for sampling and analyzing sinking and suspended microplastic particles in Lake Superior and sharing this data with those who could use it. The figure also includes pictures of microplastics found in the lake by the PI's research group....

Optional Attachments

Support Letter or Other

Title	File
Transmittal letter from UMD SPA	231e7cd1-b73.docx
Background Check Certification Form	9b84d64d-5a6.pdf
Research addendum for Minor et al	940be0be-350.docx

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

There has been a shift in personnel allocation to match the requested budget, with the shifts reflected in technician vs PI time on the project. The supply budget no longer includes adjustments for inflation; some supplies (e.g., sample storage containers) from the first year will be re-used to minimize budget change effects on sample throughput.

On Nov 7, the plan was amended further to address requested comments and revisions.

On Jan 23, 2023, the approved research addendum was added and the activity 1 description was edited to add sediment sampling.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

N/A

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?

Yes, Sponsored Projects Administration