



## Environment and Natural Resources Trust Fund

### 2023 Request for Proposal

#### General Information

**Proposal ID:** 2023-074

**Proposal Title:** Sinking and Suspended Microplastic Particles in Lake Superior

#### Project Manager Information

**Name:** ELIZABETH MINOR

**Organization:** U of MN - Duluth - Large Lakes Observatory

**Office Telephone:** (218) 726-7097

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#### Project Basic Information

**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.

**Funds Requested:** \$440,000

**Proposed Project Completion:** June 30, 2026

**LCCMR Funding Category:** Water Resources (B)

#### 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

## Narrative

**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, ~ 79% 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  $\mu\text{m}$ , >100  $\mu\text{m}$ ) 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 100m 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.

## Activities and Milestones

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

**Activity Budget:** \$412,255

**Activity Description:**

Sediment traps will be deployed on currently funded cruises, 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: one in May 2024, one in Oct 2024, and the last in May 2025. On these three sediment trap cruises and on additional cruises in July 2023 and July 2024, we will also 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) per site. The sinking-particle 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                                                                                             | 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 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:** \$27,745

**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                                                                                      | 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              |

## 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      |

## Project Manager and Organization Qualifications

**Project Manager Name:** ELIZABETH MINOR

**Job Title:** Professor, Department of Chemistry and Biochemistry and Large Lakes Observatory, University of Minnesota Duluth

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

Minor's research group studies carbon cycling in lake, river, and ocean water columns across seasonal to decadal scales. As part of this work, the group found microplastics in samples originally taken to look at natural organic matter. They started studying where and what types of microplastics are found in the environment and working on methods development in order to better identify these particles. Among Minor's 59 peer-reviewed publications, there are three papers on microplastics works so far, with an additional two manuscripts submitted for review. Minor recently participated in the Microplastics Intercalibration Study run by the Southern California Coastal Water Research Project

(SCCWRP), an intercalibration exercise among 26 labs (primarily in the United States, Canada, and Europe). Minor's past and current research projects (27 in total) have included projects from NSF-Chemical Oceanography, Minnesota Sea Grant, LCCMR, ACS-Petroleum Research Fund, and MPCA and Minor is/was principal investigator (PI) for 17 of these projects. In her most recent projects as PI, Minor has also been responsible for data archiving. Minor has extensive experience as chief scientist on research cruises, pertinent to the extensive field work included in this proposal.

**Organization:** U of MN - Duluth - Large Lakes Observatory

**Organization Description:**

This project will be housed at the Large Lakes Observatory (LLO) at the University of Minnesota Duluth. LLO's mission is to use oceanographic techniques to improve understanding of the world's great lakes, including Lake Superior, the world's largest freshwater lake by area. LLO's faculty (12 faculty in residence and 10 affiliated members) span the disciplines involved in limnology research: biology, geology/earth sciences, physics, chemistry, and engineering. As the twelve resident faculty, their students, and LLO staff all share one building, there is a wealth of collaborative science and an efficient sharing of major instrumentation. Students at LLO include both undergraduate and graduate researchers earning degrees in the individual disciplines listed above as well as master's and Ph.D. level students in Water Resources Science at the University of Minnesota. LLO's research staff include lab technicians with chemical, biological, geological, and physical expertise and the marine technician, captain, and crew that run the R/V Blue Heron, UMD's research vessel.

## Budget Summary

| Category / Name                       | Subcategory or Type | Description                                                                                                                                                                                                                                                                                                                                   | Purpose                                                                                                                                                                                                                                                   | Gen. Ineligible | % Benefits | # FTE | Classified Staff? | \$ Amount        |
|---------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------|-------|-------------------|------------------|
| <b>Personnel</b>                      |                     |                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                           |                 |            |       |                   |                  |
| PI                                    |                     | Will oversee the sampling, analyses, reporting, and data archiving                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                           |                 | 25%        | 0.24  |                   | \$47,082         |
| Co-I                                  |                     | Will assist in sampling and analyses, and will oversee the polymer identification and weathering measurements                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                           |                 | 25%        | 0.24  |                   | \$38,643         |
| Technician                            |                     | Will be in charge of packing for sampling cruises and will perform and teach microplastic isolation and identification protocols.                                                                                                                                                                                                             |                                                                                                                                                                                                                                                           |                 | 22.3%      | 0.48  |                   | \$40,169         |
| Summer PhD Grad Student               |                     | Will assist in sampling and will perform microplastic isolation approaches and microscopy,                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                           |                 | 19.1%      | 0.36  |                   | \$25,424         |
| 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  |                   | \$28,303         |
|                                       |                     |                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                           |                 |            |       | <b>Sub Total</b>  | <b>\$179,621</b> |
| <b>Contracts and Services</b>         |                     |                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                           |                 |            |       |                   |                  |
| 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. |                                                                                                                                                                                                                                                           |                 |            | 0.36  |                   | \$60,177         |
|                                       |                     |                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                           |                 |            |       | <b>Sub Total</b>  | <b>\$60,177</b>  |
| <b>Equipment, Tools, and Supplies</b> |                     |                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                           |                 |            |       |                   |                  |
|                                       | 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 (\$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              | The hydrogen peroxide, ferrous chloride, tetrahydrate, and the sodium choride are reagents used to remove sample matrix and to isolate the microplastics for analyses. After treatment the reagent solutions plus microplastics are filtered onto anodisc |                 |            |       |                   | \$24,727         |

|                                     |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  |                  |                 |
|-------------------------------------|----------|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|------------------|-----------------|
|                                     |          | (\$300), 6 boxes of kimwipes (\$67), 144 glass sample jars (\$1477), 2 pairs forceps (\$28) | 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. |  |  |  |                  |                 |
|                                     |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  | <b>Sub Total</b> | <b>\$24,727</b> |
| <b>Capital Expenditures</b>         |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  |                  |                 |
|                                     |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  | <b>Sub Total</b> | <b>-</b>        |
| <b>Acquisitions and Stewardship</b> |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  |                  |                 |
|                                     |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  | <b>Sub Total</b> | <b>-</b>        |
| <b>Travel In Minnesota</b>          |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  |                  |                 |
|                                     |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  | <b>Sub Total</b> | <b>-</b>        |
| <b>Travel Outside Minnesota</b>     |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  |                  |                 |
|                                     |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  | <b>Sub Total</b> | <b>-</b>        |
| <b>Printing and Publication</b>     |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  |                  |                 |
|                                     | Printing | Outreach duplicating/copying                                                                | Printing costs for materials shared in science on deck outreach                                                                                                                                                                                                              |  |  |  |                  | \$1,185         |
|                                     |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  | <b>Sub Total</b> | <b>\$1,185</b>  |
| <b>Other Expenses</b>               |          |                                                                                             |                                                                                                                                                                                                                                                                              |  |  |  |                  |                 |
|                                     |          | Lab analyses                                                                                | For lab analyses to identify polymer type in microplastics samples                                                                                                                                                                                                           |  |  |  |                  | \$4,926         |
|                                     |          | Blue Heron ship time                                                                        | Blue Heron Ship time at ~\$10,400 per day in 2023. 6.5 days in Period 1 and 9.5 days in Period 2                                                                                                                                                                             |  |  |  |                  | \$169,364       |

|  |  |  |  |  |  |  |                        |                  |
|--|--|--|--|--|--|--|------------------------|------------------|
|  |  |  |  |  |  |  | <b>Sub<br/>Total</b>   | <b>\$174,290</b> |
|  |  |  |  |  |  |  | <b>Grand<br/>Total</b> | <b>\$440,000</b> |

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           |
|------------------|-------------------------------------|----------------------------------------------------------------------|----------------------------|------------------|
| <b>State</b>     |                                     |                                                                      |                            |                  |
|                  |                                     |                                                                      | <b>State Sub Total</b>     | -                |
| <b>Non-State</b> |                                     |                                                                      |                            |                  |
| In-Kind          | University of Minnesota             | Unrecovered indirect costs at 55% of MTDC project costs of \$440,000 | Secured                    | \$242,000        |
| In-Kind          | University of Pittsburg - Joe Werne | 6 days of Blue Heron time at \$10,400/day                            | Secured                    | \$62,400         |
|                  |                                     |                                                                      | <b>Non State Sub Total</b> | <b>\$304,400</b> |
|                  |                                     |                                                                      | <b>Funds Total</b>         | <b>\$304,400</b> |

## 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 | <a href="#">231e7cd1-b73.docx</a> |

## 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

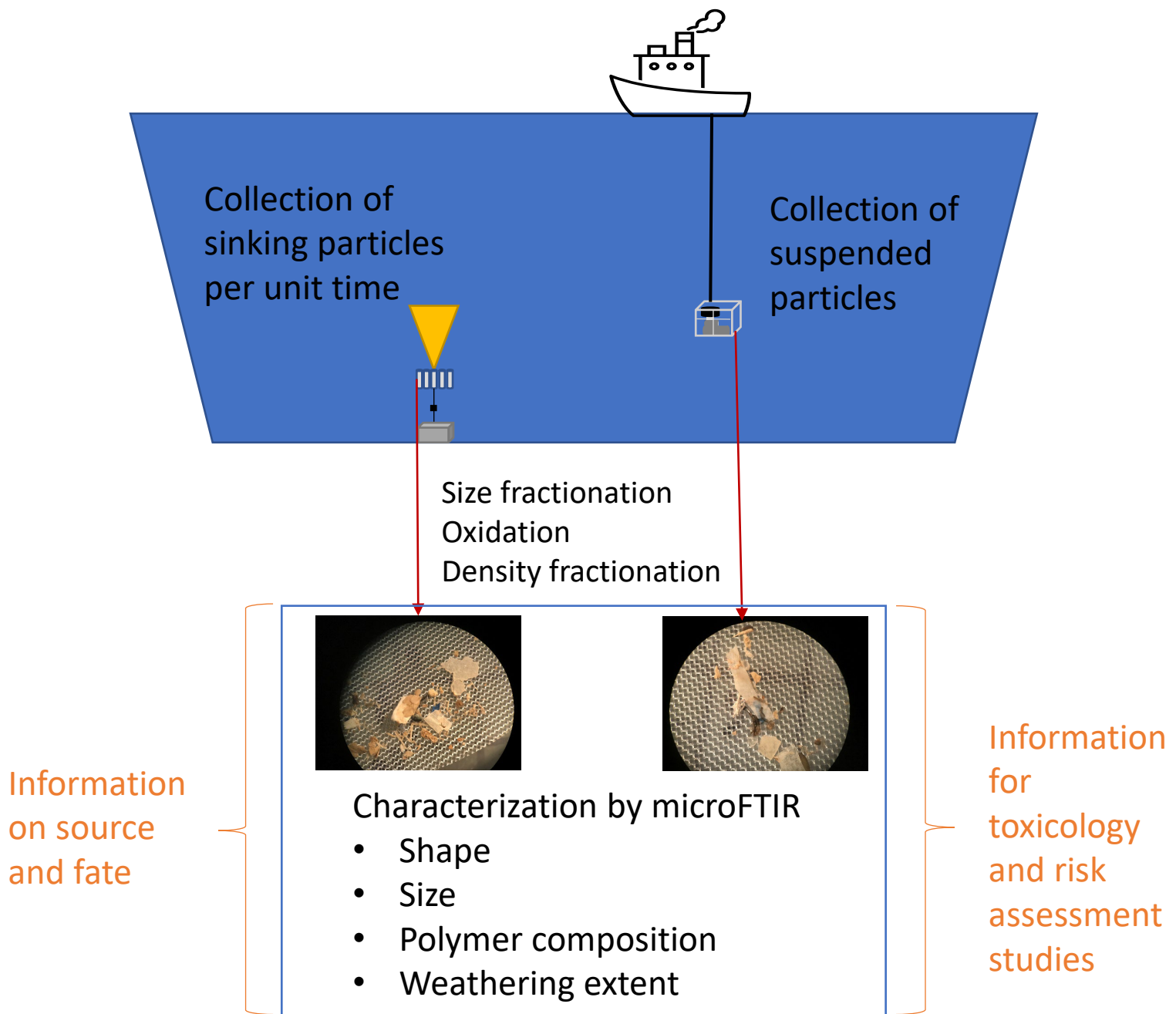
**Does your project include original, hypothesis-driven research?**

Yes

**Does the organization have a fiscal agent for this project?**

Yes, Sponsored Projects Administration

# Sinking and suspended microplastic particles in Lake Superior



## *Sharing of results with:*

1. Interested public through website and Science on Deck presentations
2. Minnesota aquatic scientists and managers through Freshwater Folks meetings and Minnesota Water Resources Conferences
3. The scientific community at large through peer-reviewed journal publications