

**Environment and Natural Resources Trust Fund**

# 2021 Request for Proposal

## **General Information**

**Proposal ID:** 2021-025

**Proposal Title:** Does Micro-Pollution Impact Aquatic Food Webs And Birds?

## **Project Manager Information**

**Name:** Katya Kovalenko

**Organization:** U of MN - Duluth - NRRI

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## **Project Basic Information**

**Project Summary:** We will assess the extent and impact of different types of micro-pollution on birds, fish, invertebrates, and food webs in Minnesota lakes

**Funds Requested:** $175,000

**Proposed Project Completion:** 2023-06-30

**LCCMR Funding Category:** Small Projects (H) **Secondary Category:** Water Resources (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?** In the Future

## **Narrative**

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

Microscopic man-made materials are contaminants of emerging concern in Minnesota freshwaters. Due to the size of these micro-contaminants, they are not effectively removed by wastewater treatment plants. Microplastics have garnered considerable attention in the media, but they comprise only a fraction of the micro-pollution that can enter aquatic food webs. Other types of micro-pollution include metal flakes, paint particles, and synthetic and naturally-derived fibers. These man-made materials are often mistaken for food and eaten by a wide range of animals. Items ingested by lower trophic level organisms, such as zooplankton, could have cascading effects up the food web, potentially disrupting nutrient and energy transfer among organisms. Importantly, we have observed brightly colored synthetic microfibers ingested by macroinvertebrates and in the stomachs of dead birds in our previous studies in Minnesota, but their prevalence and effects are unknown. The vast majority of micro-pollution studies are marine, and comparatively little is known about distribution and impact of man-made materials in freshwater ecosystems.

**What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.**

To understand the impact of micro-pollution on Minnesota freshwaters, we will characterize distribution and transfer of man-made particles through the aquatic food web. Our study will focus on the St. Louis River Estuary, a fishing and birding hotspot important to Minnesota’s economy, and several inland lakes. The estuary is home to a nesting colony of Common Terns (Sterna hirundo), a fish-eating colonial waterbird that is listed as threatened in Minnesota and is among the highest priority species for conservation. The estuary and the nesting colony are within 1.5 km of the Western Lake Superior Sanitary District wastewater treatment plant, a potential point source for micro-pollution. To quantify micro-pollution spanning multiple levels of the food web, we will sample the water column to determine availability of synthetic particles for ingestion and sample the stomach contents of macroinvertebrates, prey fish, and waterbirds across the gradient of micro-pollution. We will evaluate the relative abundance and size distribution of micro-pollution to determine ingestion at each trophic level and infer potential transfer and accumulation. We will also sample inland lakes with limited point-source pollution to understand background levels of micro-pollution effects on food webs.

**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 results of this project will provide novel insight into mechanisms of accumulation of emerging contaminants in a freshwater ecosystem of statewide importance, with implications for drinking water, fishing and threatened species management. Information of the pathways leading to ingestion of man-made particles will be applicable to other freshwaters across the state. Data from inland lakes will provide baseline information for broader studies on the effects of micro-pollution. Quantifying and categorizing micro-pollution will help inform consumers and regulatory agencies which materials are most prevalent in the water and which are most likely to disrupt entire food webs.

## **Activities and Milestones**

### **Activity 1: Sampling and analysis of nearshore aquatic food webs for micro-pollution**

**Activity Budget:** $80,000

**Activity Description:**In Year 1, we will collect water and zooplankton (10 samples/site), macroinvertebrates (>20/site) and fish (20/site) within the estuary and nearshore Lake Superior to quantify the relative abundance and size distribution of micro-pollution in aquatic food webs. Sampling sites will be distributed based on typical avian foraging ranges and will target locations both upstream and downstream of the wastewater treatment plant. In addition to Common Terns, we will also sample the stomach contents of Ring-billed Gull (Larus delawarensis) and Herring Gull (L. argentatus) chicks, which are generalist foragers, to provide information about how foraging behaviors and diets of avian top consumers influence ingestion of micro-pollution. Carcasses of Common Tern and gull chicks (>10/species) will be collected at Interstate Island, a designated Wildlife Management Area for colonial nesting waterbirds. In Year 2, we will conduct a subset of that sampling in 5 large inland lakes away from point-source pollution (Lake of the Woods, Mille Lacs, Leech, Kabetogama, Rainy). We will determine ratios of edible material vs. micro-pollution at each trophic level by pre-processing gut samples using an established peroxide-based digestion method to dissolve organic tissues, leaving man-made materials for analyses and quantify relative volumetric contributions using microphotography.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Collect water, fish, bird samples in 5 inland lakes with limited point-source pollution | 2022-08-31 |
| Collect water, zooplankton, invertebrates, fish and birds at eight sites spanning a point-source pollution gradient | 2022-08-31 |
| Process samples using peroxide digestion and determine dietary contribution of micro-pollution | 2022-12-31 |

### **Activity 2: Quantifying abundance, size distribution, and dynamics of man-made particles in aquatic food webs**

**Activity Budget:** $95,000

**Activity Description:**We will use visual microscopic characterization and melting point forensic analysis to measure and count micro-pollution materials (> 0.2-0.5 mm minimum dimension) at each level of the food web. Pyrolysis gas chromatography mass spectrometry will be used to more precisely characterize the chemical nature of a subset of particles. Carbon and nitrogen stable isotopes collected from a subset of organisms at each trophic level will be used to confirm food web structure and micro-pollution particle size distribution will be used to infer the level at which man-made particles entered the food web.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Quantify distribution of micro-pollution at multiple food web levels relative to distance from wastewater plant | 2023-01-31 |
| Compare particle types and food web impact of micro-pollution in the estuary and inland lakes | 2023-04-30 |
| Evaluate food web linkages using stable isotopes and infer micro-pollution transfer and accumulation pathways | 2023-04-30 |
| Disseminate findings to local organizations and state agencies | 2023-06-30 |

## **Project Partners and Collaborators**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Organization** | **Role** | **Receiving Funds** |
| Dr. Kathryn Schreiner | Department of Chemistry and Biochemistry, Large Lakes Observatory, University of Minnesota Duluth | Provide expertise on microplastic identification, contribute to study design, particle analysis, report and manuscript preparation | Yes |
| Annie Bracey | NRRI, UMD | provide bird expertise, collect bird samples, do stomach analyses and processing, contribute to analyses, reports and manuscripts | Yes |
| Dr. Alexis Grinde | NRRI, UMD | provide bird expertise, input on study design, analyses and report/manuscript preparation | 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 be funded?**Information on types and fate of micro-pollution will help inform development of standards and new ways to address this growing concern at wastewater treatment plants or consumer sources. Sampling inland lakes with limited point-source pollution will provide essential baseline data for future studies. Additional outcomes will include outreach and education (MDNR, St. Louis River Alliance, National Estuarine Research Reserve) and peer-reviewed publications. This is a stand-alone project, but part of a larger research effort led by Dr. Kovalenko to understand freshwater food webs and ecosystem services, and identify and protect key freshwater ecosystems, while providing solutions relevant for Minnesota.

## **Project Manager and Organization Qualifications**

**Project Manager Name:** Katya Kovalenko

**Job Title:** Research Associate and Data Scientist

**Provide description of the project manager’s qualifications to manage the proposed project.**Dr. Katya Kovalenko specializes in food web structure, aquatic invasive species and functional changes in response to anthropogenic stressors as well as ecological statistics. She has worked with stable isotopes in lake ecosystems (including all of the lakes in this study) and has 13 years of experience with sampling and identification of fish and macroinvertebrates and ecological data analyses. Her overall research effort focuses on freshwater food webs and ecosystem services, and seeks to identify and protect key freshwater ecosystems, while providing solutions relevant for Minnesota. She is a co-PI at the Minnesota Supercomputing Institute.

**Organization:** U of MN - Duluth - NRRI

**Organization Description:**Natural Resources Research Institute is a part of the University of Minnesota Duluth. The Microscopy Laboratory, directed by Dr. Valerie Brady (invertebrates and fish) and Dr. Euan Reavie (algae and diatoms), is a 2,500 ft2 facility within NRRI. Laboratory staff include aquatic macroinvertebrate, algal, and diatom taxonomists and fisheries ecologists. Staff are experienced at assessing organism assemblages from a variety of aquatic habitats, evaluating aquatic habitat conditions, and establishing biological indicators for fish, amphibian, macroinvertebrate, diatom and periphytic communities. Equipment includes a variety of high quality research-grade compound and stereomicroscopes, some with digital imaging capabilities for training, archiving images, and estimating sample biomass. NRRI field sampling equipment includes a fleet of six open water sampling vessels and two shallow water, flat bottom water craft; a variety of invertebrate, water sampling and benthic coring devices; water quality instrumentation units (e.g., Hydrolab Sondes, YSI multi-probes); shallow-water electrofishing equipment; passive fish collection equipment (fyke trap nets, purse and standard seine nets).

## **Budget Summary**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Category / Name** | **Subcategory or Type** | **Description** | **Purpose** | **Gen. Ineli gible** | **% Bene fits** | **# FTE** | **Class ified Staff?** | **$ Amount** |
| **Personnel** |  |  |  |  |  |  |  |  |
| Dr. Katya Kovalenko, PI |  | Oversee field sampling of aquatic food web, isotope and diet processing, analyze results, prepare reports |  |  | 26.7% | 0.2 |  | $22,172 |
| Dr. Kathryn Schreiner, Co-PI |  | Provide expertise on microplastic identification, contribute to study design, particle analysis, report and manuscript preparation |  |  | 26.7% | 0.08 |  | $12,894 |
| Dr. Alexis Grinde, Co-PI |  | Oversee sampling of the avian part of the food web, provide input on study design, analyses and ms preparation |  |  | 26.7% | 0.14 |  | $17,246 |
| Annie Bracey, Co-PI |  | Provide input on study design, collect bird samples, do stomach analyses and processing, contribute to analyses, reports and manuscripts |  |  | 26.7% | 0.44 |  | $39,278 |
| Josh Dumke |  | Assist with field work and provide input into fish diet analyses |  |  | 26.7% | 0.1 |  | $8,932 |
| Robert Hell |  | Assist with field work and lab work including sample prep for SIA and invertebrate sorting |  |  | 24.1% | 0.2 |  | $14,017 |
| Kari Hansen |  | Assist with lab work including sample prep for SIA |  |  | 24.1% | 0.18 |  | $9,240 |
| Holly Wellard Kelly |  | Macroinvertebrate Lab Technician will dissect macroinvertebrate guts and analyze particle dimensions on all samples except birds |  |  | 24.1% | 0.3 |  | $18,653 |
| Julia Agnich |  | Analytical Lab Technician will prepare samples for stable isotope and pyrolysis analyses |  |  | 24.1% | 0.2 |  | $11,670 |
| Field Summer Tech (undergraduate student) |  | Assist with field sampling |  |  | 0% | 0.08 |  | $2,619 |
|  |  |  |  |  |  |  | **Sub Total** | **$156,721** |
| **Contracts and Services** |  |  |  |  |  |  |  |  |
| Large Lakes Observatory (UMD) | Internal services or fees (uncommon) | Stable Isotope Analyses to understand food web connections: 500 samples at $11.74/sample, internal rate by LLO |  |  |  | 0 |  | $5,870 |
| Large Lakes Observatory (UMD) | Internal services or fees (uncommon) | Pyrolysis GC/MS Analysis for microplastics characterization: 160 at $40 per sample, internal rate by LLO |  |  |  | 0 |  | $6,400 |
|  |  |  |  |  |  |  | **Sub Total** | **$12,270** |
| **Equipment, Tools, and Supplies** |  |  |  |  |  |  |  |  |
|  | Tools and Supplies | Vials for SIA analysis (500 vials $100), misc field supplies and wet ice ($100), ethanol ($200), dry ice ($200) | Sample collection and preservation |  |  |  |  | $600 |
|  | Tools and Supplies | Peroxide (6 x 1L, 30%), dissecting tools and supplies (2 sets), vials (quantity will depend on the number of particles recovered) | Microplastics digestion supplies and reagents |  |  |  |  | $1,200 |
|  |  |  |  |  |  |  | **Sub Total** | **$1,800** |
| **Capital Expenditures** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Acquisitions and Stewardship** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Travel In Minnesota** |  |  |  |  |  |  |  |  |
|  | Miles/ Meals/ Lodging | Y1 local travel (10 d, 300mi at $0.575/mi, truck, trailer rental $15/d); Y2 state 3 ppl visit 5 lakes, 2 days per visit, lodging $125/night, per diem/meals $48 partial days, 450mi, truck rental) and local travel (150 miles at $0.575/mi, 5 days of truck $15/d) | Needed to collect samples of water, zooplankton, fish, invertebrate and birds in the Minnesota portion of the St. Louis River Estuary and 5 inland lakes across MN |  |  |  |  | $4,209 |
|  |  |  |  |  |  |  | **Sub Total** | **$4,209** |
| **Travel Outside Minnesota** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Printing and Publication** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Other Expenses** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
|  |  |  |  |  |  |  | **Grand Total** | **$175,000** |

### **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 | UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modifiedtotal direct costs. | Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs) | Secured | $96,250 |
|  |  |  | **Non State Sub Total** | **$96,250** |
|  |  |  | **Funds Total** | **$96,250** |

## **Attachments**

### **Required Attachments**

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

File: [95f7765c-eb7.pdf](https://lccmrprojectmgmt.leg.mn/media/map/95f7765c-eb7.pdf)

#### ***Alternate Text for Visual Component***

This visual shows how micro-pollution can be consumed by organisms at each level of the food web, leading to accumulation at the higher trophic levels

### **Optional Attachments**

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

|  |  |
| --- | --- |
| **Title** | **File** |
| Sponsored Projects Authorization | [1aa4239c-b80.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/1aa4239c-b80.pdf) |

## **Administrative Use**

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

**Does your project have patent, royalties, or revenue potential?**
 No

**Does your project include research?**
 Yes

**Does the organization have a fiscal agent for this project?**
 Yes, Sponsored Projects Administration