Environment and Natural Resources Trust Fund
2019 Request for Proposals (RFP)

Project Title: **ENRTF ID: 088-B**

Pathways of Human Impact in Lake Superior

Category: B. Water Resources

Sub-Category:

Total Project Budget: $ 568,470

Proposed Project Time Period for the Funding Requested: June 30, 2022 (3 yrs)

Summary:

Watershed impact on Lake Superior is not evenly distributed. This project will establish zones of heavy human influence in western Lake Superior to further assessments of many kinds.

Name: Robert Sterner

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

Title: Director and Professor

Department: University of Minnesota Duluth

Address: 2205 East 5th St.

Duluth MN 55812

Telephone Number: (218) 726-7926

Email stern007@umn.edu

Web Address https://scse.d.umn.edu/large-lakes-observatory

Location

Region: Northeast

County Name: Aitkin, Carlton, Itasca, Lake, Pine, St. Louis

City / Township: Duluth

Alternate Text for Visual:

Watershed map and pathways of impact

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%
____ If under $200,000, waive presentation?			

PROJECT TITLE: Pathways of human impact in Lake Superior

I. PROJECT STATEMENT

There is much concern over how present and future human activity will affect Lake Superior. However, to properly assess potential impact we need to know much more than we presently do about how substances enter and move through this huge lake. Such fundamental information is needed to improve risk assessments and management decisions of many kinds, including those made by fisheries managers, water utilities, public health services and others. This project will assess human impacted areas in Lake Superior by focusing upon the fate of water and sediment exiting the Duluth-Superior harbor, which form a distinct, uniquely active environment as they move through the lake. Vulnerable locations, such as water intakes, lake trout spawning sites, and areas of concentrated recreational use are of particular concern. This work will build on past and current research (some funded by LCCMR) to learn where the impact from Minnesota watersheds is largest and how zones of high impact differ from the bulk of offshore waters. Without this critical foundational information we cannot properly perform specific risk assessments.

We will focus on the water and sediment leaving the Duluth-Superior harbor. Upwards of 11,000 km^2 of land surface (the majority of this from Minnesota) drains into this harbor, mostly via the St. Louis and Nemadji rivers. This location is by far the largest source of surface water and sediment to western Lake Superior. Watershed activities such as forest product processing, wastewater treatment, mining, and industrial activities together with intense streambank erosion take place in these watersheds. These activities may increase the sediment supply from the watershed, increase nutrients levels in the lake, and increase the risk of introducing harmful contaminants into the lake. But, this potential harm is not evenly and equally distributed. The area of highest impact has been largely overlooked by previous investigations. By describing for the first time the behavior of this nearshore zone of high impact, we will lay the groundwork for more specific assessments of specific pollutants and impacts later.

The experienced LLO scientific team on this project will take an interdisciplinary approach to understanding the extent of watershed influences on Lake Superior, combining physics (how water moves), geology (how sediment moves), and ecology (how the chemistry and biology of the lake is affected). Field work will utilize the 86' *R/V Blue Heron* for most in-lake sampling and the 25' *R/V Kingfisher* for shallow-water work.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Pathways of water* - This activity will assimilate new information and build tools to chart the movement of harbor water in western Lake Superior, revealing what locations in the lake are most susceptible to potentially harmful substances from the land. Data for the model will include satellite observations of lake color and light attenuation, underwater autonomous glider observations of temperature and water-born substances, and discrete and continuous water column measurements (temperature, light, and chemistry) collected from vessels. A new sediment sub-model will be developed, linking this activity with the next one.

ENRTF BUDGET: $46,951 (excl. ship costs)

Outcome	Completion Date
1. Chart the physical pathways of terrestrially sourced water and its constituents within the lake under a variety of meteorological scenarios	Early 2022
2. Implement a sediment transport submodel in existing hydrodynamic model	
3. Share new model results via publications, outreach, and websites.	

Activity 2: *Pathways of sediment*– Some pollutants that enter the lake do so tightly bound to solid particles, but we do not yet know where on the lake bottom these end up. Transects from the harbor entrance to the offshore will be studied in detail using acoustic mapping technology to characterize the spatial and temporal distribution of sediment supplied from the watersheds Corresponding sediment measurements will include C, N, P and S

content, oxygen penetration, and grain size. Biological communities will be studied as well. Sediment-water exchange will be studied at representative locations.

ENRTF BUDGET: $49,959 (excl. ship costs)

Outcome	Completion Date
1. Create geophysical maps of lake bottom from harbor to offshore	*Early 2022*
2. Quantify composition of sediment in and out of zones of high land influence	
3. Quantify rates of sediment-water exchanges	

Activity 3: *Characteristics and activity of riverine water in Lake Superior –* This activity will address the questions of 1) How does the zone of heavy human influence differ from the bulk of offshore waters, and 2) What are some of the processes that may affect anthropogenic substances as they move and mix into the lake waters? We will use chemical markers (e.g., sucralose, dissolved colored carbon, salinity) as tracers of sewage and other stressors to understand how they distribute around the lake. Measurements will also include nutrient concentrations and pH, as well as abundance of lower food web organisms (algae, microbes, zooplankton, and benthos) and rates of key biogeochemical processes. Work in this activity will establish for the first time what fundamental processes are occurring in the zone where most terrestrial influence is felt in Minnesota's portion of Lake Superior. Results will be assembled into a new ecological model.

ENRTF BUDGET: $122,289 (excl. ship costs)

Outcome	Completion Date
1. Quantify chemical composition in zones of high and low river influence	*Early 2022*
2. Quantify organism abundance in the same zones as above	
3. Create an ecosystem model of the south shore river	
4. Share results with project partners	

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding. This project will be run entirely out the Large Lakes Observatory, University of Minnesota Duluth. The LLO at UMD is uniquely positioned to perform this work.

Receving research (not salary) support form this project from the Large Lakes Observatory, UMD:
R Sterner (Director, project management, biological productivity), J Austin (Professor, lake physics), J Downing (Professor, limnology), C Filstrup (Research Associate, algal dynamics), S Katsev (Associate Professor, lake physics, biogeochemistry), E Minor (Professor, carbon, nutrient cycling), T Ozersky (Assistant Professor, food webs); C Sheik (Assistant Professor, microbes), R Ricketts (Research Associate, ship operations, logistics), J Swenson (Associate Professor, sediment movement), N Wattrus (Associate Professor, bottom mapping).

B. Partners NOT receiving ENRTF funding. None

IV. LONG-TERM- IMPLEMENTATION AND FUNDING

We have shared this proposal with several parties, who have expressed an interest in our results. We will plan to host an annual briefing so we can bring partners up to date and get their input about future plans. Partners will include the MN-DNA (Dr. Cory Goldsworthy) and the LS-NERR (Dr. Erika Washburn).

V. TIME LINE REQUIREMENTS:

Three years of funding (July 1, 2019 through June 30, 2022) will allow for two partial and two full field seasons.

2019 Proposal Budget Spreadsheet

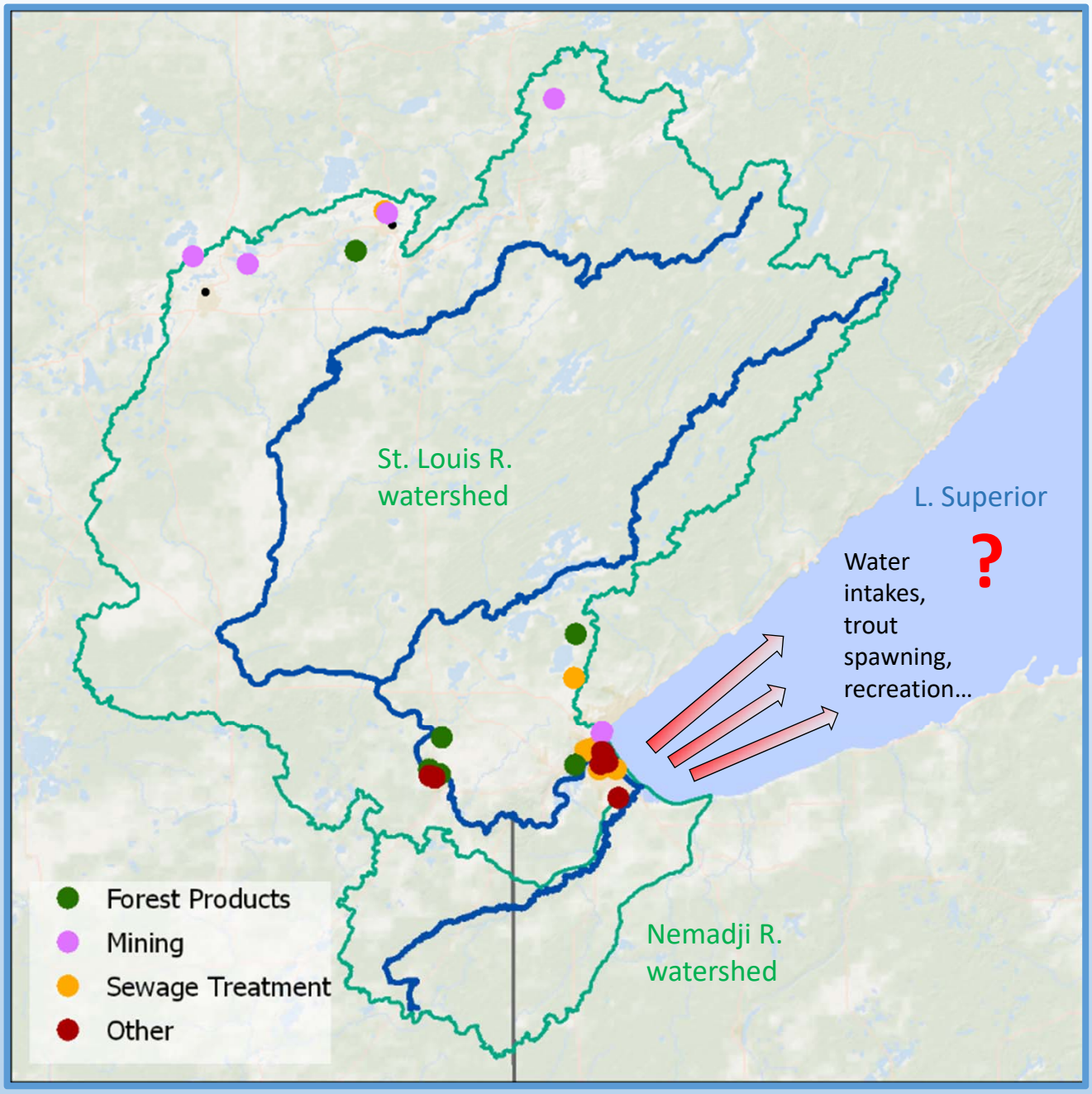
Project Title: Pathways of Human Impact in Lake Superior

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM (See "Guidance on Allowable Expenses")	**AMOUNT**	
Personnel:	$	159,199
Technicians, 3 positions, 2 y: Physics (.15 FTE), Ecology (.5 FTE), Sediment (.13 FTE) (79% Salary/21% fringe) Technicians will assist with field logistics, provide field and laboratory support, and collect and organize data.		113615
Graduate Research Assistants; 6 summer positions .33 FTE (87% Salary/13% fringe) Collect data in collaboration with senior personnel to be used toward their MS or PhD theses		45584
Professional/Technical/Service Contracts:	$	-
Equipment/Tools/Supplies: Field sampling/laboratory supplies. Includes: specialized batteries for glider and profilers, chemical reagents for laboratory analyses of pH, oxygen, and nutrients, glass and teflon bottles, calibration standards to ensure accurate measurements by laboratory instruments, maintenance and calibration of field instruments, monitoring and workshop supplies.	$	60,000
Acquisition (Fee Title or Permanent Easements):	$	-
Travel:	$	-
Additional Budget Items: Shiptime Blue Heron sum = 30 d. Day rate = $11,000. Covers fuel, crew salaries, insurance, maintance, meals. Shiptime Kingfisher =20 d. day rate $500. Includes fuel, crew salaries, insurance, maintenance. Inflation applied to years two and three	$	349,271
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$	568,470

V. OTHER FUNDS *(Incomplete information in this draft)*

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ To Be Applied To Project During Project Period: Related funded projects that will provide additional relevant information to LCCMR work include:	$ -	
National Science Foundation grants to UMD for support of the R/V Blue Heron.	$ 1,848,921	*Current*
Kelly/Austin NSF, "Coastal inertial-band dynamics"	$ 626,197	*Current*
Katsev/Ozersky NSF "Ecosystem-scale responses"	$ 588,388	*Current*
Other State $ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period: Unrecovered F&A	$ 176,605	*Secured*
[#] Faculty investigator's time in each of 3 years. Investigators are enthusiastic about this project and are willing to work on it without compensation. Total of 2 months by 11 faculty investigators		*Secured*
Past and Current ENRTF Appropriation:	$ -	
ENRTF 2013; Chap 52, Sect 2, Subd. 5f Evaluation of Lake Superior Water Quality Health	$ 600,000	Past
ENRTF 1999; Chap 231, Sect 16, Subd. 12g Assessing Lake Superior Waters Off the North Shore	$ 400,000	Past
TF/GLPA 1997 Chap 216, Sect 15, Subd 14g Training and Res. Vessel for Lake Superior	$ 250,000	*Past*
Other Funding History: The R/V Blue Heron, which was purchased in part with LCCMR funds, has been used in ~$20 million of federally funded grants (research and ship ops). The LLO is one of the University's largest water-based research centers and it averages >$1 million/y in external grant funding.		



How do materials from land concentrate or distribute in the lake?

Scientists from UMD-LLO will study the water, organisms and sediment to find out.

Project Manager

Robert W. Sterner, Professor and Director, Biology and Large Lakes Observatory, University of Minnesota Duluth, 218-726-7926, stern007@d.umn.edu. He will serve as project lead with fiscal responsibility, organizing field work, insuring coordination among investigators, and filing necessary LCCMR reports and updates.

Dr. Sterner has experience in limnology and in science management. He received a PhD in Ecology, Evolution and Behavior in 1986 from the University of Minnesota, Minnapolis. He then worked as a Postdoctoral Associate at the Max Planck Institute for Limnology in Ploen, Germany from 1986-87. Following that, he was an Assistant then Associate Profesor at the University of Texas-Arlington from 1988-1994. In 1994, he was hired by the University of Minnesota, where he served as Head of the Ecology Evolution and Behavior Department from 1998-2003. He took a leave of absence to hold a senior manager position at the National Science Foundation in the DC area from 2007-9. In 2014 he became Director of the Large Lakes Observatory and joined the UMD faculty.

He has held federal funding from the NSF, USGS and NOAA, and has participated in past LCCMR projects managed out of the LLO. Dr. Sterner has published >90 peer-reviewed articles, has been cited >7,000 times (h-index = 42), and is one of the founding scientists in the field of ecological stoichiometry. He has advised numerous agency and private firms in water quality issues.

Institution

The Large Lakes Observatory at the University of Minnesota Duluth is a 20+-year-old research unit with the unique mission to perform scientific studies on the large lakes of Earth. Located in Duluth, research on Lake Superior has been a large part of LLO activities since its inception. Its thirteen faculty include representation from all basic limnological sciences (physics, chemistry, biology, geology). Including all faculty, staff and students, LLO comprising ~60 individuals.

Among LLO's crucial infrastructure assets are its two largest boats. The R/V Blue Heron is the largest university-owned research vessel on the Great Lakes and the only member of the US oceanographic UNOLS fleet. It is capable of multi-day, round the clock operations. Bookkeeping rules associated with UNOLS membership mean that an accurate measure of true operational costs (crew salaries, meals, insurance, fuel, maintenance, etc.) are closely examined each year and make up the day rate that all projects including this one must cover. The Blue Heron gives six scientists at a time a capable and adaptable platform for investigation and its instrumentation includes a Knudsen echo sounder, an ADCP (to measure currents), and an underway system that makes continuous measurements of temperature, chlorophyll, CDOM, and salinity. A smaller, nearshore boat, the Kingfisher, can carry 2-3 scientists with one maritime crew. It provides access to near shore locations.

Other infrastructure which this project will benefit from include one or two buoyancy gliders that allow for autonomous sampling from the surface to the bottom, a full analytical chemical lab, a multi-corer, grab samplers, plankton nets, a Geopulse seismic reflection system, several Satlantic nitrate sensors, as well as microscopes.