Environment and Natural Resources Trust Fund
2015 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **055-B**

Nutrient Dead-Zone Interactions in the St. Louis Estuary

Category: B. Water Resources

Total Project Budget: $ 550,200

Proposed Project Time Period for the Funding Requested: 3 years, July 2015 - June 2018

Summary:

Stakeholders need to know the nutrient-absorbing capacity of the St. Louis River to prevent establishment of dead zones and resulting further mobilization of contaminants due to changes in oxygen levels.

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Sponsoring Organization: U of MN - Duluth Large Lakes Observatory

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Location

Region: NE

County Name: St. Louis

City / Township: Duluth

Alternate Text for Visual:

Map of lower St. Louis River showing Dead Zones from March 2014

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage		_____ TOTAL

PROJECT TITLE: Nutrient dead-zone interactions in the St. Louis estuary

I. PROJECT STATEMENT

There is a natural limit to the levels of nutrients that the St. Louis River can absorb before its ecosystem functions are impaired, and stakeholders need to know this limit and the regions of the waterway that will be most impacted. Links between excessive nitrogen, phosphorus and organic matter inputs, subsequent algal blooms, organic matter decay, and the resulting lack of water-column oxygen have been shown for many water systems, including the St. Louis River, a key Lake Superior tributary and home to the largest shipping port on the Great Lakes. Low oxygen prevents fish and wildlife from thriving in a region and can release legacy contaminants from underlying sediments. Prior to mitigation by the Western Lake Superior Sanitary District (WLSSD), violations of oxygen standards occurred in 25% of monitored water samples in the St. Louis River, and poor water quality resulted in the loss of the river's fishery and water-dependent recreation opportunities. The control of point source inputs of nutrients, organic matter, and toxins has led to the environmental transformation of the St. Louis River over the past thirty-five years. The City of Duluth and the surrounding region have benefited significantly; a clean river brings economic opportunities including an increase in tourism dollars and a high quality of life drawing people to the region. While point-source discharges have been addressed by WLSSD, non-point source inputs, such as overland runoff and atmospheric deposition, are harder to control. These are likely to have increased due to land use and hydrology changes (e.g., increased prevalence of severe storm events). Although some $420M have been put into cleaning up the St. Louis River, recent observations and study results suggest that additional efforts are needed to maintain these improvements:

- Measurements in the past two winters have documented large areas where there is not enough oxygen to support healthy fish populations.
- Over the past 14 years inorganic nitrogen concentrations have increased in the St. Louis River and Lake Superior. The growth of algal communities near Oliver, MN has been shown to be limited by nitrogen while, in some back bay areas, algal growth is co-limited by both nitrogen and phosphorus or is phosphorus-limited.
- After the Solstice Flood of 2012, there were reports of algal blooms in nearshore Lake Superior. Very high phosphorus concentrations (greater than those in Lake Erie during the 1970s) were measured in Superior Bay and in nearshore Lake Superior in flood-impacted waters.

In his 2014 State of the City address Duluth Mayor Don Ness, announced plans to develop the western side of Duluth, which is intimately connected to and benefits from a healthy St. Louis River. Will the region continue to benefit from a healthy river or are stressors acting to return it to its former, degraded state? Concurrently-collected data on anoxia, nutrient levels, and chlorophyll levels in the St. Louis River are very sparse. Results from bioassays, used to determine what limits algal growth in the river, are even sparser. We propose to provide this key information to stakeholders, who can use it to understand recent changes in the St. Louis River and to manage this important natural resource for future generations.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Measuring patterns in oxygen and water quality in the lower St. Louis River during summer growth and winter conditions **Budget: $284,900.00**

Six stations will be sampled along a river-to-lake transect extending from above the town of Oliver to nearshore Lake Superior. An additional 6 stations, arranged along the flow gradient at 2 shallow bays will also be sampled. Sampling will occur in March (under ice), monthly from May through Oct, and opportunistically to follow two storm events. During each sampling event, pH, oxygen, temperature, and conductivity will be measured at 1 m intervals from the surface to the bottom using in-water sensors. In addition, water samples will be collected and analyzed in the lab for carbon, nutrients, photosynthetic pigments, and algae communities.

Outcome	Completion Date

1. Distribution map of areas of low oxygen	February 2016 & 2017
2. Report describing the algal communities along the transect	June 2017
3. Report describing the nutrient, carbon and water quality	June 2017

Activity 2: Using bioassays to determine the nutrient levels that trigger adverse biological response

Budget $244,039.00

Monthly field and lab studies will be conducted to determine whether nitrogen or phosphorus (or both or neither) controls algal growth. A better understanding of these patterns will help to determine the natural capacity of the St. Louis to assimilate nutrients, where low oxygen zones may develop in the future, whether nitrogen is removed from the river *via* denitrification or is transported into Lake Superior, and when conditions may favor algal blooms.

Outcome	Completion Date
1. Distribution map of areas of where nutrients affect algal growth	June 2017
2. Final report describing the nutrient assimilation capacity of the St. Louis	June 2017

Activity 3: Communication to stakeholders and the interested public through webpages, videos, press releases, and presentations **Budget $21,261.00**

Seagrant will produce outreach materials including, an explanation of the study and its results and implications for non-technical audiences will be posted on the St. Louis River Estuary Stories and Science Website (http://stlre.pebbleonline.com). We will host a professional development workshop for teachers and non-formal educators about nutrient impacts on the estuary. We will also develop press releases and regular updates through social media outlets. We will give a presentation on this work to the Freshwater Folks, a community of scientists, managers, and stakeholders involved in water quality issues in the Twin Ports area.

Outcome	Completion Date
1. Distribution of outreach materials to stakeholders and the interested public	June 2016 & 2017

III. PROJECT STRATEGY

A. Project Team/Partners

U of M Duluth Large Lakes Observatory: Dr. Ralph J. Garono, biologist (ENRTF-funded; project management, algal communities, water quality)**;** Dr. Elizabeth Austin-Minor, chemical limnologist (ENRTF -funded; water quality, lake sampling, and carbon); **MN Sea Grant:** Cindy Hagley, outreach specialist (ENRTF-funded; Public outreach)**; Lake Superior National Estuarine Research Reserve:** Dr. Shon S. Schooler will assist in outreach and coordination at no cost to the project.

B. Project Impact and Long-Term Strategy: This project will enable resource managers to evaluate the relationship between nutrient levels, degraded fish habitat (low oxygen), and algal blooms in the St. Louis River and nearshore Lake Superior. It will also provide insights into the impacts of storm event inputs on the water quality and biology of the St. Louis River. Water quality and algae community data will be directly used by and disseminated by MN Sea Grant, the NERR, UMD, and other researchers. The NERR and LLO currently operate arrays of continuous monitoring equipment; this project will benefit from these detailed time-series of water-column parameters, adding additional water-quality and biological impact data, and allowing the potential correlation of our detailed data with the monitored parameters.

C. Timeline Requirements: 3 yr: We are requesting funds to begin work in July 2015. ***2015***: July-October, monthly sampling of transects and storm-event sampling. November & December, analysis of data. January and February, season 1 report and development of outreach materials. March, under ice sampling. ***2016****:* May-October monthly sampling of transects and storm-event sampling. November and December, analysis of data. January and February, writing of season 2 report, further development of outreach materials. ***2017****:* March, last under ice, winter sampling, synthesis of 2015 and 2016 data. May and June: Final report preparation.

2015 Detailed Project Budget

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IV. TOTAL ENRTF REQUEST BUDGET *3* **years**

BUDGET ITEM	AMOUNT
Personnel:	$ -
R. Garono (3 yrs at 0.6 FTE + 33.6% Fringe; UM-D/ LLO; Project Management, Algae, WQ)	$ 216,514
E. Minor-Austin (3 yrs at 0.5 FTE for summer + 33.6% Fringe; UM-D/ LLO; Water Quality)	$ 62,676
C. Hagley (2 yrs @ 0.1 FTE + 33.6% Fringe; MN Sea Grant; Outreach)	$ 17,516
Research Tech (2 yrs @ 0.2 FTE + 23.1% Fringe; UM-D/ LLO; Laboratory & Field Analysis)	$ 30,182
Graduate Student (3 yrs @ 0.5 FTE + 1.0 FTE Summer + 23.1% Fringe; UM-D/ LLO)	$ 119,397
Undergraduate Student (2 yrs @ 1.0 FTE Summer; Laboratory & Field)	$ 11,473
Contracts:	N/A
Equipment/Tools/Supplies:	$ -
Plankton Nets (4 @$500 ea.) various mesh sizes to sample algae in river and lake	$ 2,080
Ice Auger to sample winter ice algae	$ 7,500
Laboratory and Field Supplies: reagents, disposal, gloves, tubing, etc. for$2500 per yr. for 2 yrs.	$ 5,100
Water Quality Probe reagents and use (@$1500 per yr)	$ 3,060
Fluroprobes to measure algal pigments @ $2000 per yr. for 2 yr.	$ 4,080
Acquisition (Fee Title or Permanent Easements):	N/A
Travel:	N/A
Additional Budget Items:	$ -
LLO Water Quality: Testing of 336 samples (@ $80 ea.) for CDOM and other water quality components	$ 30,060
Bioassays (200 @$6.80 ea)	$ 1,392
Outreach Materials: webpage updates, color brochures, PowerPoint slides.	$ 3,745
R/V Blue Heron (6 trips @ $4535, $4715 per day)	$ 27,775
Shallow Draft River Boat (15 trips @$500 per day)	$ 7,650
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 550,200

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	N/A	
Other State $ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period: *R/V Blue Heron Cruises Provided by LLO*	$ 18,860	*Secured*
Funding History:	N/A	
Remaining $ From Current ENRTF Appropriation:	N/A	

St. Louis River
Dead Zone Survey
March 2014

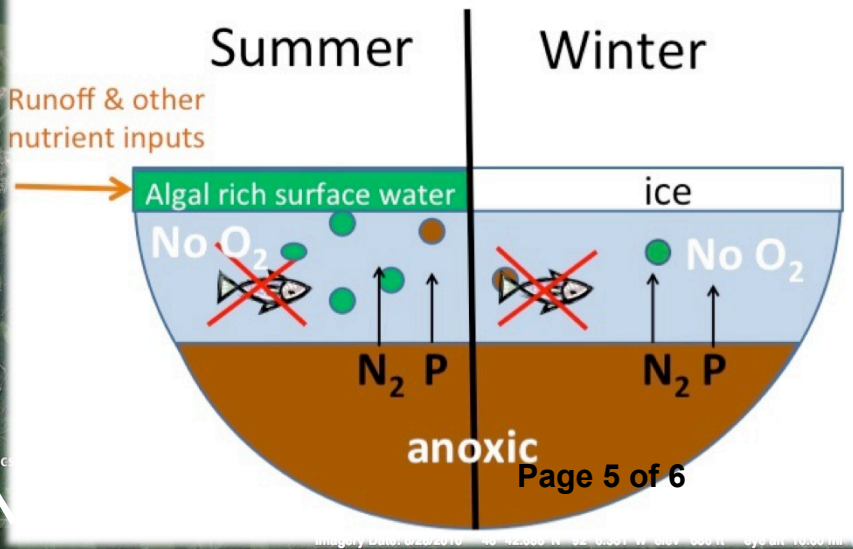
Duluth

Superior

Oliver

Key

- Anoxic: Lethal to Fish
- Low Oxygen: Stressed
- Good
- Unknown



04/21/2014

Project Manager Qualifications

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Dr. Ralph Garono is a Research Associate at the Large Lakes Observatory at the University of Minnesota Duluth (UMD). He has published more than 60 scientific articles and technical reports. He recently worked to establish the NOAA-funded, Lake Superior National Estuarine Research Reserve, serving as the Manager/Director during its first two years of operation. He has managed numerous grant-funded research projects including those from the U.S. Army Corps of Engineers, U. S. EPA, NOAA, and the National Park Service. Dr. Garono has served on committees for national and international scientific organizations.

Relevant research projects:

- Periphyton Community Survey And Nutrient Limitation In The Siuslaw River Basin (OR)
- Periphyton Community Survey And Nutrient Limitation In The Siletz River Basin (OR)
- Phosphorus dynamics of plankton communities in Sandusky Bay, Sandusky Ohio: Examination of a contemporary hypothesis along a continuum of phosphorus availability."

Relevant publications:

Garono, R.J., R.T. Heath and S. J. Hwang. 1996. Detrended correspondence analysis of phytoplankton abundance and distribution in Sandusky Bay and Lake Erie. Journal of Great Lakes Research. 22(4): 818-829.

Organization Description

The **Large Lakes Observatory** (LLO) is a research institute at the University of Minnesota Duluth. LLO was established in 1994 to make systematic use of oceanographic techniques in lake studies. We have grown (currently 10 faculty members) to have a global outlook and an international reputation with field programs and collaborators on 6 continents. In addition to housing a vibrant graduate program (we have attracted students from Malawi, Tanzania, Uganda, Ghana, China, Malaysia and the Netherlands), LLO provides unique research opportunities to undergraduates; in the past few years UMD undergraduates have participated in field programs in Indonesia, Mexico, Malawi, as well as on Lake Superior. Close ties have been formed with institutes in Canada, Uganda, France, Norway, Kyrgyzstan, Kenya, Nicaragua, Malawi, Tanzania and England, as well as with many universities within the United States. We are working to understand how lakes function, how they behaved in the past, and what will happen to them in the coming years.

The LLO operates the largest university-owned research vessel in the Great Lakes. The R/V Blue Heron was purchased with LCMR support in 1997, and is the only member of the University National Oceanographic Laboratory System (UNOLS) on the Great Lakes. The ship is outfitted with state-of-the-art research equipment that provides unique capabilities for observing Lake Superior. Although LLO is the lead organization on this proposal, researchers from other parts of the University of Minnesota Duluth, the University of Minnesota Twin Cities, and the Minnesota Department of Natural Resources will be involved in the collaborative research we propose