

**Environment and Natural Resources Trust Fund
2016 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 061-B

Vanishing Winter: Effects on Lakes Small to Large

Category: B. Water Resources

Total Project Budget: \$ 600,000

Proposed Project Time Period for the Funding Requested: 3 years, July 2016 to June 2019

Summary:

Climate-driven declining ice cover on Minnesota lakes from small to large will be studied using state of the art science tools and public involvement.

Name: Robert Sterner

Sponsoring Organization: U of MN - Large Lakes Observatory

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Location

Region: NE

County Name: St. Louis

City / Township: Duluth

Alternate Text for Visual:

Winter is vanishing on Minnesota lakes from small to large. This project will obtain new data to help us understand what that means for Minnesota water resources.

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



PROJECT TITLE: Vanishing Winter: Effects on Lakes Small to Large

I. PROJECT STATEMENT

This project combines science, outreach and education to expand knowledge of how changing winter conditions impact Minnesota’s northern lakes, including Lake Superior. Ice-covered lakes are iconic of our region, but Minnesotans have seen a drastic reduction in the extent and duration of ice cover on Lake Superior and smaller lakes alike. Further declines are forecasted. Ice has major impacts on lake ecosystems and on the way people interact with lakes, but science has only begun to address basic questions about what “vanishing winter” means for Minnesota lakes. Our efforts will strategically combine state-of-the-art science tools (e.g. ship-board analytical measurements, autonomous vehicles, automated profilers) with the assistance of interested members of the public to meaningfully expand direct winter observations, creating new knowledge and communicating it in novel and creative ways. Our overall strategy is to make direct winter observations on a range of lakes small to large and to continue lengthening our observational data on Lake Superior that includes summers following high-ice and summers following low-ice years.

The Large Lakes Observatory at the University of Minnesota Duluth has been engaged in studies of Lake Superior and other lakes for the two decades of its existence. \$1.6 million of LCMR/LCCMR support to obtain the Blue Heron (in 1997) and for three research projects since (1999, 2006, 2013) has helped leverage \$15 million in research funding from other sources to date. The Research Vessel Blue Heron continues to be a uniquely valuable research platform during open water seasons, and state-of-the-art autonomous instruments such as a glider and moored profilers are allowing us to expand the scope of our observations to the rest of the year. From these data a picture is emerging of how winter conditions affect the lake during the following summer. However, despite these advances, the dearth of direct winter observations of Lake Superior and of comparative data from inland lakes leaves us with an incomplete picture of potential long-term impacts of “vanishing winter”. Simply stated, what happens in lakes under ice is a big question mark. The proposed project will extend the scope of our research on the role of winter in Minnesota’s lakes by including direct observations of winter conditions in Lake Superior and smaller lakes. New crowdsourcing collaborations among LLO researchers and ice angler and other citizen scientists will enable collection of data during the winter and summer seasons, while expanding opportunities for members of the public to experience science.

The overall goals of this project are to enhance scientific understanding of changing winter conditions on Minnesota lakes; train a cadre of citizen scientists, including educators, to extend our research spatially and temporally; and provide opportunities for citizens, teachers, and students to gain experience and knowledge about Lake Superior, research techniques, and impacts of a changing climate on Minnesota’s lakes.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Extending the Lake Superior Observational Record

Budget: \$380,000

Our observation record of physical, chemical and biological parameters from onboard the Blue Heron and using autonomous glider and profiling moored instruments has begun to reveal differences in summers following high vs. low ice years. This part of the project will extend this observational record and allow us to test emerging ideas of how climate affects Earth’s largest lake. Sampling will be a strategically reduced subset of the work being performed under the current LCCMR award. Part of this activity will be to build an integrated database to serve data to scientists and the public.

Outcome	Completion Date
<i>1. Build database and open up selected information to the public</i>	June 2017
<i>2. Interim report on seasonal and annual changes in the lake ecosystem</i>	Mar. 2018
<i>3. Final report on seasonal and annual changes in the lake ecosystem</i>	Mar. 2019



Activity 2: “LLO Science on Deck” up the shore

Budget: \$100,000

Knowledge that is generated is of little utility unless communicated. We will expand our popular “Science Friday” public outreach events, now to be called “LLO Science on Deck,” to communities along the Minnesota North Shore, sharing knowledge and connecting scientists with the public.

Outcome	Completion Date
1. Science on Deck at Duluth, Two Harbors, Beaver Bay, Grand Marais	Fall 2017, 2018
2. Public and/or Citizen Scientist tours of the R/V Blue Heron	Fall 2017, 2018

Activity 3: Citizen Science Program

Budget: \$120,000

This part of the project extends our reach by enlisting citizen scientists in data collection. Avid ice anglers, teachers, and lake home-owners will be recruited and trained to collect summer and winter research quality data from selected lakes. Volunteers will be trained by scientists and they will experience Lake Superior research on the R/V Blue Heron, to be further exposed to analysis, interpretation, and visualization of research results.

Outcome	Completion Date
1. Citizen/teacher/student data collection	Jan 2018 & 2019
2. Citizen/teacher participation on the RV Blue Heron	Fall 2017 & 2018
3. Online- dissemination of data and analyses to participants, agencies, and the public	Jul 2017 & ongoing

III. PROJECT STRATEGY

A. Project Team/Partners

Requesting Trust Fund support:

U of M Duluth LLO: Robert Sterner (project management, biological productivity; data management); Jay Austin (lake circulation); Erik Brown (carbon & nutrient cycling); Sergei Katsev (water-sediment interactions); Elizabeth Minor (carbon & nutrient cycling); Ted Ozersky (under-ice biology; food webs); Richard Ricketts (ship operations; logistics); Kathryn Schreiner (carbon cycling).

UMD MN Sea Grant: Cynthia Hagley (Citizen Scientist Program).

UMD Biology: Donn Branstrator (zooplankton ecology); Tom Hrabik (fish ecology).

UMD NRRI: Richard Axler (data dissemination; on-line data visualization).

B. Project Impact and Long-Term Strategy

Our goal is to understand seasonal responses of lake systems, including Lake Superior’s, under changing climatic conditions. Information collected will be especially useful when integrated with work of other organizations including: USEPA, MNDNR, MPCA, USGS, Lake Superior National Estuarine Research Reserve. We will extend long-term datasets resulting from earlier work supported by NSF, MN Sea Grant and LCCMR. Lengthening our observational record will add great value to the existing data and make us more competitive when seeking funding from other sources. Integration of citizen science into the project will expand our research temporally and spatially and increase citizen understanding and stewardship of Minnesota’s lakes.

C. Timeline Requirements

Three years of funding (July 2016 through June 2019) will allow work on the lake over two full field seasons (2017 and 2018) with supplemental observations in 2016 to assure continuity in our datasets.

2016 Detailed Project Budget

Project Title: Vanishing Winter on Minnesota's Lakes from Small to Large

IV. TOTAL ENRTF REQUEST BUDGET 3 years

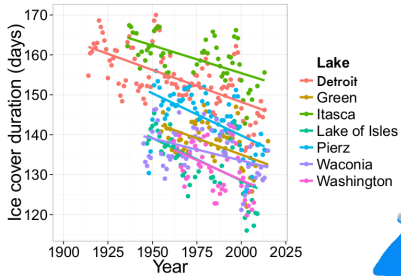
BUDGET ITEM	AMOUNT
Personnel: Includes fringe benefits- 33.7% for academic professionals, 27.4% for technicians, 22.4% for Graduate Assistants and 7.9% for undergraduate students	
Education/outreach professionals; Cynthia Hagley and Marte Kitson; 10%, 2 years	\$ 18,500
Data server/visualization professionals; Richard Axler and 2 others TBD; 5-10%, 3 years	\$ 45,000
Graduate Teaching Assistants (Teacher training, Citizen Science, Chemical and Physical Limnol); 5 positions during summer and 1 during academic year. Assistants TBD.	\$ 90,000
Chemical Field/Lab Technicians; 2 positions; part time; 3 years	\$ 70,000
Undergraduate students; 2 positions summer only, 3 years. Students TBD.	\$ 20,000
Equipment/Tools/Supplies:	
Field sampling/laboratory/outreach 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, mooring anchors, fitting and wire for moored systems, maintenance and calibration of field instruments, monitoring and workshop supplies.	\$ 32,000
Laboratory analyses: Costs charged by the sample, including organic carbon, nutrients, pH, photosynthetic pigments, C:N, stable isotopes, ~500 samples	\$ 22,000
Satellite telephone for instrument control and data transfer. Mooring: 25 min/day for 400 days. Profilers: 60 min/day for 60 days. \$0.65 per minute.	\$ 8,840
Travel:	
Mileage for UMD employees to participate in 'Science on Board' events and to assist Citizen Scientists. UMD reimbursement rate	\$ 3,250
Additional Budget Items:	
Shiptime sum = 30 d. Day rate = \$9500. Covers fuel, crew salaries, insurance, maintenance, meals. Teacher Training 4d, LLO Science on Deck 10d, Strategic open lake monitoring 16d	\$ 285,000
Educator support, busing, and subsistence	\$ 5,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 599,590

V. OTHER FUNDS

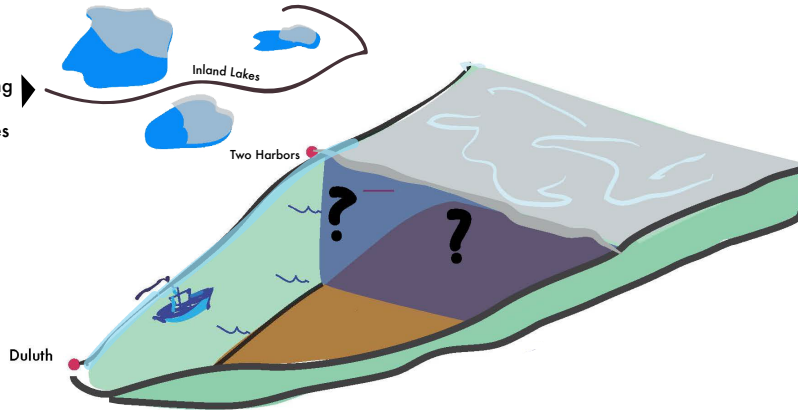
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period:		
Characterizing and Understanding Climate Warming on Large Lakes. Austin. NASA	\$ 39,999	Current
National Science Foundation grants to Ricketts for support of the R/V Blue Heron.	\$ 802,280	Current
Small plastics in a big lake: Improved Detection and enhanced understanding of micro-plastics in the Lake Superior food web. Sterner, Minor, Schreiner. Minnesota Sea Grant.	\$ 109,633	Pending
Opening the black box of winter: ice cover and biological productivity in Lake Superior. Ozersky. Minnesota Sea Grant	\$ 57,579	Pending
Interacting drivers of pH variability in the Laurentian Great Lakes. Sterner. NOAA.	\$ 235,397	Pending
Organic matter production, processing, and storage in a permanently and seasonally hypoxic and seasonally ice-covered freshwater environment. Schreiner. Amer. Chem. Soc.	\$ 110,000	Pending
Flipping a foundational interdisciplinary graduate curriculum while strengthening connections outside academia. Schreiner, Katsev, Sterner and two others. Nat. Sci. Foun.	\$ 369,579	Pending
Other State \$ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period:		
LLO/UMD will provide its small boat as needed for deployment of the underwater glider	\$ 3,000	Secured
Nine Investigator's time in each of 3 years. Investigators are enthusiastic about this project and are willing to work on it without compensation.		Secured
Funding History (partial):		
ENRTF 2013; Chap 52, Sect 2, Subd. 5f Evaluation of Lake Superior Water Quality Health	\$ 600,000	
TF/GLPA 1997 Chap 216, Sect 15, Subd 14g Training and Res. Vessel for Lake Superior	\$ 250,000	
Remaining \$ From Current ENRTF Appropriation: E. T. Brown 2013; Chap 52, Sec 2, Subh 5f	\$ 298,440	Unspent

Winter Summer

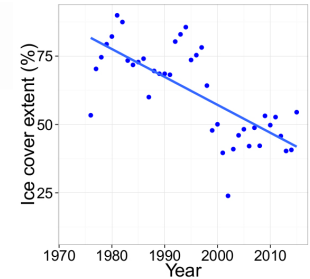
Vanishing Winter, Small Lakes



Ice cover duration (as 5-year moving average) from 7 lakes throughout Minnesota. On average, these lakes lost between 5 and 10 days of ice cover over the past 50 years.



Vanishing Winter, Lake Superior



Ice cover extent (as 5-year moving average) on Lake Superior. There has been about a 25% drop in winter ice extent since the 1970s

The Team
Scientists
Teachers
Students
Anglers



Research Vessel Blue Heron. This ship has been instrumental in many scientific advances made about Lake Superior in the past 20 years.



LLO Science on Deck events connect scientists with an interested public.



LLO scientists sampling Lake Superior winter conditions.

Project Manager Qualifications

Robert W. Sterner

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Dr. Robert Sterner is the Director of the Large Lakes Observatory and Professor of Biology at the University of Minnesota Duluth. He has a PhD in Ecology (1986, University of Minnesota) and has held a research position at the Max Planck Institute in Germany and faculty positions at the University of Texas at Arlington, the University of Minnesota, Twin Cities and now at UMD. From 2007-9 he served as the Director of the Division of Environmental Biology at the National Science Foundation. He has done field studies of the Lake Superior ecosystem for > 15 years.

The Large Lakes Observatory has the unique mission of scientific study of the large lakes of Earth. It is part of the University of Minnesota Duluth. LLO held its 20-y anniversary in July, 2014. Eleven scientists in diverse disciplines make up the LLO research and teaching faculty. The NRRI also is affiliated with UMD and scientists there have extensive experience with serving data effectively to the public. Minnesota Sea Grant is one of the Nation's 33 Sea Grant programs and it supports research and outreach throughout the State.

RWS selected grants:

- 2013 Legislative Commission on Minnesota Resources – “Evaluating Lake Superior’s Health in a Changing World” \$600,000 over two years. Co-PI with 8 other PIs.
- 2007 Minnesota Sea Grant. Primary Production and Grazing Dynamics in the Ultra-Oligotrophic Waters of Lake Superior. \$224,220 for two years. RWS sole PI.
- 2009 National Science Foundation – Chemical Oceanography – “Collaborative Research: Sources and Sinks of Stoichiometrically Imbalanced Nitrate in the Laurentian Great Lakes” with one other Co-PI at Minnesota and two Co-PI’s at other institution. RWS Project Director. 4 years. Total project, \$1,168,051; Minnesota part, \$824,761.

RWS selected most-relevant publications:

- Finlay, J. C., G. E. Small, and R. W. Sterner. 2013. Human influences on ecosystem nitrogen removal in lakes. *Science* 342:247-250.
- Sterner, R. W. 2011. C:N:P stoichiometry in Lake Superior: Freshwater sea as end member. *Inland Waters* 1:29-46.
- Sterner, R. W. 2010. In situ-measured primary production in Lake Superior. *Journal of Great Lakes Research* 36:139-149.
- Sterner R.W., Andersen T., Elser J.J., Hessen D.O., Hood J.M., McCauley E., Urabe J. 2008. Scale-dependent carbon:nitrogen:phosphorus seston stoichiometry in marine and freshwaters. *Limnology and Oceanography* 53:1169-1180.
- Sterner, R. W. and J. J. Elser. 2002. *Ecological stoichiometry: The biology of elements from molecules to the biosphere*. Princeton University Press, Princeton, NJ.