Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-235

Proposal Title: Different causes=different cures for murky lakes

Project Manager Information

Name: John Downing

Organization: U of MN - Duluth - Sea Grant

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Project Basic Information

Project Summary: We build on recent ENTRF-funded work showing decreased clarity in north-central lakes, leveraging a unique dataset and a unique team to diagnose causes, prescribe cures and stop or reverse it.

Funds Requested: $769,000

Proposed Project Completion: June 30 2025

LCCMR Funding Category: Water Resources (B)

Project Location

What is the best scale for describing where your work will take place?

Region(s): Central, NE, NW,

What is the best scale to describe the area impacted by your work?

Region(s): Central, NE, NW,

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.

"Why would these lakes be changing in northern Minnesota where there's not a lot of land use changes going on?" Leif Olmanson, StarTribune, 2/21/2021.

Recent ENTRF-funded work shows a concerning decrease in water clarity in many of Minnesota's prized north-central lakes. For decades scientists have known that increased phosphorus from lakeshore development fuels algal growth, which decreases clarity. Obvious cures for this are to limit lakeshore development, replace old septic systems, etc., with direct impacts to both landowners and local economies. Although lakeshore development can cause decreased clarity, there are many other possible causes. Newspaper articles point to climate change as a contributing factor. Adopting a one-size-fits-all management approach will not work in many cases and could cause major needless expenditures. If your car won't start, do you automatically buy a new ignition switch or try to figure out what's wrong first? This study is a unique opportunity to determine which of the many causes are in play for many of the hardest-hit north-central lakes and will identify diagnostic tools applicable to many others. We need to find the causes first, then apply the right cure.

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.

There are at least 12 different reasons that north-central lakes could be losing clarity (see Activity 3); some are related to development while many are not. We will use Itasca County lakes as a bellwether to determine why north-central lakes are getting murky. This diagnosis will allow us to prescribe the best cures for all Minnesota's lakes sharing similar characteristics. In 2008-2010 two of us (JD & JJ) assisted a broad citizens' group, the Itasca Water Legacy Partnership (itascawaters.org), by designing and executing an MPCA-funded program to create full assessments, meeting MPCA's rigorous standards, of all 179 "recreational development" lakes among Itasca County's 1000 lakes. This base-line is unique in Minnesota. Itasca County is ground-zero for lakes experiencing clarity changes (see visual). The data included all of the measurements that, when repeated now, will tell us whether and how much each lake is changing and why those changes are happening. This unique team of experienced lake- and watershed-restoration scientists will use that knowledge to prescribe the right cost-effective cure for each lake. Knowing the right cures for different lake types will yield guidance for lakes across Minnesota's lake region and indicators to Minnesota agencies on future water quality assessment needs.

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?

We will determine if, how much, and why water clarity has changed in these bellwether lakes. Mechanisms responsible for changes since 2008-2010 will be correlated with commonly measured lake characteristics so findings can be applied where intensive surveys do not exist. This will allow prediction, region-wide, of the prevalence of different causes of change, avoiding wasted public and private money from pointless management. Cause of clarity change will be associated with the most impactful remedial measures and outreach will help lake interest groups and agencies determine how best to assess, protect and improve water quality in Minnesota lakes.

Activities and Milestones

Activity 1: Analyze the 2008-2010 survey data, calculating the measures to compare with 2022-2025

Activity Budget: $105,447

Activity Description:

To most effectively use the original 2008-2010 survey as a baseline for determining the causes of transparency change, we need to first make several summaries and calculations. The first activity will be to supplement the Itasca Waters dataset in a way to facilitate the design of the new survey and comparison with it. In the 2008-2010 survey, at each site, overboard photographs were taken of a white and black Secchi disk lowered to a known depth. This helps understanding of the color cast of the water as well as the types and relative colors of particles on the surface and suspended beneath it. Photographs will need to be analyzed for some of the measurements needed to triage the sources of transparency change (see list under Activity 3). Several new measures will need to be calculated from profiles (e.g., thermal resistance to mixing, thermocline depth, oxygen depletion rates). Weather records will be summarized to account for storms and heating. Retrospective GIS analysis will determine past land use and shoreline development during the 2008-2010 survey and historical records will be summarized to determine the timing of past invasions of aquatic invasive species.

Activity Milestones:

Description	Completion Date
Assemble 2008-2010 data, photos, field sheets and profiles and make public	December 31 2022
Calculate thermal resistance to mixing, thermocline depth and oxygen depletion	March 31 2023
Perform historical GIS analysis of land cover and use, and historical weather and development data	March 31 2023

Activity 2: Design and execute the 2022-2025 assessment to compare to 2008-2010 baseline

Activity Budget: $555,893

Activity Description:

The original survey took 10 sets of samples on each date in each lake, took a water profile of temperature, oxygen, and other variables on each date, and measurements were made using a certified laboratory. In order to keep the design as powerful as possible the 10 new sets of samples for each lake will be done using the same methods and will be seasonally synchronized to yield measurements performed at approximately the same time of year as in the 2008-2010 survey. This is powerful because we will be able to pair each new sample with the equivalent-date sample from the baseline survey instead of comparing seasonal averages. Travel among lakes will require a lot of personnel time so we will spread sampling over two years. Two graduate students will lead the field crews and undergraduate students will be hired to assist them. We will attempt to support graduate and undergraduate students who have regional and tribal college backgrounds preferentially. Field equipment including boats and profiling equipment will be drawn from NRRI, UMD and LLO. Rigorous training will ensure that standard protocols are observed. Laboratory analyses will follow certified protocols and data will be uploaded to MPCA's EQuIS database.

Activity Milestones:

Description	Completion Date
Design an assessment that will closely replicate the timing of sampling for each 2008-2010 lake	April 30 2023
Hire and train graduate students and field personnel	May 31 2023
Deploy assessment program	May 31 2023
Complete assessment program	September 30 2024
Analyze and summarize all data including rates of change since 2008-2010	December 31 2024

Activity 3: Group lakes by the causes of transparency change, extrapolate region-wide, and recommend cures for these lakes and others

Activity Budget: $107,660

Activity Description:
There are several plausible causes of altered clarity of north-central Minnesota lakes. Some likely ones are:

-Acidification
-Altered oxygen depletion
-Aquatic invasive species
-Atmospheric nutrient loading
-Brownification
-Change in algae size from warming
-Deeper algae from surface stabilization
-Eutrophication from shore development
-Land erosion from storms and land use change
-Marl suspension
-Phosphorus:nitrogen balance
-Surface algae blooms from warming

The cause of clarity change in each lake will be determined from analyses across the 14-year period. Characteristics of lakes with different causes of clarity change will be grouped and extrapolated to other Minnesota lakes by analysis of publicly available data. This will reveal the most likely frequency of the causes of clarity change in Itasca County and the entire lake region. Because each cause will prescribe a different cure, a region-wide set of recommendations for individual lake and watershed management will be developed. For example, eutrophication from shoreland overdevelopment would prescribe riparian protection, septic tank improvement and decreases in permeable surface area. Progressive brown-staining of water (brownification) would indicate management of run-off and liming. An extension and outreach program through Minnesota Sea Grant will help lake associations, agencies, and others implement optimal lake and watershed management and restoration strategies.

Activity Milestones:

Description	Completion Date
Determine rates of change in all measures, especially transparency, for individual lakes	December 31 2024
Group lakes by the most plausible mechanism for change	December 31 2024
Associate clarity change mechanisms with curative measures	December 31 2024
Execute outreach program to help lake associations, counties, agencies, etc. with implementation	June 30 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Christopher T. Filstrup	Natural Resources Research Institute	Filstrup will lead efforts to collect and measure water quality in Itasca lakes, including training project personnel in field and analytical methods and co-mentoring graduate students, and will assist with statistical analyses, data interpretation, and project reporting.	Yes
John R. Jones	University of Missouri; Curators' Professor Emeritus	Jones will be engaged in design, data analyses and formation of management plans in this project. He has owned a summer cabin on Deer Lake, Itasca Co. for 25 years. His career addressed causes and correctives of lake eutrophication (over 140 publications), including involvement in the early Itasca lake study.	No
Lesley Knoll	Itasca Biological Station and Laboratories, UMN Twin Cities	Knoll will be engaged in project design, data analyses, formation of management plans, scientific publications, outreach efforts, and co-mentoring students as needed.	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 be funded?

By June 2025, we will publish a list of study lakes that are changing in clarity, which causes are occurring in each lake, and the restoration techniques needed to best restore or protect them. We will publish a list of likely causes and cures for other north-central lakes. We will help other organizations create, execute and fund restoration projects from diverse funding sources by supporting a web portal of accessible information on Minnesota Sea Grant's website. We will seek funding to support workshops and free consultations from the National Oceanic and Atmospheric Administration and hire a lake restoration extension educator.

Project Manager and Organization Qualifications

Project Manager Name: John Downing

Job Title: Professor

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

Downing has 40 years of experience in aquatic research and community outreach. He is Director of the Minnesota Sea Grant College Program, a research scientist at the Large Lakes Observatory, and a Professor in the Department of Biology at UMD. He has more lake diagnostic and restoration experience than any lake scientist in the Midwest US, having overseen the restoration of at least 14 lakes. He also oversaw the full design for at least two new lakes. He has overseen lake assessment of over 400 lakes and watersheds, having assessed 140 lakes over a 14-year time-span. Downing, with Jones and Filstrup, are likely the only scientists in the Midwest who have undertaken successful whole-lake/whole-watershed lake restoration projects, Knoll has performed extensive landscape-lake pattern assessments in the Midwest, and Jones oversaw the longest-standing lake assessment program in the US. Although Downing has life-long roots in north-central Minnesota and the Twin Cities Metro area, he was formerly a Regent's Professor of Ecology, Evolution, & Organismal Biology and Agricultural & Biosystems Engineering at Iowa State University and ran one of the best-funded and long-standing research operations at that institution. His 150+ peer-reviewed books and journal articles cover diverse topics in limnology, marine science, environmental economics, and terrestrial ecology. His leadership has been as the Director of the Laurentian Biological Station (Montreal), the co-founder of the Inter-University Limnological

Research Group (Montreal), Director of the Iowa State University Limnology Laboratory, Chair of the Environmental Science Graduate Program (Iowa State), President of the Association for the Sciences of Limnology and Oceanography, and Chair of the Council of Scientific Society Presidents. Recent outreach has assisted those in agricultural regions to understand and mitigate nutrient pollution and helped citizens and industries in northern Minnesota combat eutrophication and avoid lake degradation from aquatic invasive species.

Organization: U of MN - Duluth - Sea Grant

Organization Description:
Minnesota Sea Grant is part of the National Oceanic and Atmospheric Administration's (NOAA) Sea Grant Program, which supports 34 similar programs in coastal states throughout the United States and Puerto Rico. Our mission is to facilitate interaction among the public and scientists to enhance communities, the environment and economies along Lake Superior and Minnesota's inland waters by identifying information needs, fostering research and communicating results. Minnesota Sea Grant concentrates on research, outreach, and education in four focus areas: Healthy coastal ecosystems, sustainable fisheries and aquaculture, resilient communities and economies, environmental literacy and workforce development. This research will be performed using the facilities of the Large Lakes Observatory (LLO) and the Natural Resources Research Institute (NRRI), both in Duluth, Minnesota. Laboratory analyses will be performed in Filstrup’s Laboratory at NRRI. It is a fully certified facility and equipped with state-of-the-art analytical infrastructure. LLO has a unique mission: to perform scientific study of the largest lakes of Earth. It is one of the largest water-centered research units at the university and its impact has been felt all over the world. NRRI's mission is to deliver research solutions to balance our economy, resources and environment for resilient communities.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
John Downing		Principal Investigator; Manage project, supervise students, operate outreach			26.73%	0.03		$9,779
Christopher Filstrup		Co-investigator; Supervise sampling and analytical work, data analysis, and interpretation			26.74%	0.3		$32,040
Beth Bernhardt		Laboratory technician; coordinate laboratory work			24.12%	0.3		$22,040
Jerry Henneck		Field technician; Coordinate field work and training			24.12%	0.3		$26,687
Zachary Wagner		Field and lab technician; Perform field sampling and analysis			24.12%	0.3		$18,335
Undergraduate student workers		Perform field sampling and analysis			0%	1.5		$40,923
Graduate student 1		Perform field work and data calculations			46.34%	1.5		$138,195
Graduate student 2		Perform field work and data calculations			46.34%	1.5		$138,195
							Sub Total	**$426,194**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	Laboratory supplies	Provide sample bottles in each project year					$7,158
	Tools and Supplies	Field supplies	Provide sampler columns, notebooks, pens, batteries, calibration supplies, sunscreen, replacement sensors					$9,666
							Sub Total	**$16,824**
Capital Expenditures								

							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	38 sampling days each year including 16,000 miles each year at $0.56 per mile plus 2 vehicle base rentals at $120 per week for 16 weeks per year; each sampling team will consist of 2 people	Move sampling teams among 179 lakes to collect samples and transport them to the laboratory					$32,640
	Miles/ Meals/ Lodging	In each of three years: motel cost for 3 nights per week for 16 weeks at $96 per night for each of two rooms; per diem for 2 people at $385 per person per week for 16 weeks during each of three years	Lodging and feeding sampling crews					$46,128
	Other	Mileage only for travel for Jones (unpaid) living in Itasca County to collaborate with work at laboratories in Duluth; 200 miles round-trip for seven trips per year at $0.56 per mile in years 2 and 3	Bring Jones to laboratories to work with investigators, staff and students					$1,568
	Other	Mileage only for travel for Knoll (unpaid) to Duluth laboratories from Itasca Biological station; 14 trips per year at $0.56 per mile, 200 miles round-trip in each of years 2 and 3	Bring Knoll to laboratories to work with investigators, students and staff					$3,136
							Sub Total	**$83,472**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		Analytical fees	Analysis of 1790 sets of samples (10 sets each for 179 lakes); This is at a very competitive rate of $135 per set					$242,510

			and will be done at cost in Filstrup's lab at the Natural Resources Research Institute; including chlorophyll, total and volatile suspended solids, a full nutrient panel, dissolved organic carbon, pH, alkalinity, and true color; all analyses are certified and full subjected to full quality assurance and quality control processes					
							Sub Total	**$242,510**
							Grand Total	**$769,000**

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	University of Minnesota unrecovered indirect costs	55% of direct costs less graduate student tuition	Secured	$368,744
			Non State Sub Total	**$368,744**
			Funds Total	**$368,744**

Attachments

Required Attachments

Visual Component

File: 6731c9dc-cfe.docx

Alternate Text for Visual Component

The visual illustrates press coverage of the murky lakes phenomenon and shows four different causes of altered water clarity and how they each lead to different cures or remedial measures. It also illustrates that the lakes we will study are positioned directly in the path of clarity changes in north-central Minnesota lakes....

Optional Attachments

Support Letter or Other

Title	File
LCCMR Transmittal letter Downing 1043142	f19042d8-4e3.pdf

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?

No

Different causes = different cures for murky lakes

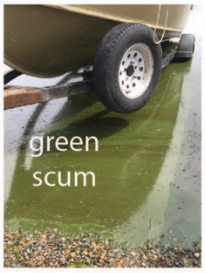
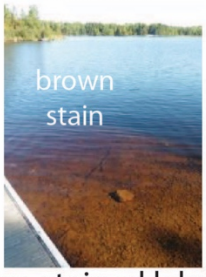
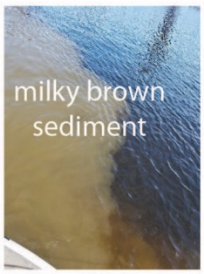
SUNDAY, FEBRUARY 21, 2021 — StarTribune — STARTRIBUNE.COM/LOCAL • SECTION B

MINNESOTA

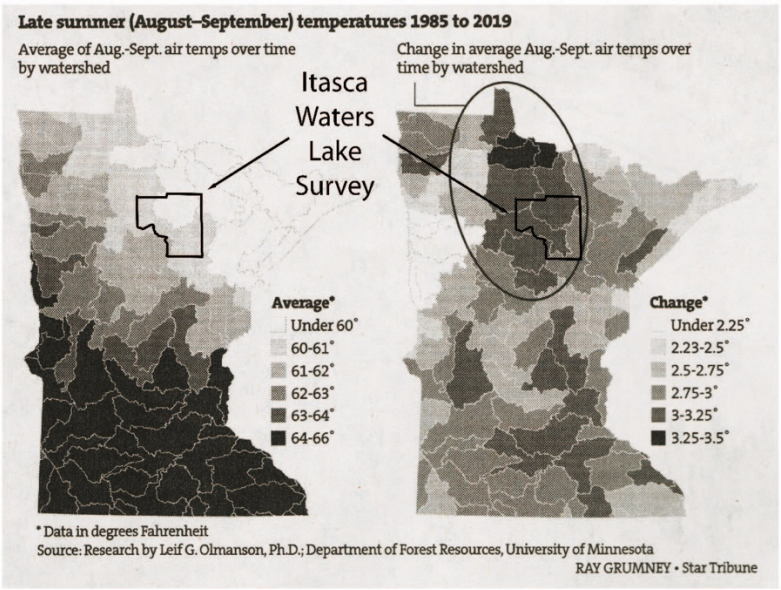
LOCAL • STATE • REGION

North-central Minnnesota lakes get murkier

You can't fix the problem if you don't know the cause!

Cause	Example Cure	Cause	Example Cure
			
Algal blooms	Nutrient management	Tea-stained lakes (brownification)	Neutralization and source control
			
Sediment loading	Erosion Control	Increased Oxygen Demand	Reoxygenation and reducing uptake

(Shown above are four of the more than dozen reasons for lake clarity changes)



*Itasca County lakes are at ground-zero for changing lakes so can help all north-central lakes.

*We will analyze unique data on 179 bellwether lakes assessed in 2008-2010 to find why clarity has changed and prescribe cures for these and other MN lakes.