Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)

Project Title: **ENRTF ID: 085-B**

Assessing Water Quality in Mississippi Headwaters Region Lakes

Category: B. Water Resources

Total Project Budget: $ 406,200

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

The goals of this project are to preserve, analyze, interpret, and augment historical water quality data for lakes with minimal, but increasing, external stressors to inform statewide lake management strategies.

Name: Lesley Knoll

Sponsoring Organization: U of MN

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Lake Itasca MN 56470

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Web Address

Location

Region: Northwest

County Name: Clearwater, Hubbard

City / Township:

Alternate Text for Visual:

Historical data showing long-term declines in water clarity in Lake Itasca. Information like this allows for a better understanding of present-day lake health and management strategies

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

PROJECT TITLE: Assessing Water Quality in Mississippi Headwaters Region Lakes

I. PROJECT STATEMENT

Lakes in the Mississippi Headwaters region experience little human impact from urbanization and agriculture. These northern lakes are regarded as some of the highest quality in the state and can serve as a baseline for understanding how statewide lakes are responding to various stressors like pollution, land use change, and invasive species. Some of these stressors are heading north and capturing these changes will allow us to understand how broad processes influence lakes.

Part of the motivation for this project was the discovery of boxes of historical water quality data in a barn at the University of Minnesota (UMN) Itasca Field Station (established in 1909). These data, collected by students, researchers, and faculty based at the Field Station, extend back to the 1930s. In at least nine lakes, various parameters were measured such as temperature and oxygen, water clarity, water chemistry, algae, and zooplankton. Environmental data can be noisy and there are many examples where long-term records like ours revealed trends that would not have otherwise been found. An example of the type of trends we will explore is highlighted by preliminary water clarity results in the iconic Lake Itasca, the headwater lake of the Mississippi River (Figure 1). Lakes with exceptional water clarity are perceived as the best for recreation and in Minnesota, water clarity is often influenced by the amount of algae in the lake. We found unexpected and surprising long-term declines in water clarity in Lake Itasca since the 1960s. Understanding what is causing these declines will inform management specific to this lake and as well as to those regionally/statewide.

Our project will use Mississippi Headwaters region lakes with minimal, but increasing, human disturbance to understand how statewide lakes are responding to external stressors. Specifically, we will: 1) preserve and analyze historical lake data, 2) collate existing electronic data (e.g., MNDNR, MPCA, Sentinel Lakes Program, UMN), 3) collect new data using state-of-the-art aquatic instrumentation, 4) interpret historical data in conjunction with modern data and predictive models to inform lake management, and 5) share discoveries by partnering with Itasca State Park to offer interpretive programs to the over half a million annual visitors to the park.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Legacy lake data: preserving historical water quality data and documenting trends in Mississippi Headwaters region lakes **Budget: $128,250**

We have historical data for at least nine lakes in the Headwater region including Elk Lake, a sentinel lake in the Sentinel Lakes Program (other lakes: Arco, Deming, Josephine, Itasca, LaSalle, Long, Mary, and Ozawindib). We will digitize these data into electronic format and couple them with other existing electronic datasets (MNDNR, MPCA, and UMN) to examine long-term water quality trends. Of special note is that these documents include some of historical significance such as those of Dr. Raymond Lindeman who is known as the originator of modern ecosystem science.

Outcome	Completion Date
1. Preservation of historical lake data for lakes in the Mississippi Headwaters region	*June 2019*
2. Analyze long-term water quality trends	*June 2020*

Activity 2: Understanding the past and predicting the future: combining historical and modern water quality data for baseline lakes to inform statewide lake trends **Budget: $249,450**

We will collect new samples in nine lakes that we can combine with historical data to understand how water

quality is changing in lakes with minimal, but increasing, human impact. For example, we already documented declining water clarity in Lake Itasca and we may find a similar trend for other lakes. We can use these new data to better understand what is causing these trends and then use modeling techniques to create predictions on the statewide level. Two of our nine lakes (Itasca and Elk, a sentinel lake) will be instrumented with a complete suite of state-of-the-art automated water quality sensors (funding anticipated by the National Science Foundation beginning summer 2017). This instrumentation allows for high-frequency measurements (as often as every 5 minutes). For the remaining lakes, we will deploy oxygen and temperature sensors to inform our modeling efforts.

Outcome	Completion Date
1. Measure lake characteristics (physical, chemical and biological parameters) in 9 lakes	*October 2020*
2. Deploy automated sensors and retrieve high-frequency data for 9 lakes	*October 2020*
3. Develop a mechanistic understanding of water quality trends in Mississippi Headwaters region lakes	*June 2021*
4. Communicate findings via scientific presentations and peer-reviewed publications	*June 2021*

Activity 3: Sharing discoveries with Minnesota citizens and visitors through interpretive programs at Itasca State Park **Budget: $28,500**

We will collaborate with Naturalists at Itasca State Park and undergraduate interns to provide educational programming as part of the park's popular Interpretive Naturalist Program series. The park serves over 500,000 annual visitors. We will translate our findings into an engaging format with the goals of building awareness on the state of Minnesota lakes and providing knowledge on how citizens can promote healthy lakes. This activity offers unparalleled opportunities to connect our results with the constituents who live in or invest in this region of the state. This activity will provide environmental education training for two undergraduate students each year.

Outcome	Completion Date
1. Offer educational water quality programs to the 500,000+ visitors of Itasca State Park	*June 2021*

III. PROJECT STRATEGY

A. Project Team/Partners

Partners receiving funds: Dr. Lesley Knoll (Station Biologist, UMN Itasca Field Station), Project Manager
Dr. James Cotner (Professor, UMN), Collaborator on Activities 1 and 2
Partners not receiving funds: Itasca State Park, Interpretive Programs (Connie Cox), Collaborator on Activity 3

B. Project Impact and Long-Term Strategy

Our project preserves historical data and leverages existing public state datasets (MNDNR, MPCA, Sentinel Lakes Program) to provide key information on long-term water quality trends in baseline lakes with minimal, but increasing, human impact. Investments are commonly focused on lakes found in disturbed settings because this is where dramatic water quality changes are often observed. By looking at trends extending back many decades coupled with modern techniques and modeling, we can capture how northern lakes are responding to present-day stressors and use these results to inform management on a statewide level. We will seek supplementary funding from NSF and other sources to support long-term research on Mississippi Headwaters region lakes.

C. Timeline Requirements. The project will be completed in three years (7/18 – 6/21).

2018 Detailed Project Budget

Project Title: *Assessing Water Quality in Mississippi Headwaters Region Lakes*

IV. TOTAL ENRTF REQUEST BUDGET 3 years

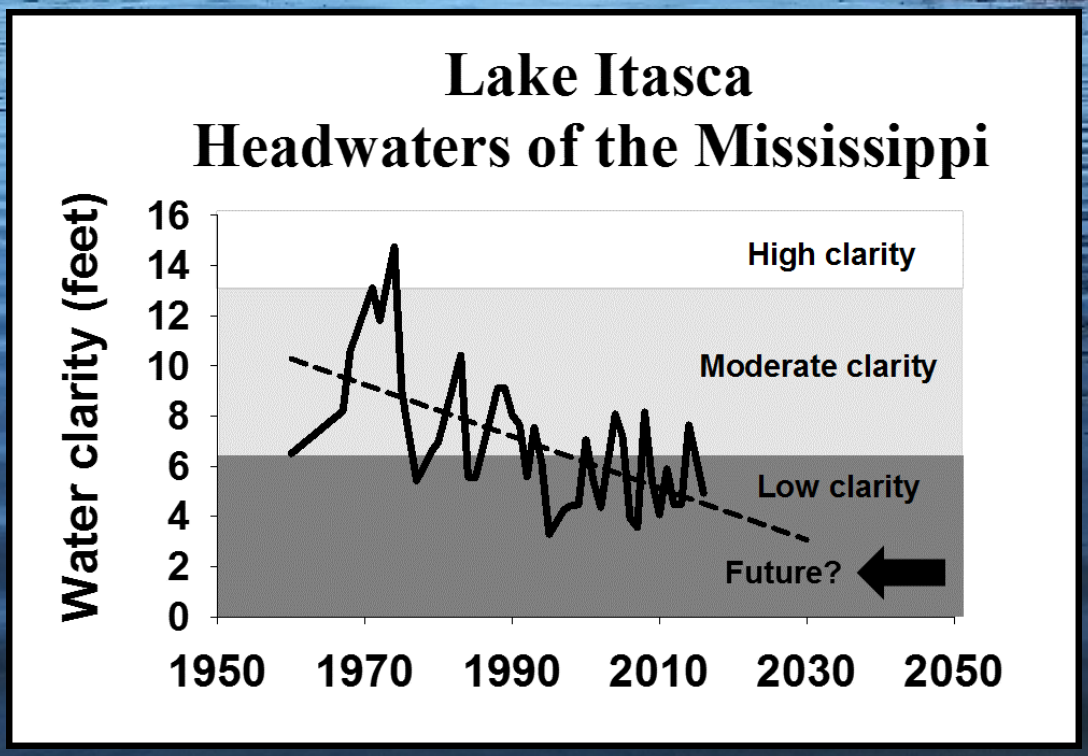
BUDGET ITEM	AMOUNT
Personnel:	$ 247,100
Postdoctoral associate (78.6% salary, 21.4% fringe benefits); 100% FTE for two years. Will lead data analysis and modeling efforts. $116,500	
Graduate student assistant (52.3% salary, 47.7% benefits during the academic year - includes tuition) (87% salary, 13% benefits during the summer); 50% FTE for two years . Will lead sampling and lab analysis efforts. $93,600	
Undergraduate students (100% salary, 0% benefits); Two students at 100% FTE for 14 weeks during the summer for 3 years. Will assist with sampling and outreach efforts while gaining in-depth training in both areas. $37,000	
Professional/Technical/Service Contracts:	$ 70,000
Data management analyst; one highly trained data manager. Will preserve legacy data into electronic format. $70,000	
Equipment/Tools/Supplies:	$ 61,600
Sample bottles (1500/year for 3 years; $1/bottle). $4,500	
Glass fiber filters (1500/year for 3 years; $1/filter). $4,500	
Lake temperature sensors (75 sensors; $200/sensor). $15,000	
Lake oxygen sensors (12 sensors; $1000/sensor). $12,000	
Light meter to measure water clarity. $3,000	
Fluorometer to measure algal abundance in the lakes. $11,000	
Surface water sample analyses: Dissolved Phosphorus (200 @ $12/sample), Particulate Phosphorus (200 @ $12/sample), Inorganic Nitrogen (200 @ $14/sample), Total Dissolved Nitrogen (200 @ $3/sample), Dissolved Organic Carbon (200 @ $14/sample), Algal biomass (200 @ $3/sample). $11,600	
Acquisition (Fee Title or Permanent Easements):	N/A
Travel:	$ 25,500
Travel to Itasca Field Station (from Twin Cities) and lodging at the station (for 14 weeks of undergraduate lodging each summer and frequent lodging by all other personnel). $20,000	
Travel to research sites and lab bench fees at Itasca Field Station. $4,000	
Travel to and registration for the Minnesota Resources Conference. $1,500	
Additional Budget Items:	$ 2,000
Sponsored publications - Publication costs to disseminate work. $2,000	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 406,200

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: NSF funds for automated water quality instrumentation to Cotner (PI) and Knoll (co-PI). Expected summer 2017.	$ 391,050	Pending
Other State $ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period: Indirect Costs (54% MTDC) associated with this proposal	$ 219,348	Secured
Past and Current ENRTF Appropriation:	N/A	
Other Funding History:	N/A	

Using Mississippi Headwater region lakes with minimal, but increasing, external stressors to inform statewide lake management

- **Preserve and analyze historical data**
- **Compile and analyze existing state data**
- **Collect new data with automated state-of-the-art instrumentation**
- **Generate predictive models**
- **Inform statewide lake management**



Newly discovered long-term data show declining water clarity in Lake Itasca

Qualifications for Project Manager Lesley Knoll

As Station Biologist at the University of Minnesota Itasca Field Station, Knoll conducts independent research, supervises students and lab personnel, performs outreach activities, and manages the lab facilities. She recently served as the Principal Investigator on a completed National Science Foundation award to construct a new aquatic analysis lab. In her role as project manager, Knoll will oversee the entire project and coordinate all the activities. She will work closely with Dr. James Cotner on sample collection efforts, lake modeling, and analyzing new and historical data.

Education

Ph.D.	2011	Miami University, Oxford, OH (Ecology, Evolution, and Environmental Biology)
M.S.	2004	Michigan State University, East Lansing, MI (Fisheries and Wildlife)
B.S.	2001	Miami University, Oxford, OH (Botany, magna cum laude)

Positions

2016-present	*Station Biologist*, University of Minnesota Itasca Field Station (Lake Itasca, MN)
2012-2015	*Director of Research and Education*, Lacawac Sanctuary Field Station (Lake Ariel, PA)

Selected Recent Publications (17 peer-reviewed publications in total)

Knoll, L.B., A. Morgan, M.J. Vanni, T.H. Leach, T.J. Williamson, and J.A. Brentrup. 2016. Quantifying pelagic phosphorus regeneration using three methods in lakes of varying productivity. *Inland Waters* 6: 509-522.

Brentrup, J.A., C.E. Williamson, W. Colom-Montero, W. Eckert, E. de Eyto, H.P. Grossart, Y. Huot, P. Isles, L.B. Knoll, T.H. Leach, C.G. McBride, D. Pierson, F. Pomati, J.S. Read, K.C. Rose, N.R. Simal, P.A. Staehr, and L.A. Winslow. 2016. The potential of high-frequency profiling to assess vertical and seasonal patterns of phytoplankton dynamics: An extension of the Plankton Ecology Group (PEG) model. *Inland Waters* 6: 565-580.

Williamson, C.E., E.P. Overholt, R.M. Pilla, T.H. Leach, J.A. Brentrup, L.B. Knoll, E.M. Mette, and R.E. Moeller. 2015. Ecological consequences of long-term browning in lakes. *Scientific Reports* 5: 18666. doi:10.1038/srep18666.

Knoll, L.B., E.J. Hagenbuch, M.H. Stevens, M.J. Vanni, W.H. Renwick, J.C. Denlinger, R.S. Hale, and M.J. González. 2015. Predicting eutrophication status in reservoirs at large spatial scales using landscape and morphometric variables. *Inland Waters* 5: 203-214.

Knoll, L.B., M.J. Vanni, W.H. Renwick, and S. Kollie. 2014. Burial rates and stoichiometry of sedimentary carbon, nitrogen and phosphorus in Midwestern US reservoirs. *Freshwater Biology* 59: 2342-2353.

Williamson, C.E., J.A. Brentrup, J. Zhang, W.H. Renwick, B.R. Hargreaves, L.B. Knoll, E.P. Overholt, and K.C. Rose. 2014. Lakes as sensors in the landscape: Optical metrics as scalable sentinel responses to climate change. *Limnology and Oceanography* 59: 840-850.

Knoll, L.B., M.J. Vanni, W.H. Renwick, E.K. Dittman, J.A. Gephart. 2013. Temperate reservoirs are large carbon sinks and small CO_2 sources: Results from high-resolution carbon budgets. *Global Biogeochemical Cycles* 27: 52-64.

Organization Description

The proposed research will be performed at both the UMN Itasca Field Station and the University of Minnesota Twin Cities campus. The field station was established in 1909 and has a long and successful history of supporting field-based biological research. The University of Minnesota is a large and renowned public institution producing cutting-edge research products.