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

Project Title: **ENRTF ID: 065-B**

Lake Restoration: Benefits and Duration in Agricultural Landscapes

Category: B. Water Resources

Total Project Budget: $ 459,356

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

Summary:

We will quantify nutrient reduction benefits and anticipated duration from lake restoration in agricultural regions of Minnesota. Priority lakes for restoration will be identified using nutrient, social and economic data.

Name: Amy Hansen

Sponsoring Organization: U of MN

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Web Address

Location

Region: Central, Metro, Southwest, Southeast

County Name: Becker, Big Stone, Blue Earth, Brown, Carver, Chippewa, Cottonwood, Dakota, Faribault, Freeborn, Hennepin, Jackson, Kandiyohi, Lac qui Parle, Le Sueur, Lincoln, Martin, McLeod, Mower, Murray, Otter Tail, Pipestone, Pope, Ramsey, Redwood, Renville, Rice, S

City / Township:

Alternate Text for Visual:

This visual includes a graphic showing a lake before and after restoration activities. The pre-restoration lake has green, algal water and bottom feeding carp, which rip out plants, with high nutrient exports to rivers.

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

PROJECT TITLE: Lake restoration: benefits and duration in agricultural landscapes

I. PROJECT STATEMENT

Lakes are central to Minnesota's economy and culture. However, high quality lakes and the benefits they provide to local communities are not equally distributed across the state. **In southern Minnesota**, most **shallow lakes have** very poor water quality that limits local resident's access to swimming and fishing, degrading property values and constraining lake-based tourism. Lake restoration can successfully restore aquatic plant communities and reduce harmful algae, typically through the removal of bottom feeding fish such as European carp. However it is not well understood if these restorations also promote long term removal of nutrients, i.e. nitrogen (N) and phosphorus (P), which can alter the perceived recreational quality of lakes. If lake restoration simply transfers nutrient storage from algae to plant biomass, then the water quality problems may be delayed- but not solved- by shifting nutrients to a different place. However, if plant restoration results in significant and long term nutrient removal then lake restoration has a real and extremely valuable impact on long term water quality and associated benefits including reduced occurrence of harmful algal blooms, and improved recreational, aesthetic, and water use. **To assess the effects of lake restoration projects on water quality, we will:**

1. Compare nutrient removal and storage within restored and unrestored lakes
2. Determine if lake restoration delays or solves water quality issues from nutrient release
3. Quantify water quality benefits of lake restoration to downstream streams and rivers
4. Assess they impacts of improved lake quality on recreation and other lake-related ecosystem services

We propose a social and ecological assessment of 10 shallow lakes in southern MN; 5 which have had successful lake restoration projects and 5 lakes which have not been managed. For each lake, we will assess drivers of eutrophication, nutrient storage and removal and model downstream water quality improvements. We will use insights from the modeling and ecological assessment to develop a lake restoration prioritization tool to identify where lake restoration is likely to deliver the greatest benefits to local communities. This information will aid prioritization of restoration and conservation, including programs like the clean water fund and conservation easements. The work will also identify opportunities to meet the Governor's 25 by 2025 initiative and MN's commitment to state-level nutrient reduction plans.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Measure effect of lake restoration on nutrient trapping in lakes **Budget: $234,195**

We will assess water quality responses to lake restoration by comparing nutrient reductions in restored and degraded shallow lakes. We will measure inlet and outlet streamflow and N and P levels twice monthly from April – October for 2 years.

Outcome	Completion Date
1. Dataset of seasonally varying nutrient flows into and out of lakes	October 2019
2. Maps of aquatic plant and algae distribution, abundance, and type or species for restored and degraded lakes	October 2019
3. Predictive model of nutrient outflow using nutrient inflow, season, abundance of aquatic plants, carp and algae	November 2019

Activity 2: Determine internal lake nutrient removal process rates and storage **Budget: $154,904**

We will measure N and P storage and release rates in algae, aquatic plants, water and sediment within restored

and degraded lakes. This information is needed to understand links between carp removal, nutrient reduction, and mitigation of toxic algae risk.

Outcome	Completion Date
1. Scalable measurements of internal nutrient storage and release rates in algae, aquatic plants, water and sediment for restored and degraded lakes.	October 2019
2. Estimate of expected duration of water quality improvements from lake restoration based on nutrient storage and release rates and permanent nutrient removal rates	October 2019

Activity 3: Estimating the benefits of lake restoration **Budget: $70,257**

We will assess the downstream benefits of lake restoration by integrating our lake nutrient trapping results in a watershed-scale landscape model using a commonly used model to simulate water quality responses to changes in agricultural landscapes. We will link the modeled changes in nutrient removal to social and economic data to identify high priority lakes for recreational benefits.

Outcome	Completion Date
1. Watershed models of stream and river water quality improvement potential from lake restoration for the Le Sueur and Greater Blue Earth River basin	March 2020
2. Maps and prioritization tools that show where investments in lake restoration will maximize recreational value of lakes, especially for residents of southern MN.	December 2020

III. PROJECT STRATEGY

A. Project Team/Partners

Partners receiving funds:

1. Amy Hansen, SAFL, UM - Twin Cities: project coordination and reporting, nutrient loads and streamflow
2. Jacques Finlay, Ecology, Evolution and Behavior Dept., UM – Twin Cities, Sampling and laboratory analysis of algae and nutrients
3. Bonnie Keeler, Institute on the Environment, UM - Twin Cities: cost-benefit analysis.
4. Daniel Larkin, Dept. Fisheries, Wildlife, and Cons. Biology, UM - Twin Cities: Sampling and analysis of aquatic vegetation
5. Przemyslaw Bajer, Dept. Fisheries, Wildlife, and Cons. Biology, UM - Twin Cities: Quantify carp abundance
6. Brent Dalzell, Dept. of Soil, Water and Climate, UM – Twin Cities: SWAT watershed analysis

Partners not receiving funds:

1. Shell Rock River Watershed District: Share lake restoration data and expertise
2. Ramsey-Washington Metro Watershed District. Share lake restoration data and expertise

B. Project Impact and Long-Term Strategy

We expect the results of this study to immediately inform how lake restoration is implemented in high nutrient landscapes in Minnesota and specifically influence the direction of Minnesota's nitrogen reduction strategy. Although we target lakes in agricultural regions, the results will also be applicable to lake management in other locations with high nutrient loading rates such as urban areas. At the completion of this project, all analyses of specific lakes and watersheds will be turned over to the appropriate management organization, allowing them to make well-informed and long trajectory decisions on prioritization of lake restoration projects. We will also share our findings with resource managers through the Minnesota Water Resources Conference and at local meetings with lake managers in the counties where we apply the lake prioritization and watershed assessment.

C. Timeline Requirements

Three years to allow two complete field seasons and one year for modeling and cost benefit analysis.

2018 Detailed Project Budget

Project Title: ***Lake restoration: benefits and duration in agricultural landscapes***

IV. TOTAL ENRTF REQUEST BUDGET: 3 years

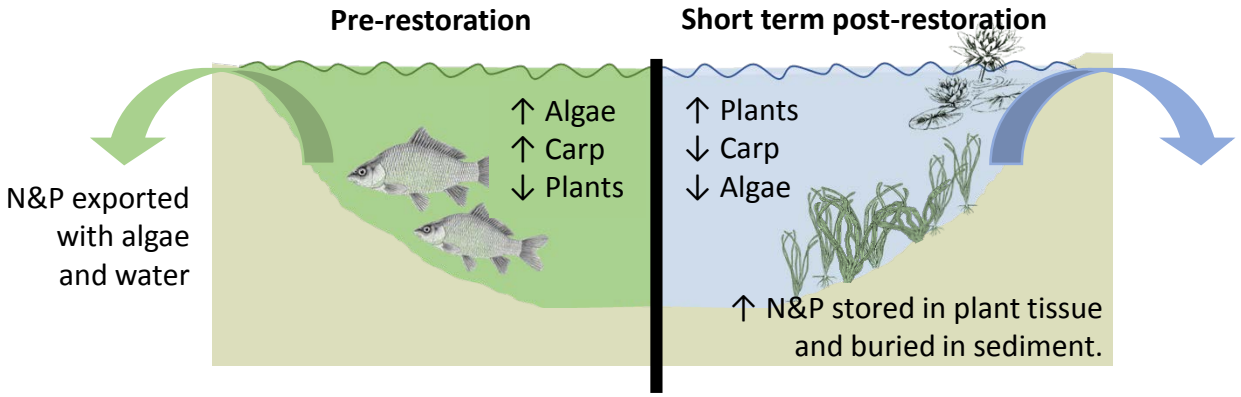
BUDGET ITEM	AMOUNT
Personnel:	$ 411,156
Amy Hansen, PI, project management including field work coordination and data synthesis [45% FTE yrs 1-2, 25% yr 3], 75% salary & 25% benefits, $115,792	
Jacques Finlay, Co-PI, supervise water chemistry data collection and laboratory analysis, [5% FTE yrs 1-2], 75% salary & 25% benefits, $18,434	
Bonnie Keeler, Co-PI, coordinate lake prioritization, [4% FTE yr 2], 75% salary & 25% benefits,	
Dan Larkin, Co-PI, coordinate aquatic vegetation component, [5% FTE yrs 1-2], 75% salary & 25% benefits, $15,894	
Przemek Bajer, Co-PI, quantify carp abundance, [10% FTE yrs 1-2], 75% salary & 25% benefits, $22,943	
Brent Dalzell, Co-PI, model watershed scale water quality responses, [25% FTE yr 2], 75% salary & 25% benefits, $23,475	
Christy Dolph, Post-Doctoral Associate, field algal and nutrient collection and analysis, [20% FTE yrs1-2], 82% salary & 18% benefits, $23,868	
Research Fellow, lake valuation and prioritization, [40% FTE yrs 1-2], 75% salary & 25% benefits, $49,757	
Research Associate, field data collection and analysis for aquatic plants, [50% FTE yr 2], 79% salary & 21% benefits, $29,000	
EEB Lab Manager, laboratory water chemistry analysis, [18% FTE yrs 1-2], 79% salary & 21% benefits, $22,176	
Technical assistance, Civil Service, [20% FTE yrs 1-2, 12% yr 3], 79% salary & 21% benefits, $31,829	
Undergraduate Student Research Assistants, many, field data and sample collection, laboratory analysis, 100% salary & 0% benefits, $53,233	
Equipment/Tools/Supplies: Laboratory supplies including but not limited to: standards, reagents, solvents, sample vials, gloves, filters, label tape. Field collection supplies including but not limited to: collection containers, filters, waders, gill nets	$ 19,000
Travel: Travel to and from southern MN lakes for two years - 64 days per year, average distance 100 mi one way. Because whole lake surveys are time intensive, 54 nights per year of lodging and meal reimbursement at approved rates are included.	$ 19,000
Additional Budget Items: External laboratory analysis services ($3,200), publications fees ($2,000), BioBase subscription fee ($5,000)	$ 10,200
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	**$ 459,356**

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	N/A	N/A
Other State $ To Be Applied To Project During Project Period:.	N/A	N/A
In-kind Services To Be Applied To Project During Project Period: Unrecovered UMN overhead (54% MTDC)	$ 248,052	Secured
Past and Current ENRTF Appropriation:	N/A	N/A
Other Funding History: The proposed work builds on two current LCCMR projects that will be completed by July 2018 awarded to Keeler. ENRTF for 2015-04a" Informed water management: Mapping scarcity, threats, and values" $234,936. This appropriation will generate statewide maps and data on future precipitation, temperature, and water scarcity that will inform the sourcewater risk assessments. Some of the underlying data and climate projections will be useful for the proposed project. The second grant is ENRTF for 2015-04a " Conservation Easement Assessment and Valuation System Development" $250,000. This appropriation funded the development of a statewide easement assessment tool. We see high potential for the proposed work to supplement the easement scoring tool to more explicity address return on investment in restoration aimed at improving lake values.	$ 484,936	

Lake restoration: benefits and duration in agricultural landscapes

Lake restoration promotes aquatic plants which store nutrients and can quickly result in clearer, cleaner water. But lake restoration does not change the amount of nutrients entering the lake. Do lakes have a limit to nutrient storage capacity? If so, when will stored N and P be released back into the lake?



Outcome: Determine how long a restored lake will remain restored

Short term post-restoration

Long term post-restoration??

Outcome: Measure effect of lake restoration on nutrient trapping

Outcome: Prioritize lakes for restoration using social and economic data

Project title: Lake restoration: benefits and duration in agricultural landscapes

Project manager qualifications and organization description

Amy Hansen, University of Minnesota – St. Anthony Falls Laboratory
Dr. Hansen is a Research Associate at St. Anthony Falls Laboratory at the University of Minnesota. Her research focuses are interactions between hydrology and ecology water and how those could be leveraged to improve water quality. She is currently investigating wetland restoration as a means to promote nitrate removal in the Minnesota River basin. This research addresses the critical issue of degraded water quality through an unconventional perspective in which surface water is seen as part of the solution, through promoting nutrient removal processes within them, and not just as the recipients of contaminated run-off.

Dr. Hansen received her doctorate degree in Civil Engineering with a minor in Ecology, Evolution and Behavior at the University of Minnesota – Twin Cities. She completed her master's degree at the University of Michigan – Ann Arbor and her bachelor's degree at California Institute of Technology (Caltech). She was a project manager and design engineer in the semiconductor industry prior to a career change to water quality and sustainability.

Organization Description:

St. Anthony Falls Laboratory (SAFL) is an interdisciplinary facility within the College of Science and Engineering at the University of Minnesota with a broad focus on fluids research and education. Research at SAFL ranges from field and laboratory experiments to advanced computational tools and theory, all to obtain innovative, science-based solutions to real-world fluid-flow problems. Along with academic research, SAFL also serves as an applied science resource with connections and collaborations across the country and all over the world. With SAFLs tradition of academic excellence in engineering, environmental, biological and geophysical fluid dynamics, it is uniquely positioned to support interdisciplinary research confronting environmental water quality issues.

SAFL has supported and will continue to support research and outreach activities related to water quality in southern Minnesota. For the past five years, SAFL has been the home institution for a $5 million collaborative National Science Foundation Observatory grant focused on natural and human induced change in the Minnesota River Basin. SAFL will support this proposed work with; facilities, space, technical expertise, access to common software, data hosting and complimentary activities. In addition, this project will leverage many of the world class facilities throughout the University of Minnesota to complete the tasks outlined. The investigators collaborating on this work are associated with SAFL; the Department of Ecology, Evolution and Behavior; the Department of Soil, Water and Climate; the Department of Fisheries, Wildlife and Conservation Biology; and the Institute on the Environment, all of which will contribute towards the success of our collective efforts.