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

Project Title: **ENRTF ID: 084-B**

Reducing Water Nitrogen to Restore Minnesota Lakes

Category: B. Water Resources

Total Project Budget: $ 362,000

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

Summary:

This project will improve water quality in shallow lakes by developing management strategies that reduce nutrient levels and reduce blooms of noxious and toxic cyanobacteria.

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Sponsoring Organization: University of St. Thomas

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

The attached figure summarizes our hypothesis that submerged plant reduce nitrogen and phosphorus in lakes and reduce blooms of noxious cyanobacteria.

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

PROJECT TITLE: Reducing water nitrogen to restore Minnesota lakes

I. PROJECT STATEMENT

Why this project needs to be done: High levels of nitrogen (N) in surface and subsurface water in Minnesota increases eutrophication, threatens drinking water safety, and is associated with noxious blooms of cyanobacteria. Cyanobacteria produce toxins that can harm and kill cattle, pets, and humans. Lake managers need additional tools to reduce N levels in surface waters of Minnesota (see Figure). This research addresses the LCCMR priority of protecting and conserving the quality of our water resources.

Goal 1: **Reduce N in water by managing shallow lakes for high abundance of submerged plants**
Our results indicate that N levels in water decrease by 68% as shallow lakes shift from turbid to clear, or in other words, from algal-dominance to submerged plant dominance. We hypothesize that high submerged plant abundance reduces N by increasing rates of gaseous losses of N to the atmosphere, a natural process.
The **outcomes** will be:

1) Determine if high submerged plant abundance causes elevated N losses and reduced N in water
2) Provide statewide guidelines for increasing N loss rates in shallow lakes and other surface water
3) Develop models that predict lakes at risk of high nitrogen levels

We will **achieve** this goal by:

1) Sampling N concentrations and gaseous loss rates of N to the atmosphere in 12 shallow lakes, with some lakes dominated by algae and others by submerged plants
2) Conducting a survey of N loss rates in 100 shallow lakes across Minnesota
3) Developing statewide models that identify lakes at risk of elevated nitrogen levels

Goal 2: Reduce blooms of noxious cyanobacteria by reducing N and phosphorus (P) in shallow lakes
Our preliminary evidence indicates blooms of cyanobacteria are linked to high levels of N and P in shallow lakes. However, the importance of lake nutrient levels relative to other factors such as water temperature and CO_2 has not been determined. Moreover, there is increasing evidence that the toxicity of cyanobacteria is coupled to N concentrations in eutrophic lakes.
The **outcomes** will be:

1) Determine if blooms of noxious cyanobacteria can be predicted based on levels of N and P in shallow lakes
2) Develop guidelines for maintaining N and P levels where the risk of cyanobacteria blooms is minimized
3) Develop management recommendations to lower the chance of cyanobacteria blooms in lakes by managing for high abundance of submerged plants that reduce N and P

We will **achieve** this goal by:

1) Determining the relationship between abundance of cyanobacteria, N, P, and submerged plants in 12 lakes intensively sampled and in our statewide survey of 100 lakes
2) Developing models that predict the chance of cyanobacteria blooms based on N, P, and abundance of submerged plants

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Reduce N in water by managing shallow lakes for high abundance of submerged plants **Budget: $ 292,000**

We will intensively sample 12 shallow lakes in western Minnesota (not yet identified) six times a year to determine whether rates of N loss are higher in lakes with high plant abundance compared to lakes dominated by algae. We will also conduct a one-time survey of N loss rates in 100 shallow lakes (not yet identified) across the state. Lastly, we will use results from the 12-lake intensive study and 100-lake survey to develop a model that identifies lakes at risk for high N statewide.

Outcome	Completion Date
1. Determine whether managing shallow lakes for high submerged plant abundance can reduce N in surface waters by increasing rates of N loss. Provide management recommendations for how shallow lakes can be managed to reduce N (and P) statewide.	June 2021
2. Using results from Outcome 1, produce a model that identifies lakes at risk of high N levels statewide. It will also identify lake specific (abundance of submerged plants) and broader factors (water temperature) associated with high N loss rates.	June 2021

Activity 2: Reduce blooms of noxious cyanobacteria by reducing N and P in shallow lakes **Budget: $ 70,000**

We will quantify the abundance of cyanobacteria during spring, summer, fall and winter in our 12 intensively sampled lakes, and also in the 100 shallow lakes sampled once in August when cyanobacteria blooms are most common. We will also assess lake-specific factors (e.g. N levels, abundance of submerged plants) and broader landscape factors (e.g. water temperature) to develop a predictive model for identifying lakes most at risk for cyanobacteria blooms.

Outcome	Completion Date
1. Determine whether blooms of noxious cyanobacteria are most related to biological factors (fish, turbid vs. clear lakes), chemical factors (nutrients, alkalinity) or physical factors (temperature or lake size).	June 2021
2. Develop a model to predict cyanobacteria blooms, and develop management recommendations to minimize chances of blooms based on relationships among N, P, submerged aquatic plants, etc. and abundance of cyanobacteria.	June 2021

III. PROJECT STRATEGY

A. Project Team/Partners

Our team consists of two scientists who will both receive funding from this request:
- Kyle Zimmer (University of St Thomas, $119,000) is a shallow lake ecologist and will serve as the overall projector coordinator. He will assist Cotner with the 12-lake study, conduct the 100-lake statewide survey, and be the lead in developing management strategies to reduce N and P in shallow lakes.
- Jim Cotner (University of Minnesota, $243,000) is a microbial ecologist and he will lead the 12 lake intensive study, supervise the sampling of cyanobacteria, and be responsible for developing management strategies to reduce blooms of noxious cyanobacteria in lakes.

B. Project Impact and Long-Term Strategy

Our long-term goal is to reduce levels of N in surface and subsurface waters by managing shallow lakes and potentially other aquatic systems for high levels of submerged plants that promote gaseous losses of N to the atmosphere where it is innocuous. High plant abundance has the additional benefit of reducing P in water and providing excellent habitat for waterfowl, fish, amphibians, and aquatic invertebrates. We will also identify factors associated with noxious blooms of cyanobacteria and develop management strategies for reducing abundance of cyanobacteria.

C. Timeline Requirements

We request funding July 2018 through June 2021, with no costs beyond this time frame.

2018 Detailed Project Budget

Project Title: Reducing water nitrogen to restore Minnesota lakes

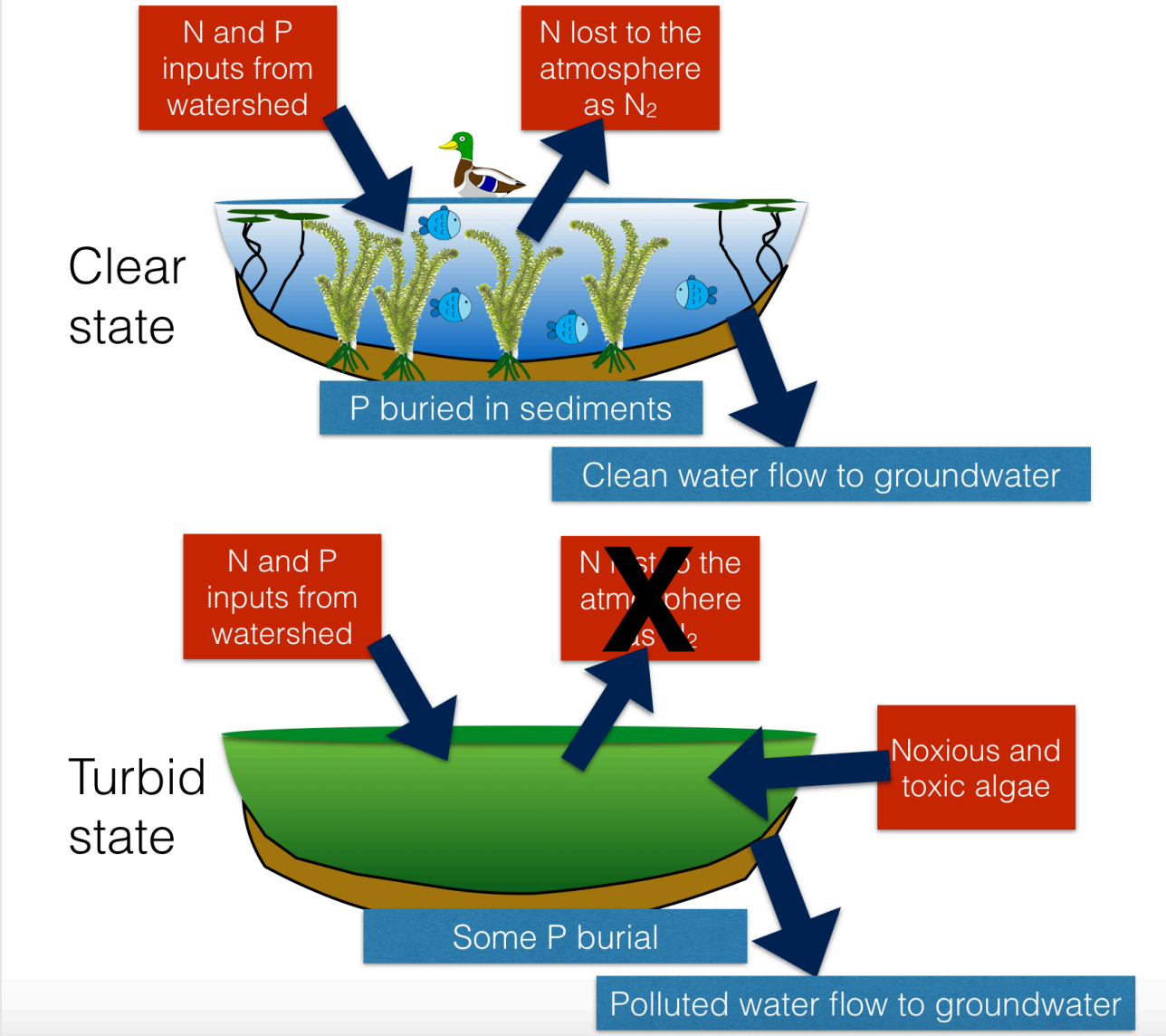
IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Personnel:	$ -
Kyle Zimmer: (93% salary, 7% benefits). One month salary per year for all three years.	$ 34,000
Undergraduate students (93% salary, 7% benefits). 2 students full time during summer for all three years.	$ 32,000
Undergraduate students (100% salary, 0% benefits). 2 students part time during school year for all three years.	$ 20,000
Professional/Technical/Service Contracts:	$ -
Subcontract to University of Minnesota (J. Cotner) for work on intensive sampling of 12 lakes and sampling cyanobacteria. Includes $210,000 for salaries and fringe, $27,000 for supplies, and $6,000 for travel while sampling study sites.	$ 243,000
Equipment/Tools/Supplies: Laboratory supplies include analytical reagents, disposable labware, filters, and maintenance costs of equipment such as spectrophotometers and fluorometers. Field supplies include sample jars, chemicals for sampling preservation, filters, and sample vials. We also request funds for stable isotope analysis of carbon and nitrogen for 1,050 samples at a cost of $8.50 per sample.	$ 21,000
Travel: Costs are for K. Zimmer and 2 undergraduates sampling our study sites. Lodging is estimated at $100/night and per diem at $30/day. Each of the 3 years the 12 lakes will be sampled 6 times with a toal of 22 nights of lodging ($2,200) and 44 days of per diem ($1,320) (3 year total = $10,560). The 100 lakes will be sampled once with a total of 6 nights loding ($600) and 12 days per diem ($360).	$ 12,000
Additional Budget Items:	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 362,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	NA	NA
Other State $ To Be Applied To Project During Project Period:	NA	NA
In-kind Services To Be Applied To Project During Project Period: Indirect costs associated with this proposal	NA	NA
Past and Current ENRTF Appropriation:	NA	NA
Other Funding History:	NA	NA

CLEAN WATER FOR MN



INCREASED WATER QUALITY, BETTER FISH AND WILDLIFE NATURAL RESOURCES AND LESS TOXIC ALGAE

This project will improve water quality in shallow lakes by developing management strategies that reduce nutrient levels and reduce blooms of noxious and toxic cyanobacteria.

COLLABORATION OF UNIVERSITY OF ST THOMAS, AND THE UNIVERSITY OF MINNESOTA

Project Manager Qualifications and Organization Description

Project Title: Reducing water nitrogen to restore Minnesota lakes

Project Manager: Kyle Zimmer, Ph.D., Department of Biology, University of St. Thomas, kdzimmer@stthomas.edu, ph. 651-962-5244

Project Manager Qualifications: My field of expertise is aquatic ecosystem ecology, and I have studied shallow lake ecosystems in Minnesota for 22 years. My research is focused on clarifying influences of fish and nutrients on shallow lakes, and in developing management strategies for improving water and habitat quality. I have published 34 peer-reviewed papers on the ecology and management of shallow lakes (several examples are given below), and I have supervised dozens of undergraduate research assistants and three postdoctoral associates. I have also served as overall project manager for multiple research grants, and I have supervised several large-scale research projects similar to the work we describe in this proposal to the LCCMR. Lastly, I have successfully collaborated previously with Jim Cotner, the other PI on this proposal.

Selected related publications:

Hanson, M.A., B.R. Herwig, **K.D. Zimmer**, and N. Hansel-Welch. 2017. Rehabilitation of shallow lakes: time to adjust expectations? Hydrobiologia 787:45-59.

Ramstack Hobbs, J.M., W.O. Hobbs, M.B. Edlund, N. Hoidal, K.M. Theissen, **K.D. Zimmer**, L. Domine, M.A. Hanson, B.R. Herwig, and J.B. Cotner. 2016. The legacy of large regime shifts in shallow lakes. Ecological Applications 26:2660-2674.

Zimmer, K.D., M.A. Hanson, and D.A. Wrubleski. 2016. Invertebrates in permanent wetlands (long-hydroperiod marshes and shallow lakes. In D. Batzer and D. Boix (eds.). Invertebrates in Freshwater Wetlands: An International Perspective on their Ecology. Springer.

Zimmer, K.D., W.O. Hobbs, L.M. Domine, B.R. Herwig, M.A. Hanson, and J.B. Cotner. 2016. Uniform carbon fluxes in shallow lakes in alternative stable states. Limnology and Oceanography 61:330–340.

Hanson, M.A., C.A. Buelt, **K.D. Zimmer**, B.R. Herwig, S. Bowe, and K.M. Maurer. 2015. Community correspondence among aquatic invertebrates, fish, and submerged aquatic plants in shallow lakes. Freshwater Science 34: 953–964.

Nolby, L.E., **K.D. Zimmer**, M.A. Hanson, and B.R. Herwig. 2015. Is the island biogeography model a poor predictor of biodiversity patterns in shallow lakes? Freshwater Biology 60:870-880.

Other related activities:

-Panelist to review proposals submitted to the National Science Foundation (2011, 2014).
-Co-organizer and moderator for the special session *Terrestrial-Aquatic Linkages II: Movement of Nutrients and Carbon* at the Ecological Society of America meeting (2013).
-Co-Chair of Student Activities Committee for the National Meeting of the American Fisheries Society (2012).

Organization Description: The University of St. Thomas in St. Paul, Minnesota, emphasizes undergraduate education. It also recognizes the importance of research, and faculty in the Department of Biology are given course-release time and dedicated laboratory space to support active research programs. Faculty research labs are also well equipped with research equipment.