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

Project Title: **ENRTF ID: 108-C**

Developing Intellectual and Scientific Infrastructure for Clean Waters

Category: C. Environmental Education

Total Project Budget: $ 475,000

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

Summary:

The overall goals are to: 1) Improve water quality; 2) Increase understanding of N losses from freshwaters; 3) Develop intellectual and scientific infrastructure to understand N cycling.

Name: Sehoya Cotner

Sponsoring Organization: U of MN

Address: 3-154 MCB; 420 Washington Ave SE

Minneapolis MN 55455

Telephone Number: (612) 626-2385

Email sehoya@umn.edu

Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

A simple schematic illustrating the twelve artificial lakes; one is enlarged to indicate approximate dimensions.

_____ Funding Priorities _____ Multiple Benefits _____ Outcomes _____ Knowledge Base

_____ Extent of Impact _____ Innovation _____ Scientific/Tech Basis _____ Urgency

_____ Capacity Readiness _____ Leverage _____ TOTAL _____%

PROJECT TITLE: Developing intellectual and scientific infrastructure for clean waters

I. PROJECT STATEMENT

Half of the lakes and rivers in southern Minnesota are too polluted for swimming and fishing. Excess nitrogen (N) is increasingly problematic for both aquatic life and the health of humans in these watersheds. Increased inputs of both N and phosphorus to farmland are impairing the use of our precious freshwaters.

Why this project needs to be done:

- Water quality is deteriorating in Minnesota lakes and rivers.
- We need better management tools to ameliorate degrading water quality.
- We need better scientific tools to understand the nitrogen (N) cycle in natural systems.

The overall goals of our work are to: 1) Improve water quality in MN; 2) Increase understanding of the controls of N losses from freshwaters; 3) Develop intellectual and scientific infrastructure to understand N cycling.

The **outcomes** of the proposed work will be: a) Increased intellectual capital focusing on undergraduate scientists and the relevance of N cycling to science and policy; b) Increased scientific capital. There are limited resources for training students on N cycling processes such as nitrification, denitrification, anaerobic ammonia oxidation (anammox), etc, and limited resources for scientists to make measurements of N cycling processes.

We will achieve our goals by*:*

- Building and instrumenting an experimental facility at the University of Minnesota's Itasca Biological Station and Laboratories (IBSL) that will be used to both train students and study N cycling processes.
- Training undergraduate students in N cycling and scientific skills.
- Developing an accessible database for use by scientists in the following development stages: science educators participating in teacher-training institutes at IBSL; incoming biology students at the University of Minnesota's Nature of Life orientation course; mid-curriculum biology students in the University of Minnesota's scientific inquiry course sequence (Foundations of Biology); graduate students at the University of Minnesota in both the College of Biological Sciences (CBS) and the College of Food, Agriculture and Natural Resources; and K-12 students participating in a novel program (InSciED Out) that uses scientific inquiry to stimulate interest and develop capacity in science.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Build an outdoor research facility at IBSL to enable manipulation and measurement of components of the nitrogen cycle in artificial ponds. This state-of-the-art facility will enable scientists and educators to manipulate water level, temperature, nutrient concentrations, and many other variables to determine their effects on N cycling. The University recently added a new $7 million laboratory and conference facility at IBSL with the help of the State of Minnesota and we will maintain some of this momentum by adding to the scientific capabilities of this facility. **Budget: $252,000**

Outcome	Completion Date
1. Design and construct experimental pond facilities	July 2017
2. Purchase and test instrumentation for measuring nitrogen and carbon components	July 2017
3. Fill the mesocosms and add plants to them	July 2017

Activity 2: Train students in the N cycle. The new research facility will be used for authentic research for Biology students in the research-based course, Foundations of Biology (Biol 3004). The students will share outcomes via the Nitrogen in Minnesota (N in MN) database described below. **Budget: $85,000**

Outcome	Completion Date
1. Facilitate course-based research focused on N-cycling at local, regional and global scales	July 2019
2. Engage students in building N in MN database with aid of scientific personnel	July 2019

Activity 3: Develop and maintain nitrogen database based on artificial pond experiments (N in MN) for use by educators and scientists. Educators will include those involved in InSciED Out, with a strong focus on discovery science. N in MN data will be used by teachers and students. Students in the Foundations course will also have access to this database and we will help make the data publicly available on the internet. **Budget: $138,000**

Outcome	Completion Date
1. Work with partners in CBS to develop a database on N cycling (N in MN).	July 2017
2. Pilot database with results from student-based and PI-directed research	July 2018
3. Implement database for use by schools, professionals and developing students	July 2019

III. PROJECT STRATEGY

A. Project Team/Partners

Our team consists of a limnologist (J. Cotner) and a science educator (S. Cotner), both professors at the University of Minnesota-Twin Cities. Both are actively involved in education and science activities through CBS at the University's Itasca Biological Station and Laboratories and S. Cotner is teaching the Foundations course discussed above. Our team also includes a graduate student (Seth Thompson) who has developed curriculum for the InSciED Out environment program; his graduate program is focused both on aquatic ecosystems science and science education.

B. Project Impact and Long-Term Strategy

The work proposed here is expected to be an ongoing endeavor long beyond the lifetime of this grant. Once the infrastructure is in place, the capacity of the state to use science to drive policy decisions focused on water quality will be vastly improved. We will generate funds to maintain the infrastructure from user's fees collected from scientists and educators as well as CBS. This project will result in a large group of highly trained student researchers prepared to tackle future water quality issues. The work proposed here complements another LCCMR proposal (K. Zimmer, PI, J. Cotner, co-PI) also focused on N-cycling in shallow lakes. The work in each proposal is complementary but independent. Zimmer and J. Cotner have submitted a related proposal to the National Science Foundation but it did not include funding for these artificial ponds.

C. Timeline Requirements (start date: July 1 2016; end date: July 1 2019)

Activity	2016			2017			2018			2019		
	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall*
Establish artificial ponds at ISBL		X	X	X								
Students enrolled in Biol 3004					X			X			X	
Publications from student projects						X			X			X
Develop N in MN database				X	X							
Pilot N in MN database projects						X	X	X				
Full Implementation of N in MN database									X	X	X	X

*Fall 2019 is include for sake of continuity even though it is after the end data of this specific project proposal.

2016 Detailed Project Budget

Project Title: Developing intellectual and scientific infrastructure for clean waters

IV. TOTAL ENRTF REQUEST BUDGET - 3 years

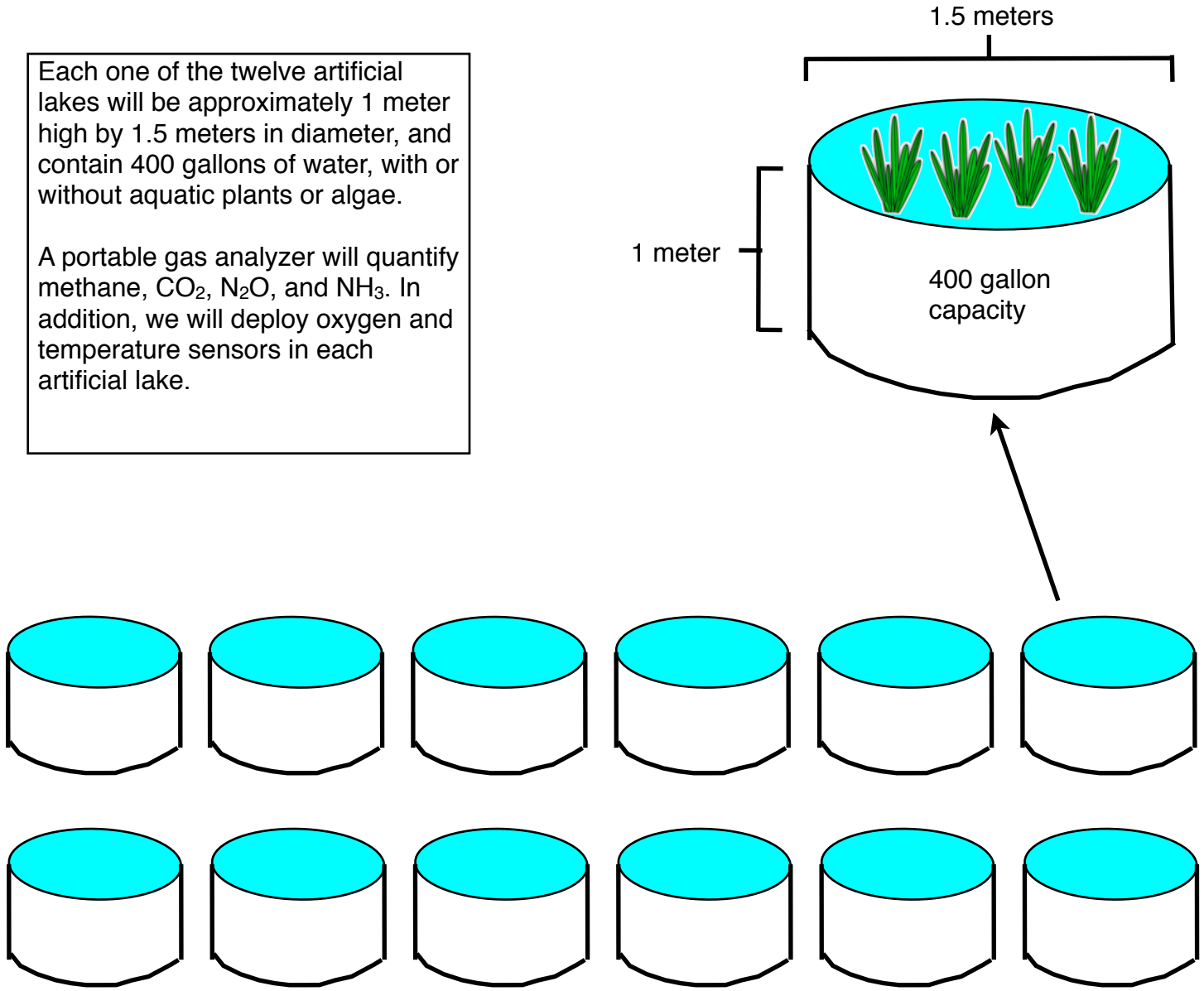
BUDGET ITEM	AMOUNT
Personnel:	
Sehoya Cotner, PI (75% salary, 25% fringe benefits); 1 month in year 3 only; Salary is requested for mentorship and supervision of the postdoctroal associate.	$ 12,000
James Cotner, Co-PI (75% salary, 25% fringe benefits); Year 1 = 1 summer month, Year 2 = 1 summer month, Year 3 = 0.5 summer months. Salary is requested for mentorship of the graduate student and support during summer teaching training.	$ 39,000
Postdoctoral associate (82% salary, 18% fringe benefits); 100% FTE in year 3 only	$ 53,000
Graduate Student (50% salary, 50% fringe benefits during the academic year -includes tuition) (85% salary, 15% fringe benefits during the summer); 50% FTE for years 1 & 2	$ 95,000
Undergraduate student (100% salary, 0% fringe benefits); 25% FTE for 3 years	$ 6,000
Technician (79% salary, 21% fringe benefits); 50% FTE for 3 years	$ 96,000
Equipment/Tools/Supplies:	
Artificial ponds: Outdoor flow-through systems with temperature control. Each pond will have internal temperature and dissolved oxygen sensors and a platform that can be used for sampling. We will build 12 ponds at ca. $3300 each.	$ 40,000
Gas analyzer: We will purchase a gas analyzer for measuring fluxes of N2O, CH4, CO2, and NH3. This instrument will enable measuring the release of these important nitrogen and greenhouse gases from our experimental treatments. The instrument we have targeted is designed for soil measurements so we will adapt it for measurements from water.	$ 100,000
Supplies (reusable and expendable): analytical standards, reagents, solvents, disposable labware, filters, fluorescent probes, isotopes, maintenance costs, fluorometer, microplates, etc. These funds will also be used for sample analysis costs such as particulate nutrients (CHN), phosphorus, etc.	$ 27,000
Travel:	
Travel funds are requested (car rental for transporting people and equipment to Itasca Biological Station; lodging costs at IBSL)	$ 7,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 475,000

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: *Indirect costs (52% MTDC) associated with this proposal*	$ 163,000	*Secured*
Funding History: N/A	N/A	
Remaining $ From Current ENRTF Appropriation: *N/A*	N/A	

Each one of the twelve artificial lakes will be approximately 1 meter high by 1.5 meters in diameter, and contain 400 gallons of water, with or without aquatic plants or algae.

A portable gas analyzer will quantify methane, CO_2, N_2O, and NH_3. In addition, we will deploy oxygen and temperature sensors in each artificial lake.



Project Manager Qualifications and Organization Description

Project Manager: Dr. Sehoya Cotner, Associate Professor, Department of Biology Teaching and Learning, 420 Washington Ave SE, 3-154 Molecular and Cellular Biology Building; (612) 626-2385; sehoya@umn.edu

Education:

Ph.D., University of Minnesota, Twin Cities, 1999, Conservation Biology.

B.S., North Carolina State University, Raleigh, NC, 1992, Biological Sciences.

Organization description: University of Minnesota, Twin Cities Campus; Education and research facility serving the entire state of Minnesota.

Project responsibilities: Professor Cotner will oversee all research and education activities. She will coordinate design and construction of the artificial lakes (with J. Cotner), and will develop scientific curriculum for student-led investigations. She will supervise the post-doctoral database-construction project, and collaborate with area schools to disseminate curriculum centered on data gathered from the artificial lakes.

Research Interest: Authentic research experiences in undergraduate biology education.

Relevant Publications:

- Cotner, S., and Hebert, S. Bean beetles make biology sexy. In press at *The American Biology Teacher*.
- Ratcliff, *Raney, *Westreich and Cotner, A novel laboratory activity for teaching about the evolution of multicellularity, 2014. *The American Biology Teacher* 76(2): 81-87.
- Cotner, *Loper, Walker and Brooks, D. 2013. It's Not You, It's the Room (or, Are the High-Tech, Active Learning Classrooms Worth It?), *Journal of College Science Teaching* 42(6), 82-88.
- Cotner, S. & Gallup Jr, G.G., 2011, Introductory Biology Labs…They Just Aren't Sexy Enough!, *Bioscience Education*, 18, p. 5.
- Walker, J.D., Cotner, S., *Beermann, N. & Walker, J.D., 2011. Vodcasts and Captures: Using Multimedia to Improve Student Learning in Introductory Biology, *Journal of Media and Hypermedia*.
- Cotner, S., *Ballen, C., Brooks, D.C. and R. Moore. 2011. "Instructor Gender and Student Confidence in the Sciences: A Need for More Role Models?" *Journal of College Science Teaching* 40(5), pp. 96-101.
- *Uyehara, I.K., T. Gamble, and S. Cotner. 2010. "The presence of ranavirus in anuran population at Itasca State Park, Minnesota, USA." *Herpetological Review* 41(2): 177-179.
- Wright, R., S. Cotner, and A. Winkel. 2009. Minimal impact of organic chemistry prerequisite on student performance in introductory biochemistry. *CBE-Life Sciences Education.*
- *Rodriquez, E.M., T. Gamble, V. Hirt and S. Cotner. 2009. Presence of chytrid fungus (*Batrachochytrium dendrobatidis*) at the headwaters of the Mississippi River, Itasca State Park, Minnesota. *Herpetological Review.*