Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)

Project Title: **ENRTF ID: 094-C**

Developing Scientific and Intellectual Infrastructure for Clean Waters

Category: C. Environmental Education

Total Project Budget: $ 476,000

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 - June 2020

Summary:

We will develop tools for answering questions that will help use better manage wetlands and lakes in Minnesota. We will also build a water quality database for students and scientists.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

We show a diagram of our proposed research facility, including 12 artificial ponds (mesocosms), instrumentation for analyzing greenhouse gases released to the atmosphere and a database where data will be stored.

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

PROJECT TITLE: Developing scientific and intellectual 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) and phosphorus (P) are increasingly problematic for both aquatic life and the health of humans in these watersheds. Increased inputs of both N and P to farmland and sewage outputs are impairing the use of our precious freshwaters.

This work is critical because:

- Water quality is deteriorating rapidly in Minnesota lakes and rivers.
- We need better management tools to ameliorate degrading water quality.
- We need better scientific tools to understand the nutrient cycles in natural systems and how they respond to future changes in climate. The artificial pond/wetland/lake facility has potential to increase the capacity of the University of Minnesota to address climate and eutrophication issues.

The overall goals of our work are to: 1) Improve water quality in MN; 2) Increase understanding of the controls of N and P losses from freshwaters and how they may change with a changing climate; 3) Develop scientific and intellectual infrastructure to understand N and P cycling.

The **outcomes** of the proposed work will be: a) A new facility enabling studies of the carbon (C), N and P cycles in freshwaters; b) capacity to address policy issues related to eutrophication.

We will achieve our goals by*:*

- Building and instrumenting an experimental facility at the University of Minnesota's Cedar Creek Nature Reserve (CCNR) drawing users and students from across the university.
- Training undergraduate students in N and P cycling and scientific skills.
- Developing an accessible database for use by scientists in the following development stages: 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 and the College of Food, Agriculture and Natural Resources; and scientists, citizens, educators, and policy makers state wide.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Build an outdoor research facility at CCNR to enable manipulation and measurement of components of the N and P cycles in artificial ponds. This state-of-the-art facility will enable scientists to manipulate water level, temperature, nutrient concentrations, pH, and many other variables to determine their effects on N and P cycling, enhancing our ability to simulate predicted changes in climate. We will be able to examine science and management questions at an appropriate research scale. **Nothing like what we are proposing currently exists in the State of Minnesota.** **Budget: $200,000**

Outcome	Completion Date
1. Design and construct experimental pond facilities	July 2018
2. Purchase and test instrumentation for measuring, N, P and C components	July 2018
3. Fill the mesocosms and add plants to them and begin experiments	July 2018

Activity 2: Train undergraduate students on the N and P cycles. 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 Nutrients in Minnesota (N in MN) database described below. Students will actively engage in analyzing, interpreting, and publishing these data, and also adding material to our database. **Budget: $100,000**

Outcome	Completion Date
1. Facilitate course-based research focused on N and P-cycling at local, regional and global scales	July 2019

2. Engage students in building N and P in MN database with aid of scientific personnel	July 2019

Activity 3: Develop and maintain database based on artificial pond experiments for use by scientists, students and policy makers with a focus on climate change issues. This database will provide vital information to a variety of stakeholders and allow for better understanding of how nutrient cycling processes are changing over time. This type of data will be imperative for future management decisions aimed at improving water quality across the state, particularly in response to the environmental stressors associated with climate change. **Budget: $176,000**

Outcome	Completion Date
1. Work with partners in CBS to develop a nutrient database	July 2018
2. Pilot database with results from student-based and PI-directed research	July 2019
3. Full release of database to all stakeholders (students, educators, citizens, etc)	July 2020

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 science and education activities through the College of Biological Sciences (CBS) and at the University's CCNR and S. Cotner is teaching the Foundations course discussed above. J. Cotner has been studying freshwater quality issues for nearly 40 years. Our team also includes a graduate student (Seth Thompson) whose graduate program is focused both on aquatic ecosystems science and science education and a post-doctoral fellow (1 year), whose efforts will focus on developing our first water quality focused research questions, and developing and maintaining our database. We have also asked for funding for Andrea Little, a technician in J. Cotner's laboratory who will oversee data analyses, maintenance of the database, and work with students to implement their projects.

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.

C. Timeline Requirements (start date: July 1 2017; end date: July 1 2020)

Activity	2017			2018			2019			2020		
	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall*
Establish artificial ponds at CCNR		X	X	X								
Students enrolled in Biol 3004					X			X			X	
Publications from student projects						X			X			X
Develop Nutrients in MN database				X	X							
Pilot Nutrients in MN database projects						X	X	X				
Full Implementation of Nutrients in MN database									X	X	X	X

*Fall 2020 is included for sake of continuity even though it is after the end date of this specific project proposal.

2017 Detailed Project Budget

Project Title: Developing scientific infrastructure for clean waters

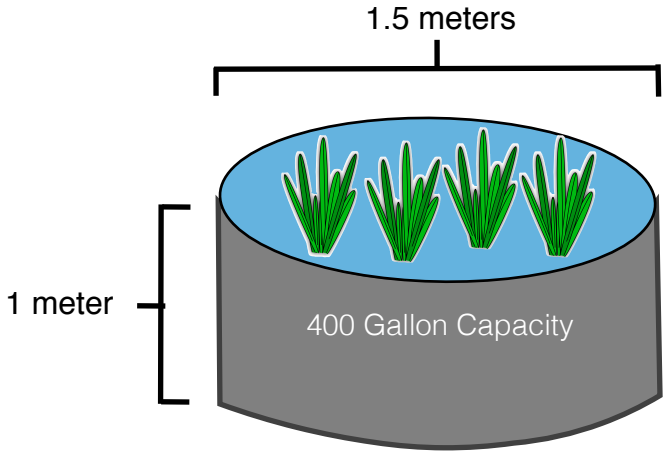
IV. TOTAL ENRTF REQUEST BUDGET *3* **years**

BUDGET ITEM	AMOUNT
Personnel: Total Request for all Personnell over the course of the 3 Year Project	**$ 358,000**
James Cotner: (75% salary, 25% benefits) 1 month salary per year for all three years of the project for mentorship of the graduate student and support during summer teaching training.	$ 48,000
Sehoya Cotner: (75% salary, 25% benefits) 1 month salary per year for all three years of the project for mentorship of the graduate student and support during summer teaching training.	$ 39,000
Postdoctoral Fellow: (82% salary, 18% benefits) 12 months for 1 Postdoc support at 100% FTE, including fringe.	$ 58,000
Graduate Student: 52% salary, 48% benefits during the academic year and 85% salary, 15% benefits during the summer) 24 months for 1 graduate student support at 50% FTE including fringe.	$ 95,000
Undergraduate Students: (100% salary, 0% benfits) Support for an 1 undergraduate at 25% FTE each year for the 3 year project.	$ 18,000
Technician support. (79% salary, 21% benefits) Six months support for 3 years. Technician will do water quality analyses, maintain the database and maintain the mesocosms.	$ 100,000
Equipment/Tools/Supplies:	**$ 40,000**
Equipment: Funding in year one to purchase equipment for basic water collection and monitoring inclduing, secchi disks, plankton nets, and data loggers (temperature and DO). All equipment will be used at the partner schools for their entire useful life and also will be made available for future partner schools after the conclusion of this specific project	$ 10,000
Supplies: $10,000 per year in consumable supplies to support student projects. This includes but is not limited to water chemistry testing supplies, petri dishes, zebrafish facility fees, media reagents, etc. This corresponds to ~$7 per students served per year (given participation of 3 partner schools)	$ 30,000
Travel:	**$ 18,000**
Milage:This is a request for $1000 annually to cover the cost for travel to and from partner schools to transport scientist volunteers and support the implemntation of the environmental curriculum	$ 3,000
Student Transport: $5000 per year to provide transport for students participating in InSciEd Out to present their research findings at the University of Minnesota in the format of a scientific poster session.	$ 15,000
Additional Budget Item:	**$ 60,000**
Summer Support Staff: Stipends for support staff during summer training program. Includes guest lecturers, undergraduate helpers, and other support. Staff receive a stipend to commensate for 12 days of service during the adult internship. Stipends are negotiated dependent on qualifications.	$ 60,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 476,000

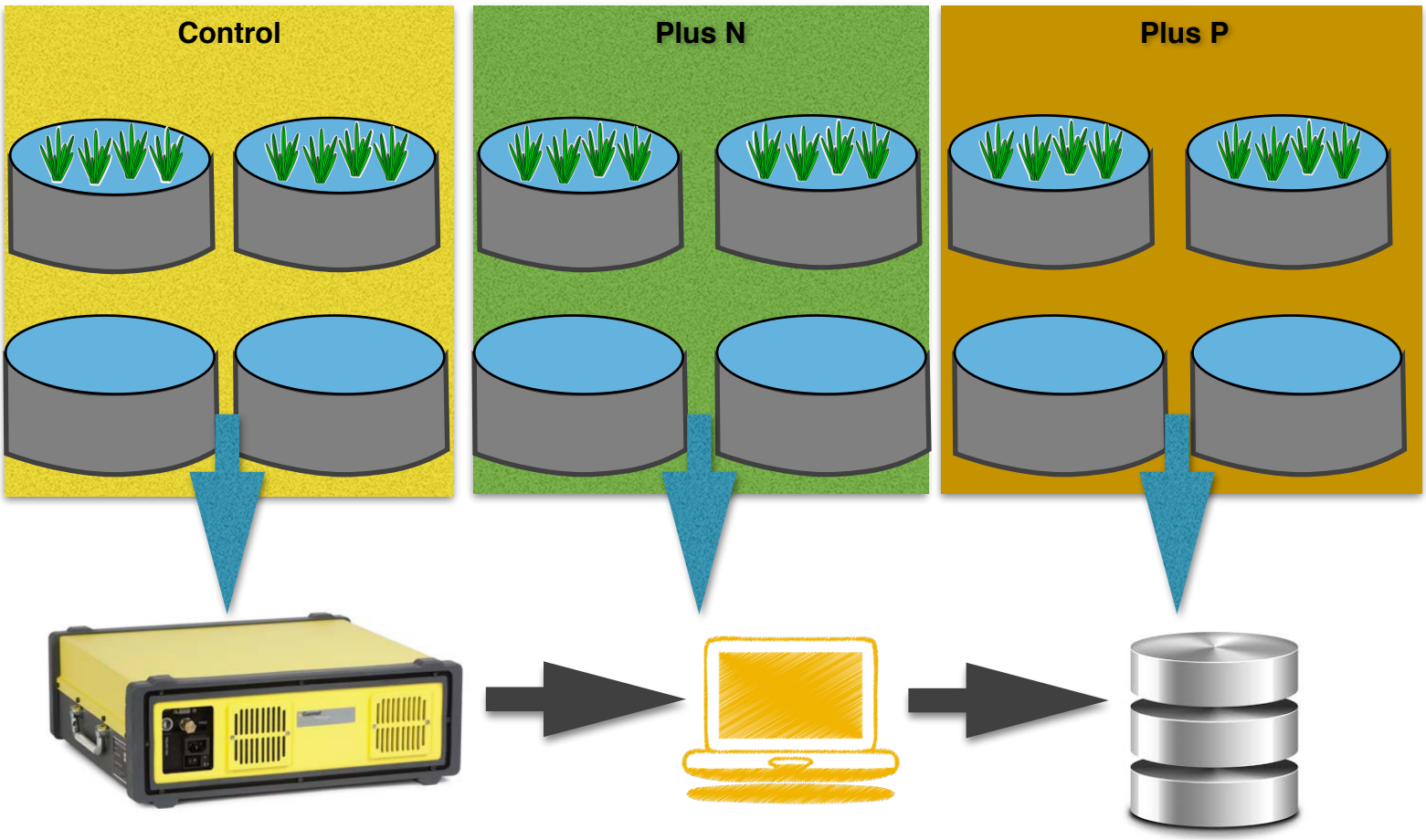
V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	N/A	
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 Associated with this Proposal*	$ 234,000	*Secured*
Funding History:	N/A	
Remaining $ From Current ENRTF Appropriation:	N/A	

Each one of the twelve artificial lakes (mesocosms) 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. Mesocosms will be deployed at CCNR in full sun with temperature control and a lid that can be placed over the top for measurements of gases emitted to the atmosphere.



An example of types of experiments that would be conducted. Replicated treatments (4) with or without plants, no additional nutrients (control), with added nitrogen, and with added phosphorus.



A portable gas analyzer similar to this one, will be used to quantify methane, CO_2, N_2O, and NH_3 as well as other important greenhouse gases and dissolved nutrients. In addition, we will deploy oxygen and temperature sensors in each artificial mesocosm. Data will be analyzed, curated and placed in our online database.

Project Manager Qualifications and Organization Description

Project Manager: Dr. James Cotner, Professor, Department of Ecology, Evolution and Behavior, 1987 Upper Buford Circle, St. Paul 55108, 612-625-1706; cotne002@umn.edu

Education:

Ph.D., University of Michigan, Ann Arbor, 1990, Biology; (Major professor-Dr. Robert Wetzel-deceased).

M.Sc., Kent State University, Kent, Ohio, 1984, Biology; (Major professor-Dr. Robert Heath).

B.A., Wittenberg University, Springfield, Ohio, 1981, Biology.

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 activities and personnel. He will assist with the design, implementation and science questions focused on nutrient cycling in lakes and wetlands.

Research Interest: Microbial ecology and biogeochemistry of wetlands and large lakes; human influences on water quality in wetlands and lakes.

Relevant Publications:

Theissen, KM, WO Hobbs, JM Ramstack Hobbs, KD Zimmer, LM Domine, JB Cotner, and S Sugita. 2012. The Altered Ecology of Lake Christina: A Record of Regime Shifts, Land-use Change, and Management From a Temperate Shallow Lake. The Science of the Total Environment 433: doi:10.1016/j.scitotenv.2012.06.068.

Cotner, JB, and EK Hall. "Comment on "A Bacterium That Can Grow by Using Arsenic Instead of Phosphorus"." Science (New York, N.Y.) 332, no. 6034 (2011): doi:10.1126/science.1201943.

Kolka, R. K.; Mitchell, C.P.J.; Jeremiason, J. D.; Hines, N. A.; Grigal, D. F.; Engstrom, D. R.; Coleman-Wasik, J.K.; Nater, E. A.; Swain, E.B.; Monson, B. A.; Fleck, J. A.; Johnson, B.; Almendinger, J. E.; Branfireun, B. A.; Brezonik, P.L.; Cotner, J.B. 2011. Mercury cycling in peatland watersheds. In “Kolka, R.K.; Sebestyen, S. .; Verry, E. S.; Brooks, K.N., eds. Peatland biogeochemistry and watershed hydrology at the Marcell Experimental Forest. Boca Raton, FL: CRC Press: 349-370.

Cotner J.B., E.K. Hall, T. Scott and M. Heldal. 2010. Freshwater bacteria are stoichiometrically flexible with a nutrient composition similar to seston. Front. Microbio. doi: 10.3389/fmicb.2010.00132

Cory, R M, K McNeill, J B Cotner, A Amado, J M Purcell, and A G Marshall. 2010. Singlet Oxygen in the Coupled Photochemical and Biochemical Oxidation of Dissolved Organic Matter. Environmental Science & Technology 44: 3683-3689.

Tranvik, L.J., J.A. Downing, J.B. Cotner and others. 2009. Lakes and reservoirs as regulators of carbon cycling and climate. Limnology and Oceanography 54: 2298-2314.

Hall, E.K., A.R. Dzialowski, S. M. Stoxen, and J.B. Cotner. 2009. The effect of temperature on the coupling between phosphorus and growth in natural bacterioplankton communities. Limnology and Oceanography 54: 880-889.

Stets, E.G., and J.B. Cotner. Littoral zones as sources of biodegradable dissolved organic carbon in lakes. Canadian Journal of Fisheries and Aquatic Science 65 :2454-2460.

Cory, R.M., J.B. Cotner and K. McNeill. 2009. Quantifying interactions between singlet oxygen and aquatic fulvic acids. Environmental Science and Technology 43: 718-723.

Hall, E.K., C. Neuhauser and J.B. Cotner. 2008. Toward a mechanistic understanding of how natural bacterial communities respond to changes in temperature in aquatic ecosystems. ISME Journal 2: 471-481.

Stets, E.G. and J.B. Cotner. 2008. The influence of dissolved organic carbon on bacterial phosphorus uptake and bacteria-phytoplankton dynamics in two Minnesota lakes. Limnology and Oceanography 53: 137-147.

Hall, E. K.; Cotner, J. B. 2007. Interactive effect of temperature and resources on carbon cycling by freshwater bacterioplankton communities. Aquatic Microbial Ecology 49: 35-45.