Environment and Natural Resources Trust Fund
2011-2012 Request for Proposals (RFP)

LCCMR ID: 122-E

Project Title: Phosphorus- Curlyleaf Pondweed Control by Sediment Iron Augmentation

Category: E. Aquatic and Terrestrial Invasive Species

Total Project Budget: $ $647,000

Proposed Project Time Period for the Funding Requested: 3 yrs, July 2011 - June 2014

Other Non-State Funds: $ 0

Summary:

Investigate impact of iron filings added to sediment on curlyleaf pondweed growth and sediment phosphorus release to the water. We will also investigate the impact on Eurasian watermilfoil growth.

Name: John Gulliver

Sponsoring Organization: U of MN

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Minneapolis MN 55455

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Location

Region: Statewide

Ecological Section: Statewide

County Name: Statewide

City / Township:

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

2011-2012 MAIN PROPOSAL

PROJECT TITLE: Phosphorus- Curlyleaf Pondweed Control by Sediment Iron Augmentation

I. PROJECT STATEMENT

It is believed that iron filings added to sediment will react over time to limit curlyleaf pondweed growth and reduce internal sediment phosphorus release to the water column. Many Minnesota lakes and ponds exhibit phosphorus-rich sediments that support nuisance infestations of rooted aquatic nuisance species and, when conditions allow, transfer into the water column reducing water clarity. One primary lake management tool to maintain water clarity is to keep the phosphorus 'locked up' in the sediments, and not allow it to seep back into the water column. To do so, we principally rely upon naturally occurring binding chemicals such as iron or aluminum and calcium. Iron is a ubiquitous mineral with no known environmental impact at the concentrations that will be considered. Hence, the widespread interest by lake associations, local and state governments in adding iron to iron-poor sediments (See attachment for a resolution by lake associations). Iron may also help reduce methyl mercury formation in wetlands and lakes subject to fluctuating water levels and enriched sulfate concentrations. These two issues cause significant economic losses of property value, fishing, and associated recreation industries in Minnesota. Significant lake sediment and dose-response questions remain which form the basis of this proposal.

It has been observed that an aquatic nuisance species, curlyleaf pondweed (*Potamogeton crispus)*, is growth-inhibited in sediments that contain substantial iron concentrations. Research has linked high dissolved iron in sediment pore water to suppression of aquatic plant growth and preliminary data has shown reduced curlyleaf pondweed abundance in lakes where iron augmentation has occurred. These observations require further substantiation and it is important to resolve whether such inhibition is due to binding of phosphorus making it preferentially inaccessible to the nuisance species, if it is due to a direct iron inhibition, or if it is due to some other factor.

This proposal will address some of the key sediment chemistry questions related to phosphorus, iron and sulfate dynamics for lake management. We will also investigate the impact on Eurasian watermilfoil growth. Our objectives are to determine the effectiveness of iron augmentation in accomplishing these goals. The results of the research could lead to an ecologically sound tool that effectively addresses two major water quality issues in lakes (clarity and nuisance plant growth) without using herbicides or other chemicals.

II. DESCRIPTION OF PROJECT RESULTS

Activity 1. Field identification of lakes and ponds with reduced curlyleaf growth. $75,000

Investigate cases in the field where iron is believed to reduce nuisance aquatic plants, including a survey of sediment iron, phosphorus, nitrogen and other constituents believed to be important to nuisance species growth, along with aquatic plant species. One field site to investigate would be the Rush Lake iron supplements versus other locations in the lake.

Outcome	Completion Date
1. Identify lakes with iron-enhanced sediment.	September 30, 2011
2. Investigate observations of reduced curlyleaf growth.	November 30, 2011
3. Correlate sediment iron and reduced curlyleaf growth.	November 30, 2011

Activity 2. Test iron-phosphorus release relation with batch water-sediment tests. $150,000

Perform batch tests on variations of sediment iron and phosphorus levels at different sulfate concentrations and on various types of pond and lake sediment. Approximately 200 – 300 batch tests are envisioned to quantify the impact of iron on phosphorus release from the sediments over a range of sulfate and dissolved oxygen concentrations.

Outcome	Completion Date
1. Relate phosphorus release to iron, dissolved oxygen and sulfate concentrations.	January 31, 2013

2. Design water column tests for Activity 4.	January 31, 2013

Activity 3. Document influence of sediment iron on nuisance plants. $225,000
Investigate the impact of iron in the sediment on plant growth, and identify the mechanism by which this occurs or if it occurs. Investigations will focus on curlyleaf pondweed and Eurasian watermilfoil, the major aquatic nuisance plants in Minnesota. Response of these plants to different sediment nutrient (N and P) levels with and without iron additions will be determined in the controlled conditions of a greenhouse or environmental chamber.

Outcome	Completion Date
1. Use results from Activities 1 and 2 to devise the experiments to determine mechanisms of growth inhibition.	January 31, 2012
2. Final report with recommendations on the impact of iron augmentation to the sediments on curlyleaf pondweed growth	June 30, 2014

Activity 4. Water column studies on selected sediments from the field. $197,000
Run pilot water column tests on selected sediments with a variation in iron dosage, sulfate concentration and dissolved oxygen concentration. These water column tests will be used to determine whether iron dosage will significantly reduce phosphorus release from the sediments.

Outcome	Completion Date
1. Use results from Activities 1 and 2 to select sediments and phosphorus, iron, sulfate and dissolved oxygen concentrations for these studies.	February 28, 2013
2. Final report with recommendations on iron dosage to reduce phosphorus release from sediments.	June 30, 2014

III. PROJECT STRATEGY AND TIMELINE

A. Project Team (Will receive funding from project)
Dr. John S. Gulliver, Professor, Department of Civil Engineering, University of Minnesota
Dr. William Arnold, Associate Professor, Department of Civil Engineering, University of Minnesota
Dr. Raymond Newman, Professor, Department of Fisheries and Wildlife, University of Minnesota
Dr. Robert Sterner, Professor, Department of Ecology, Evolution and Behavior, University of Minnesota
Mr. Steve McComas, Blue Water Science, Field experience in diagnosing curlyleaf pondweed nuisance.
Project Partners (Will receive in-kind funding from other sources)
Dr. David Wright, Minnesota Department of Natural Resources, Technical reviewer and consultant
Mr. Bruce Wilson, Minnesota Pollution Control Agency, Cooperator and linkage to urban runoff
Mr. Chip Welling, Minnesota Department of Natural Resources, Technical reviewer and consultant

B. Timeline Requirements
This project is designed as a three year effort. Eighteen months will be required to determine mechanisms and impacts of dose rates upon the behavior of various iron products in lake sediments. Those results will guide further studies of how effectively curlyleaf pondweed, Eurasian watermilfoil and internal phosphorus loading can be managed, both in batch and pilot test settings, and will determine effectiveness and potential to remediate phosphorus release and nuisance plant problems in Minnesota, with recommendations on implementation.

D. Long-Term Strategy and Future Funding Needs
This proposed research will provide foundational knowledge that is needed in order to develop future strategies for implementing iron augmentation technology as a tool for improving water quality in Minnesota Lakes. Implementation funding will come from lake associations, cities, and watershed districts who have expressed their support for the concept.

Project Budget (3 Years)

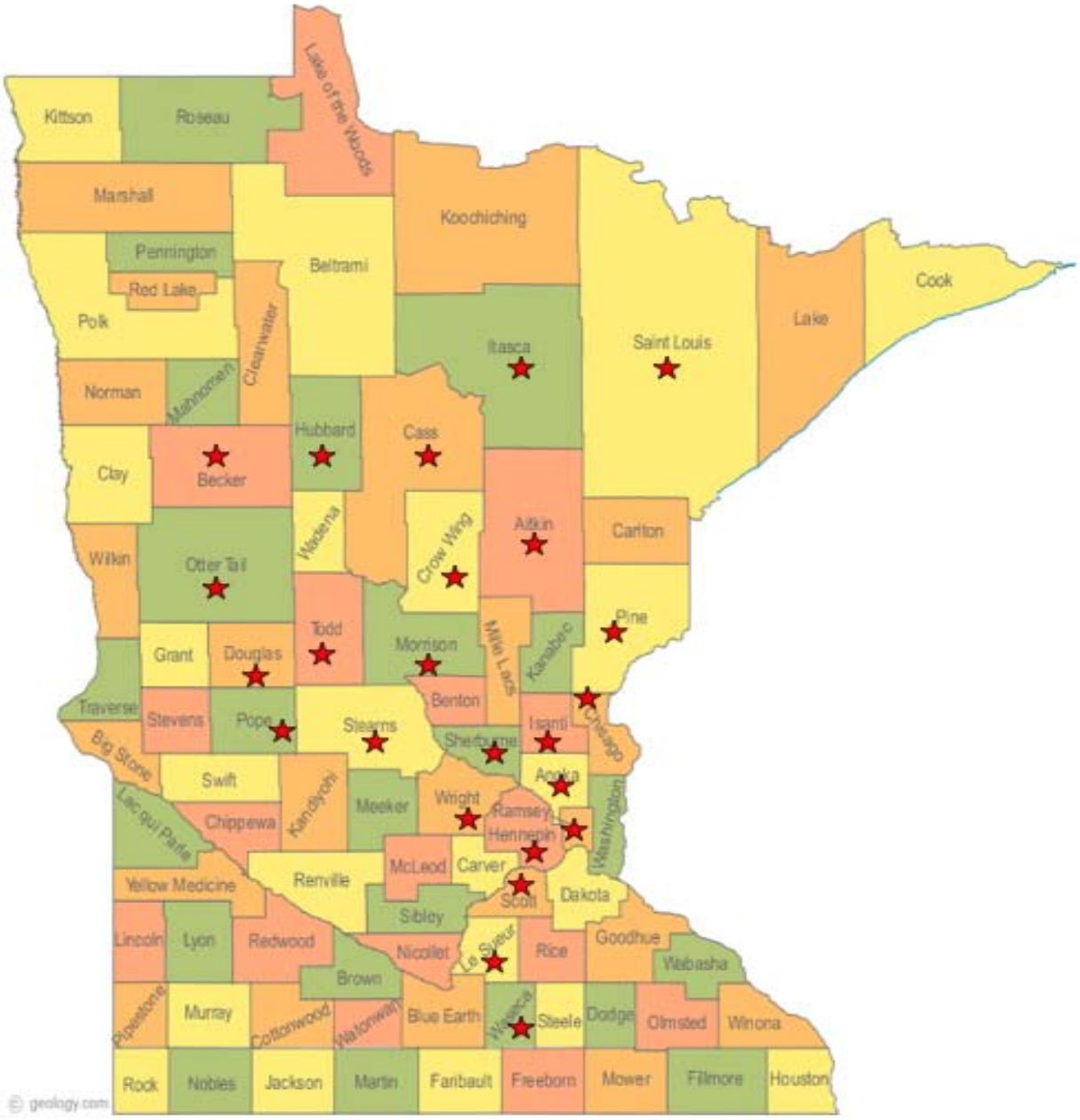
IV. TOTAL PROJECT REQUEST BUDGET

BUDGET ITEM	AMOUNT	% FTE
Personnel:		
Dr. John S. Gulliver (Salary & 35.5% FB between 7/2011 and 12/2014)	$ 107,663	15%
Dr. William Arnold (Salary & 35.5% FB between 7/2011 and 12/2014)	$ 85,632	15%
Dr. Raymond Newman (Salary & 35.5% FB between 7/2011 and 6/2014)	$ 39,456	8%
Dr. Robert Sterner (Salary & 35.5% FB between 7/2011 and 6/2014)	$ 47,484	8%
2 Graduate Research Assistants (Salary & 18% FB + Tuition between 7/2011 and 6/2014; 50% time)	$ 231,835	2 X 50%
4 Undergraduate Research Assistants (Salary & 8.6% FB between 7/2011 and 6/2014)	$ 69,551	4 X 33%
Contracts:		
Mr. Steven McComas (8% time for the 1st year to help with identifying iron based phosphorus limitation and curlyleaf pondweed response)	$ 18,000	2 yr at 4.6%
Supplies:		
Equipment rental, bottles, jars, tubes, and reagents for laboratory sediment iron augmentation research	$ 28,050	
Fiberglass enclosures, plant containers, reagents and chemicals, gases, and plant tubers for Curly-leaf pondweed mesocosm studies	$ 14,579	
Other:		
Local field trips to study sites within Minnesota. Approximately 15 trips at 200 miles round trip and $0.75 per mile	$ 4,750	
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$ 647,000	

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT
In-kind Services During Project Period: David Wright and Chip Welling, Minnesota Department of Natural Resources. Salary and benefits for technical review and consultation.	$ 22,574
In-kind Services During Project Period: C. Bruce Wilson, Minnesota Pollution Control Agency. Salary and benefits for technical review and consultation.	NA
In-kind Services During Project Period: University of Minnesota. Waiving of normal administrative fees for the project; 51% of total direct costs.	
Past Spending: Various MN Lake Associations and the Cities of Apple Valley, Burnsville, and Lakeville, Minnesota. Pilot sediment augmentation studies.	$ 20,000

Map Showing the 24 MN Counties In Which the Endorsing Organizations Listed Above Reside



John S. Gulliver, Ph. D., P. E.
Professor
Department of Civil Engineering
University of Minnesota
Biographical Sketch

PROFESSIONAL EXPERIENCE

3/98 – 7/07 Head, Department of Civil Engineering, University of Minnesota.
10/97-3/98 Acting Head, Department of Civil Engineering, University of Minnesota.
6/96 - present Professor, Department of Civil Engineering, University of Minnesota.
6/88 - present Registered Professional Civil Engineer, State of Minnesota, No. 20045.
9/87 - 9/96 Associate Professor, Department of Civil Engineering, University of Minnesota.
9/81 - 9/87 Assistant Professor, Department of Civil Engineering, University of Minnesota.
6/80 - 9/81 Research Associate, St. Anthony Falls Hydraulic Laboratory, University of Minnesota.

HONORS AND AWARDS

Rickey Medal, 2003. American Society of Civil Engineers, Award given for a career of research and education related to hydroelectric energy.

Joseph S. and Rose T. Ling Professor of Civil Engineering, 1999 - 2009.

Rickey Medal, 1990. American Society of Civil Engineers. Award given to the ASCE Technical Committee in recognition of contribution to "Civil Engineering Guidelines for Planning and Designing Hydroelectric Developments."

PRINCIPAL RESEARCH ACTIVITIES

Major research interests are environmental fluid mechanics, chemical transport and fate in environmental systems, and flow and mass transport at hydraulic structures. Current research involves interfacial mass transfer and remediation of non-point source pollution from urban runoff. Specific research projects include the measurement and prediction of air-water mass transfer at hydraulic structures, aerator effectiveness in deep reservoirs, and development of practices to remove dissolved contaminants.

SELECTED PEER REVIEWED PUBLICATIONS

Weiss, P.T., A.J. Erickson and J.S. Gulliver."Cost and pollutant removal of storm-water treatment practices," *Journal of Water Resources Planning and Management,* 133(3), 218-229, 2007.

Erickson, A.J., J.S. Gulliver and P.T. Weiss, "Enhanced Sand Filtration for Storm Water Phosphorus Removal," *Journal of Environmental Engineering,* 133(5), 485-497, 2007.

Abdul –Aziz, O.I., B.N. Wilson and J.S. Gulliver, "An Extended Stochastic Harmonic Analysis (ESHA) Algorithm: Application for Dissolved Oxygen," *Water Resources Research*, 43, W08417, doi:10.1029/2006WR005530, 2007.

Tamburrino, A. and J.S. Gulliver,"Free Surface Visualization of Streamwise Vortices in a Channel Flow," *Water Resources Research*, 43, W11410, doi:10.1029/2007WR005988, 2007.

Urban, A. L., J.S. Gulliver and D. W. Johnson, "Modeling total dissolved gas concentration downstream of spillways," *Journal of Hydraulic Engineering*, 134(5): 550-561, 2008.

Giovannettone, J.P., E. Tsai and J.S. Gulliver, Gas void ratio, bubble diameter inside a deep airlift reactor, *Chemical Engineering Journal*, 10.1016/j.cej.2008.11.024, 2008.

Giovannettone, J. P. and J. S. Gulliver "Dispersion and gas transfer inside a deep airlift reactor," *American Institute of Chemical Engineers Journal,* 54(4): 850-861, 2008.