Environment and Natural Resources Trust Fund
2010 Request for Proposals (RFP)

LCCMR ID: 220-G

Project Title:

Quantifying Carbon Burial in Healthy Minnesota Wetlands

LCCMR 2010 Funding Priority:

G. Creative Ideas

Total Project Budget: $ $432,000

Proposed Project Time Period for the Funding Requested: 3 years, 2010 - 2013

Other Non-State Funds: $ N/A

Summary:

Shallow lakes can bury carbon intensively and could be used to mitigate release from fossil fuels. We will determine how managers can increase carbon burial in Minnesotas shallow lakes.

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Sponsoring Organization: U of MN

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Location:

Region: Statewide

County Name: Grant

City / Township: N/A

_____ Knowledge Base _____ Broad App. _____ Innovation

_____ Leverage _____ Outcomes

_____ Partnerships _____ Urgency _____ TOTAL

MAIN PROPOSAL

PROJECT TITLE: Quantifying carbon burial in healthy Minnesota wetlands

I. PROJECT STATEMENT

Why this work needs to be done: **Lakes and wetlands are important sinks for atmospheric CO_2.** The US EPA stated last week that heating of the Earth from fossil fuel derived greenhouse gases threatens the environment and human health and soon CO_2 emissions will be regulated. The state of Minnesota emits over 150 million metric tons of CO_2 annually due to fossil fuel burning and a stated goal is to stabilize CO_2 releases at 1990 levels by 2010. Reaching this goal will require both minimizing sources and maximizing sinks such as lakes. Lakes are important to CO_2 removal because:

- Minnesota lakes presently bury about 10 million metric tons of carbon.
- Shallow lakes remove carbon at much higher rates than large lakes (Fig. 1).
- Managing shallow Minnesota lakes for carbon removal could remove an additional 100-200 million metric tons of carbon per year from the atmosphere and...
- Promote wildlife and waterfowl as well.

The goal of the project proposed here is to determine if we can manage our shallow lakes to bury carbon more efficiently.

Direct impacts of the project: This work will enable better management of wetlands and lakes to help Minnesota reduce the effects of greenhouse gas emissions. Our central hypothesis is that carbon burial rates are highest in our healthiest wetlands and lakes which are dominated by submerged non-algal plants (macrophytes). Lakes and wetlands are the most intensive systems in the world for carbon burial[1,2].

- A 10-acre lake may remove more carbon than a 1000 acre conservation tillage farm (Figure 2).
- Managing lakes for carbon burial needs to be part of the 'greenhouse gas equation' and could help move Minnesota toward carbon neutrality.

How we will achieve our goals: One of the problems with managing shallow lakes and wetlands is that there is so much variation in the behavior of individual systems (Figure 1). However, we know how to effectively manage shallow lakes to promote the growth of non-algal plants (macrophytes), a key component to carbon removal in healthy wetlands. We will study how macrophyte-dominated and algal-dominated lakes remove carbon and shift 5 lakes from phytoplankton to macrophyte lakes by applying rotenone (a current practice employed by the MN DNR). By measuring CO_2 fluxes into lakes both before and after rotenone treatments we will be able to determine how effective this management strategy is for increasing carbon burial in lakes.

II. DESCRIPTION OF PROJECT RESULTS

Result 1: Determine whether macrophyte-dominated or algal-dominated wetlands bury more carbon. ($227,000)

We will study production, decomposition and burial in five turbid (algal-dominated), five clear (macrophyte-dominated) and five experimentally manipulated (from turbid to clear) shallow lakes. We hypothesize that turbid lakes will have lower productivity, less organic carbon in surface sediments, and higher sediment resuspension rates which should increase decomposition rates and decrease stratification relative to clear lakes. We will:

- Measure rates of production in turbid, clear and manipulated lakes annually.
- Measure annual sediment accumulation rates and resuspension rates in turbid, clear and manipulated lakes.

- Determine what factors are most important to burial of organic matter in shallow lakes. For instance, do lakes with the highest productivity always bury the most carbon? Or does the physical structure of the lake matter as well (heat content, dissolved oxygen, etc.). The physical structure of turbid and clear lakes can be quite different.

Deliverable	Completion Date
1. Quantification of carbon burial and carbon credits associated with shallow lakes and wetlands.	30 Jun 2013
2. Management recommendations for carbon burial associated with turbid vs. clear water state.	30 Jun 2013

Result 2: Determine the plant sources of carbon for burial in shallow lakes. ($205,000)

We will determine whether the organic carbon produced in the watershed or that produced in the lake is most important to carbon burial in the lake. We will also determine which plants are preserved most effectively in different types of lakes (turbid and clear). These results are important because management efforts in the watershed and in the lake should focus on plants that are preserved most effectively.

- Measure rates of decomposition of terrestrial and aquatic plants in lakes that are turbid, clear and manipulated.
- Assess the influence of ambient nutrients, land use, and dissolved oxygen on decomposition rates of terrestrial and aquatic plants.

Deliverable	Completion Date
1. Quantification of differences in carbon burial associated with different plant types in the watershed and in the lake.	30 Jun 2013
2. Management recommendations for increasing carbon burial by managing shallow lakes and their watersheds.	30 Jun 2013

III. PROJECT STRATEGY

A. Project Team/Partners. Our project team consists of Cotner and Zimmer (Univ. St. Thomas) with help from MN DNR (B. Herwig, M. Hanson, T. Call, and N. Hansel-Welch). Collaboration with the DNR is important particularly for assistance in manipulating lakes from the turbid to clear state using rotenone.

B. Timeline Requirements. Treatment of turbid lakes with rotenone will occur in fall 2010. This will enable gathering preliminary data in summer 2010 and observing changes associated with the switch from turbid to clear state. Data on all 3 lake types (turbid, clear and switching) will be gathered throughout 2010-2012 and results will be available throughout the study. Final results will be synthesized and published by spring 2013 and recommendations made at that time.

C. Long-term strategy. This study will be performed in shallow lakes in western Minnesota. To manage lakes for the entire state, similar studies need to be performed in regions of Minnesota. Ideally, future studies would focus on these other areas. Also, as carbon trading increases, we hope to incorporate lakes and wetlands into formulations of carbon credits.

IV. References

1. Cole, J J, Y T Prairie, N F Caraco, W H McDowell, L J Tranvik, R G Striegl, C M Duarte, and others. "Plumbing the Global Carbon Cycle: Integrating Inland Waters Into the Terrestrial Carbon Budget." ECOSYSTEMS 10, no. 1 (2007): doi:10.1007/s10021-006-9013-8.

2. Downing, J A, J J Cole, J J Middelburg, R G Striegl, C M Duarte, P Kortelainen, Y T Prairie, and K A Laube. "Sediment Organic Carbon Burial in Agriculturally Eutrophic Impoundments Over the Last Century." GLOBAL BIOGEOCHEMICAL CYCLES 22, no. 1 (2008).

Project Budget-Cotner

IV. TOTAL PROJECT REQUEST BUDGET (*3 years; 2010-2012*)

Personnel:		
James Cotner (PI) Project management-will oversee field and laboratory operations, interpret, and analyze data and summarize results. (10% time annual 2010-2012; 76% salary; 24% benefits)	$	26,000
Graduate student (Conduction of field work and laboratory analyses; 50% time summer 2010-2012; 80% salary; 20% benefits)	$	25,000
Undergraduate student (Field and laboratory analyses; Summer only 100% time 2010-2012; 91% salary; 9% benefits)	$	5,000
Technician (Laboratory analyses and database management; 50% time annual 2010-2012)	$	93,000
Contracts: To University of St. Thomas (Professor Kyle Zimmer PI will oversee field experiments, stable isotope sample collection and analyses; Support includes funds for a post-doctoral fellow who will conduct experiments and interpret isotope data; 4 undergraduate students will conduct field sampling and some laboratory analyses; this budget includes funds for a canoe for sampling lakes and travel expenses- $3,700)	$	205,000
Equipment/Tools/Supplies: Sondes for measuring organic matter production (carbon incorporation) and dissolved oxygen concentrations; 7 instruments x $5000 per instrument; One laptop computer	$	38,000
Acquisition (Fee Title or Permanent Easements):	N/A	
Travel: St. Paul to Fergus Falls (340 miles x $0.50 per mile x 15 trips); Lodging- $80/night x 20 nights; Food per diem $20 x 43 days; 3%	$	15,000
Additional Budget Items: Lab expendable supplies including reagents for standardizing instruments, reagents for chemical analyses, filters; disposable labware (test tubes, pipette tips, etc.); stable isotope analyses and maintenance of equipment and instruments	$	25,000
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$	432,000

V. OTHER FUNDS

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ Being Applied to Project During Project Period:	$ -	*N/A*
Other State $ Being Applied to Project During Project Period:	$ -	*N/A*
In-kind Services During Project Period: Applied to NSF for work that focus on the mechanisms responsible for carbon burial in lakes	$ -	Pending
Remaining $ from Current Trust Fund Appropriation (if applicable):		*N/A*
Funding History:	$ -	N/A

Figures Cotner and Zimmer

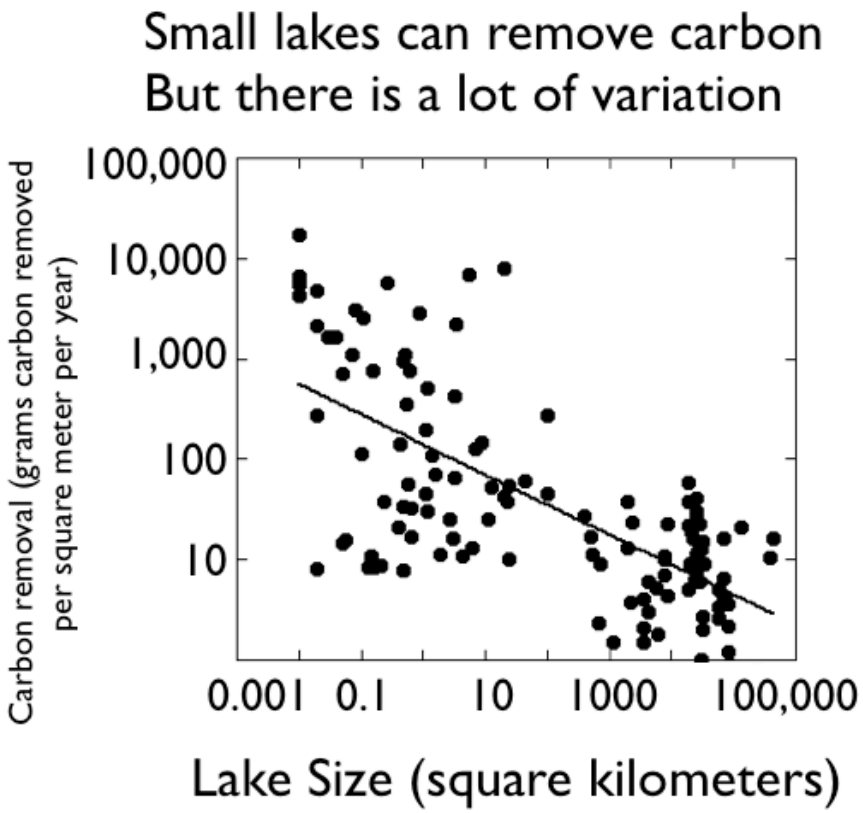

Figure 1. Variation in carbon burial with lake size. The lakes we will study are about 0.01 km^2 (far left of scale).

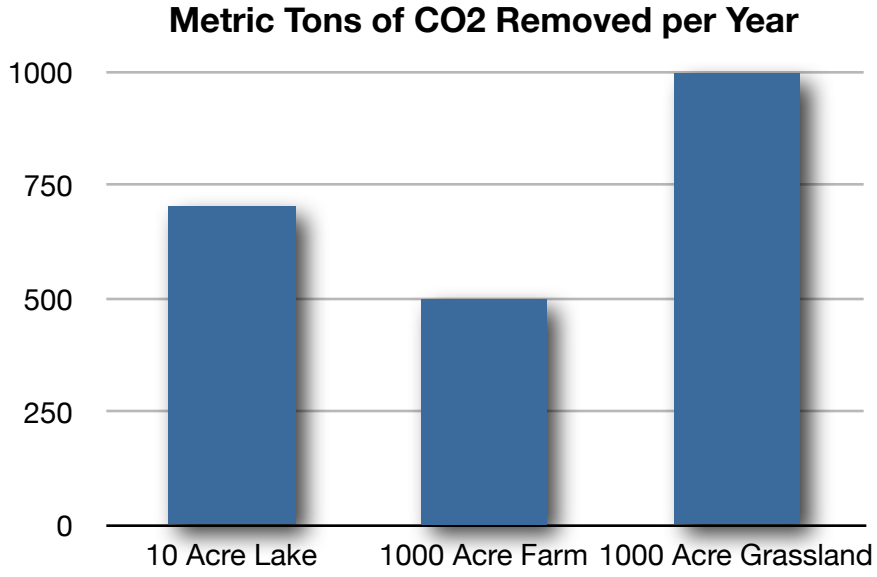

Figure 2. Burial of carbon in lakes vs. farms. A 10-acre lake can bury as much CO_2 as a 1000 acre farm using conservation tillage methods and about two-thirds of what is removed by a 1000 acre permanent grassland (based on data from Chicago Climate Exchange).

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

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

Project responsibilities: Professor Cotner will assist with site selection and supervise the graduate student on this project. He will also be in charge of collecting, analyzing, interpreting, and making management recommendations for carbon sequestration.

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

Relevant Publications:

Tranvik, L., J. Downing, J.B. Cotner and others. Accepted for publication. Lakes and impoundments as regulators of carbon cycling and climate. Invited synthesis paper for a special issue of Limnology and Oceanography on 'The role of lakes in the carbon cycle'.

Cotner, J.B., and B.A. Biddanda. 2002. Small players, large role: Microbial influence on auto-heterotrophic coupling and biogeochemical processes in aquatic ecosystems. Ecosystems 5, 105-121.

Cotner, J.B., J. Kenning and J.T. Scott. In press. The microbial role in littoral zone biogeochemical processes: Why Wetzel was right. Proceeding of the SIL Conference, Montreal, Canada, Aug 2007.

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.

Waples, J.T., B. Eadie, J.V. Klump, M. Squires, J. Cotner, and G. McKinley. 2008. The Laurentian Great Lakes in Halles, B. Continental Margins: A synthesis and planning workshop. Report of the North American Continental Margins Working Group for the U.S. Carbon Cycle Scientific Steering Group and Interagency Working Group. U.S. Carbon Cycle Science Program, Washington, DC, 110 pp.

Stets, E.G. and J.B. Cotner. Biodegradable dissolved organic carbon in lake ecosystems: Sources and effects on planktonic respiration. In press, Canadian Journal of Fisheries and Aquatic Sciences.

Kerfoot, W. C., JW Budd, SA Green, JB Cotner, BA Biddanda, DJ Schwab and HA Vanderploeg. 2008. Doughnut in the desert: Late-winter production pulse in southern Lake Michigan. Limnology and Oceanography 53: 589-604.

Johengen, T.H., B.A. Biddanda and J. B. Cotner. Stimulation of Lake Michigan plankton by sediment resuspension and river runoff. 2008. Journal of Great Lakes Research 34: 213-227.

Cotner, J B, B A Biddanda, W Makino, and T Stets. 2004. Organic Carbon Biogeochemistry of Lake Superior. Aquatic Ecosystem Health and Management 7: 451-464.

Cotner, J B, T H Johengen, and B A Biddanda. 2000. Intense Winter Heterotrophic Production Stimulated by Benthic Resuspension. Limnology and Oceanography 45(7): 1672-1676.

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.

Other issues relevant to the proposed project:

Cotner has been doing research on shallow lakes in Minnesota for the past 10 years. He is collaborating with Kyle Zimmer at the University of St. Thomas and colleagues at the Minnesota DNR. He is also working with the MN-DNR to develop a long-term monitoring program in sentinel lakes in Minnesota. Relatedly, he has been working at the Itasca Biological Station and Laboratories for the past 10 years and has deployed a buoy with meteorological station and water quality monitoring in Lake Itasca for the past 3 years. This experience will greatly enhance the present project as we plan to deploy similar instrumentation in shallow lakes throughout the state.