2008 LCCMR Proposal

LCCMR ID: 07-059-000

Project Title:

Climate change, CO2, and prairie/forest production

LCCMR Staff Confirmed or Revised Priority:

Selected Topics - Native Prairies - Working prairies

LCCMR 2008 Funding Priority: Natural Resource Data

Total Project Budget: $ $495,000

Proposed Project Time Period for the Funding Requested:

07/01/08 - 06/30/11

Other NonState Funds: $

$ 1,825,000

Project Manager: Peter Reich

Sponsoring Organization: U of M

Address: 1530 Cleveland Ave. No.
St. Paul, MN 55108

Telephone Number: 612-624-4270

Email: preich@umn.edu

Fax: 612-625-5212

Web:

Location:

County: Isanti **City / Township:** Athens/East

Other: Anoka, Carlton, Saint Louis

Summary:

Unique field projects simulate future CO2, rainfall, and temperature levels, and test biomass production, carbon sequestration, and water quality effects of prairie and tree species under these future environmental conditions.

MAIN PROPOSAL

LCCMR Proposal 2008 – Climate change and CO_2 affect prairie/forest production

DESCRIPTION OF PROJECT RESULTS--

We will test biomass production, carbon sequestration potential, and water quality effects of various prairie and forest species and mixtures under simulated future CO_2, temperature and rainfall levels, using 546 existing and 72 new field plots that will be established with LCCMR funds and targeted towards bioenergy production. In these tests, plants are grown in the open air in field soils. The 72 new plots established with LCCMR funds will examine specially designed prairie mixtures and woody mixtures that we hypothesize (based on past results) will offer the best potential under future environmental conditions. Simulating future CO_2 concentrations is done with vertical pipes that surround clusters of ≈70 plots and that release CO_2-enriched air transported by underground pipes from a nearby storage tank, increasing or decreasing the release every two seconds in response to computer tracking of CO_2 levels, wind speed and direction. Simulating future temperatures is done with infrared heat lamps and soil heating cables, also computer controlled. Altering growing season rainfall is accomplished via portable translucent "roof-like" structures that capture and remove rainfall and are in place for a limited number of rainy nights (≈8-10) and daytime hours during rainy periods.

The best scientific evidence indicates that by 2040-2060 temperature, rainfall, and atmospheric CO_2 levels in Minnesota will differ markedly from those in 1985-2005. Global carbon emissions lead to rising CO_2 levels, which in turn cause changes in temperature and rainfall. Biofuels and *in situ* carbon storage will be part of future energy solutions that can ultimately restore carbon dioxide (CO_2) in the air to 20th century levels. In the meantime, however, CO_2 is destined to rise for 50 years or more, even if we stop increasing our carbon emissions today.

Changes in temperature, rainfall and CO_2 will each influence the state's vegetation. Most relevant to this proposal, via changes in biomass production and related ecosystem processes, temperature, rainfall and CO_2 levels will influence the extent to which prairies and forests may produce potential biofuels, store carbon in plants and soils, and influence water quality. At present, our predictions regarding how prairies and forests will respond to future climate and atmospheric CO2 levels are uncertain and in part educated guesswork, as we have little direct evidence upon which to make such predictions. In this project we leverage several world-class projects that directly test the impacts of climate and CO_2 on grassland and forest species. These projects largely focus on ecological mechanisms, but the added funds from LCCMR would expand the tests to include different species mixtures and more detailed accounting of carbon balances and storage, and impacts on water quality, than is currently possible. Thus, our proposed project would provide a very cost-effective means of addressing issues regarding biomass and potential biofuel production, carbon storage, and water quality, and of broadly interpreting those findings in policy-relevant ways at the state level, including making recommendations concerning Minnesota's energy and climate future.

Result 1: "Establish, maintain, and conduct experiments". Budget: $180,000.

Test prairie response to elevated CO_2, climate warming, and altered rainfall, all at the U. Minnesota Cedar Creek research site. Test juvenile tree responses to elevated CO_2 (in new

plantings and new plots in the Cedar Creek CO_2 project) and climate warming and altered rainfall at two U. Minnesota field stations: the Cloquet Forestry Center and the Hubachek Wilderness Research Center in Ely.

Deliverables: The measurable outcome will be experimental treatment documentation displayed on the project web site, exhibited with interpretive signage at the field sites, and explained during site tours.

Result 2: "Measurements, Analyses, and Reporting": Budget, $315,000. This includes field sampling, plant and soil processing, chemical analyses, data analyses, and report preparation.

Deliverables: The measurable outcome will be reports, to include (1) results of direct measurements from the study; (2) projected impacts of predicted future CO_2 levels, temperature, and rainfall on Minnesota forest and prairie biomass production, carbon sequestration, and water quality; as well as identification of potentially useful biofuel mixtures; and (3) recommendations about potential management practices and future related studies.

II. TOTAL PROJECT REQUEST BUDGET (TOTAL = $495,000)

Staff or Contract Services: $440,000. Research interns, for sampling, sample processing, and related tasks, 225 weeks time; postdoctoral associate (36 months time) and C. Lehman (3 months) for experimental design, direction, analysis, modeling, and reporting; system engineer, D. Bahauddin, to operate and monitor CO_2 exposure facility (8 months); research supervisor, J. Trost (9 months) and technicians K. Worm (12 months) and unnamed staff person (12 months), for intern supervision, field sampling, analysis, reporting, (total for staff, $421,000); Services for chemical analyses of plants, soil, and water ($19,000).

Equipment and supplies: $ 55,000. Including costs of CO_2 ($14,700 for each of three field seasons, based on a cost of $70/ton for 210 tons) and miscellaneous supplies and equipment.

III. OTHER FUNDS AND PARTNERS

A. Project Partners. Participants from U. of Minnesota: David Tilman, Clarence Lehman, Rebecca Montgomery, Roy Rich, Jared Trost; from the U.S. Forest Service: John Bradford.

B. Other Nonstate Funds being Leveraged during the Project Period. Five grants currently in place (two U.S. National Science Foundation [NSF], two U.S. Department of Energy [DOE], one U.S.D.A. Forest Service) will provide $1,825,000 of supplemental funds towards this project during the funding period.

C. Past Spending

This project will capitalize on NSF and DOE awards that provided over $1,250,000 to establish the CO_2, warming, and rainfall experiments, as well as $659,000 of support from LCCMR for biofuel water quality research by C. Lehman and others at Cedar Creek.

D. Time: 3 years

Curriculum Project Manager Qualifications and Organization Description

Project Manager: Professor Peter B. Reich
Regents Professor, Distinguished McKnight University Professor, and
F.B. Hubachek, Sr., Professor of Tree Physiology and Forest Ecology
Department of Forest Resources, University of Minnesota, St. Paul, MN 55108
E-mail: preich@umn.edu; Phone: 612-624-4270; FAX 612-625-5212

Professional Appointments and Preparation
F.B. Hubachek, Sr., Professor, Dept of Forest Resources, U. Minnesota, 1991-
Assistant/Associate Professor, Dept of Forestry, U. Wisconsin-Madison, 1985-1991
Post-doc (1985) and Ph.D. (1983) Cornell University; M.S. (1977) University of Missouri; B.A. (1974) Goddard College

Honors, Professional Recognition and Service (Selected)
Invited speaker > 120 symposium, conferences, and seminars; e.g., Harvard; Duke; Penn State; Princeton; Stanford; National Academy of Sciences
Institute for Scientific Information (ISI) Science Citation Index, List of Top 20 Ecologists and Environmental Scientists in the World, 2002 – (currently #5)
Advisor to numerous Federal science and policy agencies
Member of numerous editorial review boards and NSF panels

Areas of Expertise
Carbon cycling, Global environmental change and Terrestrial Ecosystems, including climate, biodiversity, ozone pollution, wildfire, elevated CO2, N pollution, land use change, and exotic invasion; Plant physiology, production; Ecosystem ecology, soil fertility and biogeochemistry. Systems studied: forests, woodlands, grasslands, agricultural row crops.

Project Management Experience
Lead PI or co-PI on forest and grassland science projects (total funding, >$18 million 2000- present, from federal [NSF, DOE, USDA, NASA], state, and private sources.

Peer-reviewed publications:
> 290 scientific articles and book chapters, including > 15 in high profile general journals (Nature, Science, etc.) as well as >250 in specialized technical journals

Project Management Qualifications for this Project
Background in ecosystem ecology and plant physiology, including carbon cycling and plant productivity. Experience needed in project management.

Organization Description
The University of Minnesota is both the state land-grant university, with a strong tradition of education and public service, and the state's primary research university.