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

LCCMR ID: 083-C

Project Title:

Conserving Prairie Plant Diversity and Evaluating Local Adaptation

LCCMR 2010 Funding Priority:

C. Habitat Restoration, Enhancement, and Acquisition

Total Project Budget: $ $572,000

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

Other Non-State Funds: $ $0

Summary:

To conserve the genetic diversity of plants of the MN prairie and to provide the scientific basis for identifying adapted native seed sources for restorations.

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Sponsoring Organization: U of MN

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Location:

Region: Statewide

County Name: Statewide

City / Township:

_____ Knowledge Base _____ Broad App. _____ Innovation

_____ Leverage _____ Outcomes

_____ Partnerships _____ Urgency _____ TOTAL

MAIN PROPOSAL

PROJECT TITLE: Conserving prairie plant diversity and evaluating local adaptation

I. PROJECT STATEMENT

The overall goals of this project are to conserve the genetic diversity of plants of the MN prairie and to provide a scientific basis for identifying seed sources that are adapted to particular locations being restored to prairie (2010 LCCMR Funding Priority C1a.) This research will deliver guidance for prairie restoration based on understanding of ecological and genetic processes. **Direct impacts during the funding period include:**

- **Conservation of genetic diversity of prairie plants**
- **Experimentation to investigate the geographic scale of local adaptation.**
- **Studies of the potential for adaptation to changing climate**
- **Studies of the benefits and detriments of moving microbes with plants.**

Growing awareness of prairies' importance has spurred efforts to restore diverse prairie communities on a potentially massive scale to support diverse wildlife, for roadside stabilization, for sustainable harvest of biomass for fuel production, and for improvement of water quality. But large-scale prairie restoration faces daunting challenges. Foremost, the once vast expanses of MN prairie have been diminished to small remnants totaling less than 1% of their former extent. Consequently, large-scale restorations may threaten the very resource they aim to protect by exhausting local genetic sources and adding pressure to use seed inappropriately from distant sources. Plants tend to be genetically adapted to thrive in their local conditions, including climate and soil, as well as other organisms such as microbes associated with them. But too little is known about the geographic scale of adaptation to support sound management decisions about appropriate seed sources for particular locations. The success of prairie restorations depends on the genetic variation of seed sources and on re-establishing entire communities of plants and microbes appropriate to a particular site. Therefore, there is a critical need for research to clarify the basis of local adaptation in plants and their associated microbes. Establishment of scientifically sound criteria for selecting seed sources will enhance the success of native prairie restorations to accomplish diverse goals.

II. DESCRIPTION OF PROJECT RESULTS

Result 1: Collection and conservation of prairie plant genetic diversity. Budget: $62,000

We will collect seeds of 24 species characteristic of Minnesota prairies for research and conservation. We will sample moist and dry habitats in at least 3 populations in each of 4 ecologically defined subsections of the state, taking care both to ensure that genetically representative samples are obtained for each population and to avoid severely depleting seed input to the site. Samples will be stored in the state-of-the-art facility at the National Seed Storage Laboratory in Fort Collins, CO, through a cooperative agreement (at no cost), ensuring that seeds are kept in conditions that maximize their longevity. MN and this project will retain ownership of the seeds. We plan to make these seed sources freely available to seed producers.

Deliverables	**Completion Date**
1. A lasting archive of a well designed sample of genetic diversity of 24 prairie species	October, 2011
2. Measures of the initial viability of seed samples	December, 2011
3. Measures of the longevity of the stored seeds	December, 2013

Result 2: Establishment of long-term studies of local adaptation. Budget: $290,000

To evaluate the scale and degree of local adaptation, we will focus on 6 species that are characteristic of MN prairie, including grasses, *Andropogon gerardii* (big bluestem), *Panicum virgatum* (switchgrass) and legume, *Dalea purpurea* (purple prairie clover). At sites within the four subsections (three of them U of M Research and Outreach Centers), we will plant seeds from all sampled populations.

We will monitor survival and growth of individuals of each population in each site and relate measures of plant success to the distance to each plant's source locality. We will also relate plant success to soil moisture conditions at both source and planting locations to assess the role of habitat in the adaptation of populations to a particular site.

Deliverables: 1. Experiments to evaluate effects of seed source distance on establishment and long-term success of prairie plants in restorations. **Completion:** August, 2013**. 2.** Relationship between early performance of plants and distance to source as well as habitat characteristics. **Completion Date:** August, 2013, continuing over long term.

Result 3: Evaluation of the potential of prairie populations to adapt. Budget: $110,000

We will initiate genetic studies designed to evaluate the potential of populations to adapt to each site and to climate change. We will carry out formal genetic crosses and plant the progeny into two locations. We will collect data on individual plants and use quantitative genetic analyses to predict rates of ongoing adaptation.

Deliverable: Predictions of rates of adaptation based on genetic variation in fitness.

Completion Date: August, 2013, continuing over long term.

Result 4: Assess consequences of moving microbes with plants. Budget: $110,000

Seeds used for restoration are usually cleaned of external microbes but both pathogenic and beneficial fungi within seeds (endosymbionts) are not removed by these efforts. Moreover, as plants are moved to new locations, they may acquire new pathogens from local populations. Information on local adaptation in plant associated microbes will help to manage these resources to enhance restoration efforts.

Deliverables: 1. Identification of differences among seed sources in the composition of endosymbiotic microbial communities. **Completion date:** January 2012. **2.** Evaluation of genetic differentiation among the seed-source populations for the most common pathogenic and beneficial microbes. **Completion date:** August 2013.

III. PROJECT STRATEGY

A. Project Team/Partners: UMN faculty, Drs. Shaw, Wyse, May, Galatowitsch, and Tiffin. MN DNR's Garms. We are discussing cooperation with MN BWSR, The Nature Conservancy, and the White Earth Band of Ojibwe. The Natl Seed Storage Lab agrees to cooperate (see letter).

B. Timeline Requirements: Three years are required for evaluation of degree and scale of local adaptation of plants through the period of initial establishment.

C. Long-Term Strategy: These experiments will determine the effect of transfer distance on viability and growth of plants over the 3 years of the funding period. The processes of seedling establishment and early growth critically influence success of prairie restorations. Nevertheless, because most prairie species do not flower in their first few years, this project will become increasingly informative with monitoring of plants beyond the initial funding period. **We plan to build this project over at least 10 years**, monitoring these experiments over the long-term and expanding the project to include more species and more locations within MN. Moreover, future expansions of the scope of the project (additional species, source locations, target locations) will yield insights into differences among species, regions, and habitats in the scale and degree of local adaptation. We will seek funding supplements from LCCMR to extend and expand this project beyond this initial three-year study period, and to increase the native populations we have conserved so that these genetic resources can be made available to producers of native seed for restorations. With these studies well established, we will be in a strong position to attract additional support from federal funding agencies.

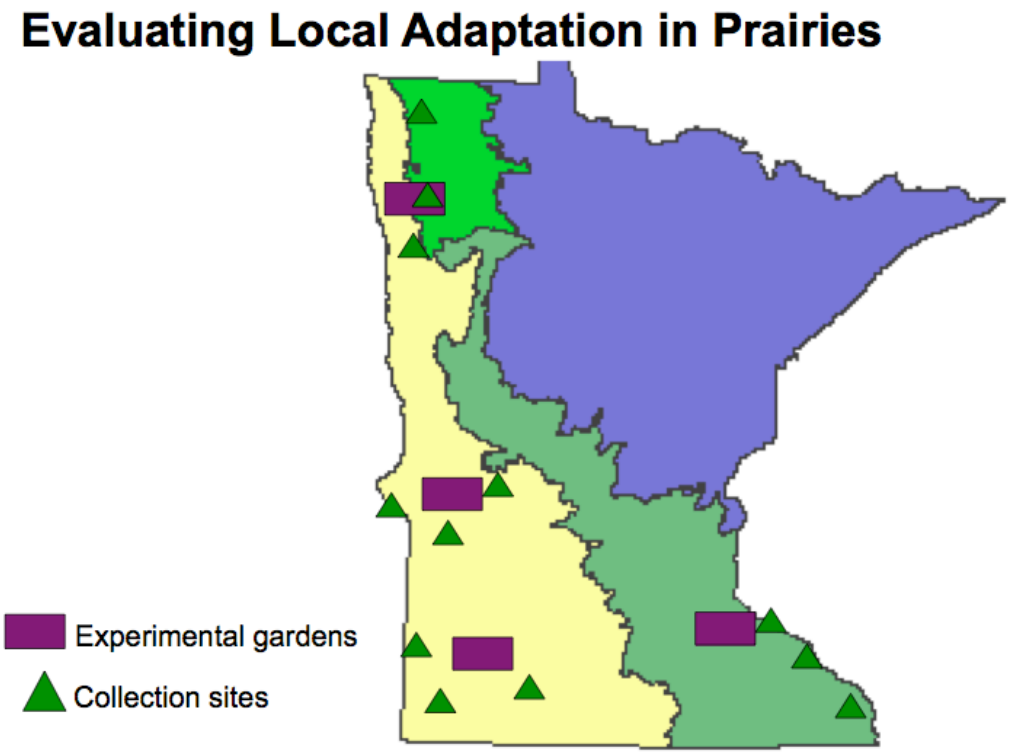
Project Budget

IV. TOTAL PROJECT REQUEST BUDGET (3 years)

BUDGET ITEM	AMOUNT
Personnel: Postdoc - 1 fulltime position for 3 years, all costs allow 4% inflation per year. 84% salary, 16% benefits	$ 149,000
Graduate student - 1 fulltime position for 3 years. 58% salary, 42%benefits	$ 146,000
Research Scientist- 1 fulltime position for 3 years. 73% salary, 27% benefits	$ 154,000
Undergraduates - 8 for 2 mo each summer for 3 years. 91% wages, 9% benefits	$ 55,000
Contracts: N/A	$ -
Equipment/Tools/Supplies: lab, field and greenhouse supplies	$ 28,000
Acquisition (Fee Title or Permanent Easements): N/A	$ -
Travel: Travel within MN to sites for collecting seeds and to locations of experimental plots. Budgeted for 3 years**.**	$ 31,000
Additional Budget Items: DNA Sequencing	$ 9,000
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$ 572,000

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: Long-term storage of seeds at the National Seed Storage Laboratory, including periodic seed viability testing	$ -	secured
Use of land at U of M ROCs for local adaptation experiments		secured
Remaining $ from Current Trust Fund Appropriation (if applicable): N/A		
Funding History: N/A	$ -	



Schematic plan for the project. Result 1: Seeds of 24 species will be gathered at three locations in each of four ecological subsections of the state (green triangles) and placed into long-term storage. Result 2: For 6 of these species, samples from each of the 12 source populations will be grown in experiments located in all four subsections (purple rectangles).

Project Manager Qualifications: Ruth Geyer Shaw
Professor, Department of Ecology, Evolution, and Behavior, University of Minnesota

Education and Experience:

B.A. Biology	1976	Oberlin College, Oberlin, Ohio;
Ph.D. Botany and Genetics	1983	Duke University, N. Carolina
Post-doctoral in Genetics	1984-1986	University of Washington, NIH Fellow
Asst Professor	1987-1992	University of California, Riverside
Asst, Assoc, Full Professor	1993-present	University of Minnesota, Twin Cities
Sabbatical	1995-6	Edinburgh University
Guggenheim Fellow	2002-3	Université de Montpellier, France

Throughout my career, my research has addressed fundamental questions regarding adaptation in native plant populations and has also yielded guidance for managing impacts of human disturbance, including climate change, introduction of invasive plants, and fragmentation of populations into small remnants. In over 16 yr at UM, I have mentored graduate students' experimental studies of adaptation in prairie plant populations, and for 9 yr I have led UM's participation in an NSF-funded long-term experimental study investigating the evolutionary consequences of severe fragmentation of prairie populations of purple coneflower, *Echinacea angustifolia* (collaboration with Dr. S. Wagenius of the Chicago Botanic Garden, see http://echinacea.umn.edu). Among the key results of these studies are demonstration of: degree of local adaptation to present-day habitats and limits to rates of adaptation to climate change in partridge pea, *Chamaecrista fasciculata*[1,2], dramatic reduction in seed production of progeny from crosses between prairie plant populations[3], large differences in survival and fecundity among remnant populations[4], and exceptionally severe inbreeding depression affecting growth and survival in purple conflower[5] (selected references in leading scientific journals below). Moreover, my colleagues and I have recently developed an approach for analyzing data on individual survival and fecundity, the fundamental measures of adaptation[4,5]. This new approach provides far more precise inferences about adaptation than previously possible, and it will be crucially important to the success of the proposed research. I have been honored with positions of leadership in scientific organizations, including the Society for the Study of Evolution and the American Society of Naturalists.

[1]Etterson, J. R. and R. G. Shaw. 2001. Constraint to adaptive evolution in response to global warming. Science 294: 151-154. [2]Davis, M.B. and R. G. Shaw. 2001. Range shifts and adaptive responses to quaternary climate change. Science 292: 673-679. [3]Heiser, D.A. and R.G. Shaw. 2006. The fitness effects of outcrossing in *Calylophus serrulatus*, a permanent translocation heterozygote. Evolution 60:64-76. [4]Geyer, C. J., S. Wagenius, and R. G. Shaw. 2007. Aster models for life history analysis. Biometrika, 94: 415-426. [5]Shaw, R.G., C. J. Geyer, S. Wagenius, H. H. Hangelbroek, and J. R. Etterson. 2008. Unifying life history analyses for inference of fitness and population growth. The American Naturalist 172: E35-E47.

Organization Description: The mission of the University of Minnesota's Department of Ecology, Evolution and Behavior is to advance and disseminate knowledge in these fields through excellence in theoretical, experimental, and field research; undergraduate and graduate education; scholarly activities; and outreach. The integration of this knowledge across levels of biological complexity is a prerequisite to addressing many of the biological and environmental challenges facing society.
http://www.cbs.umn.edu/eeb/