Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-204

Proposal Title: Healthy Prairies III: Restoring Minnesota's Prairie Plant Diversity

Project Manager Information

Name: Ruth Shaw

Organization: U of MN - College of Biological Sciences

Office Telephone: (612) 624-7206

Email: shawx016@umn.edu

Project Basic Information

Project Summary: We will collect native seed throughout Minnesota's prairie region, study microbial effects on plant survival, estimate the geographic scale and rate of adaptation, and communicate results aiding restoration and propagation.

Funds Requested: $531,000

Proposed Project Completion: June 30 2024

LCCMR Funding Category: Foundational Natural Resource Data and Information (A)

Project Location

What is the best scale for describing where your work will take place?

Region(s): NW, SW, Metro, Central,

What is the best scale to describe the area impacted by your work?

Region(s): NW, Central, SW,

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

The widely supported goal of preserving and restoring the extraordinarily diverse plant and microbial life harbored in MN prairies presents serious, pressing challenges. This work is critically important in the face of habitat loss and rapid environmental change, which threaten the persistence of the once vast prairie and its stunning biotic diversity, which nurtures wildlife, purifies water and retains topsoil. Loss of prairie and prairie plant diversity touches Minnesotans across the state, because it impairs hunting and fishing, water quality of rural areas, and the ability to cultivate beautiful and sustainable landscapes on private and public lands. Our proposed and ongoing work will address critical problems that hinder cost-effective and sustainable restoration of the iconic Minnesota prairie biome for diverse uses. Land managers working to restore and preserve prairie need greater availability of seed and improvements in methods for propagating diverse plants appropriate to any one region, and well as the knowledge base to understand how diverse plants and beneficial microbes adapt to the varied landscape of MN prairies.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

We request a third funding allocation to the Healthy Prairies Project to further realize the tremendous investment in preservation of MN prairie plant diversity, and to provide essential resources and information for prairie restoration. By evaluating the geographic scale and rate of adaptation by diverse prairie plants, and the beneficial roles of microbes, our project will guide seed deployment and improve the success of new plantings across the greatly varied environments of MN prairies. Motivated by these goals, we will build on the extensive accomplishments of two previous phases of funding and further the acquisition and propagation of materials and knowledge necessary for prairie restoration that is resilient to environmental challenges. Our team at UM-TC and UM-Morris and more than 50 volunteers have devoted over 2500 arduous hours at 66 prairie remnants across the state, collecting seeds of 90 native prairie species, retaining extensive genetic variation while tracking locality. We have shared early findings with land managers and provided seeds to producers who bring source-identified seeds to market. Because most prairie species are long-lived, our work has just now reached the crucial point of realizing the full benefits of the LCCMR's considerable investment.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

- Preserve diverse seed from 10 of the rarer prairie species, and develop methods for propagating them.
- Develop protocols for the use of beneficial microbes to improve plants' survival in conversion of marginal agricultural land to resilient prairie.
- Evaluate the distance over which prairie plants or seeds can be translocated into restorations without severely compromising survival and reproduction.

Activities and Milestones

Activity 1: Preserving prairie plant diversity for conservation and restoration

Activity Budget: $57,484

Activity Description:
Working with our partners across MN, we will increase the availability of source-identified seed for use in MN prairie restorations. New collections will target 10 rarer yet important prairie species. Efforts will be evaluated via the amount and diversity of seed collected, by the number of species for which propagation methods are developed, and by the degree of partner involvement. Having consulted with land managers and seed producers over the past three years, we have learned which species groups are most needed. Through these consultations, we have also developed a careful approach to transferring seeds to producers, several of whom have now received numerous collections of seeds that we are authorized to distribute. We will extend our collecting efforts to gather additional seeds, focusing on groups of species that are most desired, but least available, for restorations.

Activity Milestones:

Description	Completion Date
Expand availability of source-identified seed by collecting 10 additional species from geographically widespread locations.	June 30 2024
Develop propagation methods for species that are currently difficult to propagate.	June 30 2024
Continue to establish material transfer agreements with producers and to transfer seeds to them.	June 30 2024

Activity 2: Characterizing beneficial microbes: the hidden partners in prairie restoration.

Activity Budget: $234,073

Activity Description:
We will use experimental plantings in the field and greenhouse to determine the beneficial impact of naturally occurring microbes for two types of plants essential to healthy prairies - legumes and grasses. Results will inform land managers about the role of beneficial microbes for successfully establishing new prairie restorations, and provide these managers with locally-sourced microbes.
*We request an addition semester of support for the graduate student who will be carrying out this work, above our previously approved request. The additional support will allow the student to test a broader range of conditions for microbial enhancement of little bluestem's tolerance of drought and inundation, and thus generate results that have broader application across MN.

Activity Milestones:

Description	Completion Date
Compare early seedling survivorship and establishment in Dalea spp. with and without beneficial microbe inoculation.	October 31 2023
Compare drought and inundation tolerance of little bluestem grass with and without beneficial fungal inoculation.	June 30 2024

Activity 3: Evaluating adaptive genetic diversity of prairie plants

Activity Budget: $239,443

Activity Description:
Continue field experiments to characterize the spatial scale of local adaptation for six prairie perennials. This work

focuses on four field sites. In all sites, each of the six species is represented by twelve populations originally sampled from throughout the prairie region late in 2014. We assess survival and reproduction of all individuals planted. In a second major study, we are focusing on little bluestem grass evaluating, for two populations, genetic variation for survival and reproduction, and assessing effects of interbreeding between them. We have shared interim results with land managers in response to their requests for advice about restoration practices. Our further results will better inform methods of prairie conservation and restoration that maintain genetic diversity and optimize use of genetic resources.

Activity Milestones:

Description	Completion Date
Monitor survival, growth, and reproduction in established experiments with 6 species and over 6000 plants.	June 30 2024
Evaluate pedigreed little bluestem populations in field experiments to assess their genetic capacity to adapt.	June 30 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Georgiana May	Department of Ecology, Evolution and Behavior, CBS, University of Minnesota-TC	Dr. May leads research investigating the diversity of microbial symbionts of prairie plants, as well as their effects on the plants.	Yes
Dr. Margaret Kuchenreuther	Division of Science and Mathematics, University of Minnesota-Morris	Dr. Kuchenreuther leads efforts to gather seeds of prairie species. Through her classroom teaching, she trains the undergraduates who carry out this work. She supervises them through the collection process.	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

Given the long lifespans of prairie plants and complexity of microbial plant communities, continuing the established project through further field seasons (2022 – 2024) is required to accomplish its goals.

This proposal is comparable to our submission for funding beginning July 2020. Given lapse in funding from ENRTF, we sought and secured bridge funding from the UMN and thus have been able to maintain continuity of the project.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Prairie Sustainability through Seed Storage, Beneficial Microbes, and Adaptation	M.L. 2014, Chp. 226, Sec. 2, Subd. 06c	$600,000
Preserving Minnesota Prairie Plant Diversity – Phase II	M.L. 2017, Chp. 96, Sec. 2, Subd. 03c	$900,000

Project Manager and Organization Qualifications

Project Manager Name: Ruth Shaw

Job Title: Professor, Department of Ecology, Evolution and Behavior, University of Minnesota

Provide description of the project manager's qualifications to manage the proposed project.

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

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 the fragmentation of populations into small remnants. In my 27 yr at UM, I have mentored graduate students' experimental studies of adaptation in prairie plant populations, and for 20 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. Stuart Wagenius of the Chicago Botanic Garden: 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, dramatic reduction in seed production of progeny from crosses between prairie plant populations, large differences in survival and fecundity among remnant populations, and exceptionally severe inbreeding depression affecting growth and fitness in purple coneflower (all reported in leading scientific journals). Moreover, with colleagues, I have developed an approach for analyzing data on individual survival and fecundity, the central measures of adaptation. Because this approach provides far more precise inferences about adaptation than previously possible, it is crucially important to the success of our ongoing research.
I have led the Healthy Prairies Project since it began in 2014. A dedicated, hard-working team has advanced the ambitious goals of this project, and key collaborators Drs. May, Kuchenreuther, and Flint remain committed to accomplishing these aims.

Organization: U of MN - College of Biological Sciences

Organization Description:
The mission of the Department of Ecology, Evolution and Behavior within the College of Biological Sciences is to advance and disseminate knowledge spanning the fields of ecology, evolution and behavior 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.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Dr. Ruth Shaw		PI			26.7%	0.08		$19,337
Dr. Georgiana May		Co-PI			26.7%	0.08		$17,633
Dr. Margaret Kuchenreuther		Collaborator			26.7%	0.12		$19,795
Postdoc Associate		Postdoc will work on Activity 3 for 2 years.			20.25%	2		$133,398
2 Graduate Students		50% FTE graduate students - Support is requested for two semesters in year 1 plus one semester plus the summer in year 2 under Activity 2. Also, support is requested for one semester in year 1 plus one semester plus summer in year 2 under Activity 3. Tuition included in academic year support.			44.1%	1.18		$124,398
5 Undergraduate Students		Undergraduate students to work on activities 1-3.			0%	0.46		$54,415
Lab Tech		100% FTE Lab Tech			24%	2		$98,657
							Sub Total	**$467,633**
Contracts and Services								
Consultant	Professional or Technical Service Contract	Northern MN seed collections				-		$6,000
							Sub Total	**$6,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	field and lab supplies	seed collection, censuses, microbial culturing					$11,866
							Sub Total	**$11,866**

Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Travel to field sites for seed collection (Activity 1) and microbial sampling (Activity 2), establishing and monitoring experimental plots (Activities 2, 3), and seed increase plots in Rosemount. Total travel estimated: 30K mi in MN, w/ 180-hotel person overnights, over 2 yrs. All travel to be conducted per UMN Policy as required in Guidelines On Allowable Expenses.	Travel to field sites for seed collection and microbial sampling and establishing and monitoring experimental plots.					$28,000
							Sub Total	**$28,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	$3,000 per year requested for publication of research results (page charges).	Dissemination of research results.					$6,000
							Sub Total	**$6,000**
Other Expenses								
		Lab Services - Analsysis	UM Genomics Center - sequencing, 4 analyses (of 200 samples) @ $2,000 each					$8,000
		Greenhouse Fees	UM GH - 800 sq. ft for 12 months over 2 years, at $0.8 per sq. ft. per month, per current UMN greenhouse rental rates					$3,301

		Mailing or Courier Fees	Send seeds collected by collaborators at outstate sites to UMN.	X				$200
							Sub Total	**$11,501**
							Grand Total	**$531,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Other Expenses		Mailing or Courier Fees	Mailing or courier fees to cover shipping of seeds collected by collaborators at sites outside MN to UMN.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	Indirect costs associated with this project.	Indirect costs	Potential	$269,000
			State Sub Total	**$269,000**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**$269,000**

Attachments

Required Attachments

Visual Component

File: f4e72bc7-a33.pdf

Alternate Text for Visual Component

Shaw_2020_Graphic. Counter-clockwise from the top left, we show Activity 1: Ordway prairie a seed collection site with an inset showing propagation methods; Activity 2: using beneficial microbial collections to enhance seedling establishment and growth; Activity 3; Assessing adaptive genetic diversity of prairie plants with three outstate evaluation sites (green rectangles) and collection sites for prairie species across MN (blue and red dots)....

Optional Attachments

Support Letter or Other

Title	File
Healthy Prairies: accomplishments and ongoing work	ab619c40-953.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

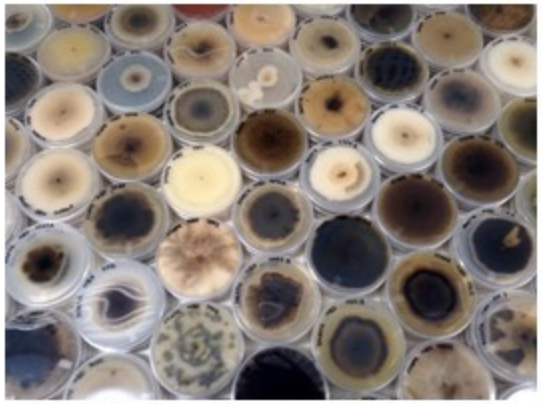
Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

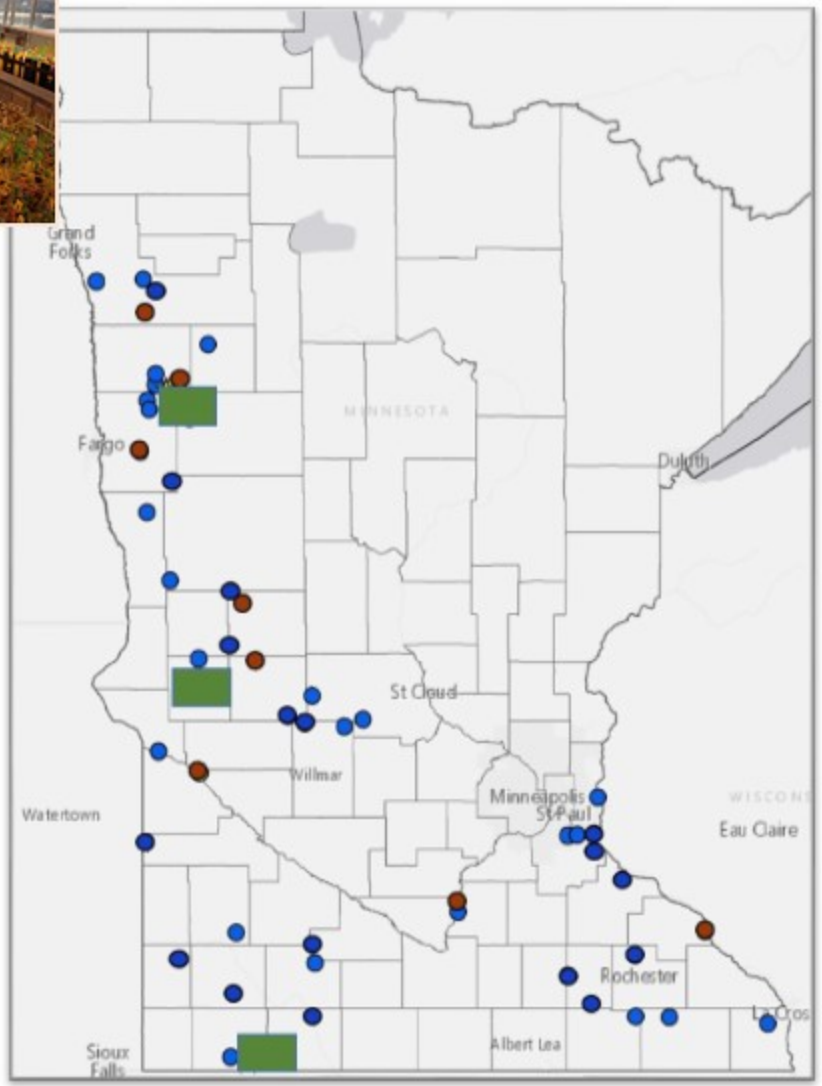
Yes, Sponsored Projects Administration

Activity 1: Preserving prairie plant diversity. With our partners across the state, collect 20 additional rare species from varied environments, develop propagation methods, and transfer to producers.



Microbial diversity cultured from plants

Activity 2: Beneficial microbes: hidden partners in prairie restoration. Characterize beneficial impacts of microbes for little bluestem (grass) and prairie clover (legume). Evaluate changes in beneficial microbes with conversion of marginal ag. land to prairie.



Activity 3: Adaptive genetic diversity of prairie plants. Map of remnant prairie collection sites (blue = SNA, red = TNC) and 3 evaluation sites (green). Seeds of 6 different species from 16 sites are grown in the three evaluation sites to assess capacity for adaptation to differing environmental conditions.