

Environment and Natural Resources Trust Fund 2016 Request for Proposals (RFP)

Project Title:**ENRTF ID: 017-A**

Promoting Prairie Pollinators: Bee Diversity in Fragmented Prairies

Category: A. Foundational Natural Resource Data and Information**Total Project Budget:** \$ 598,569**Proposed Project Time Period for the Funding Requested:** 4 years, July 2016 to June 2020**Summary:**

We will conduct an unprecedented survey of bee pollinators in prairies. We will identify factors that prevent pollinator communities from persisting in native prairie fragments and establishing in restored prairies.

Name: David Moeller**Sponsoring Organization:** U of MN**Address:** Plant Biology, 1445 Gortner Avenue

St. Paul MN 55108

Telephone Number: (612) 624-1027**Email** moeller@umn.edu**Web Address** <http://moeller.cbs.umn.edu/Home.html>**Location****Region:** Central, NW**County Name:** Kandiyohi, Norman, Pennington, Polk, Pope, Red Lake, Swift**City / Township:****Alternate Text for Visual:**

(A) Map of MN prairie remnants and the focal prairie regions for study, (B) Diagram of fragmented prairie with varying levels of fragment size and isolation for both native and restored prairies, (C) An example of a network of bee-plant relationships where some bees rely on single food plants and others rely on multiple food plants

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



PROJECT TITLE: Promoting prairie pollinators: bee diversity in fragmented prairies

I. PROJECT STATEMENT

PROBLEM: Minnesota prairie ecosystems are highly fragmented. Native bee pollinators are critical to restoring the vitality of prairie plant communities. However, we do not understand whether healthy pollinator communities are maintained in native prairie remnants and whether pollinators inhabit restored prairies.

GOALS: By conducting extensive surveys of bees in native and restored prairies, we will:

1. Determine the factors that prevent native and restored prairies from having diverse pollinator communities
2. Identify the ways to promote successful pollinator communities in prairie restorations

OUTCOMES: We will provide the state of MN with the following information:

1. An inventory of bee species and bee food plants in native prairie remnants and recently restored prairies
2. Determination of how the size of a prairie and how far it is from other prairies affects pollinator communities
3. Production of a clear set of management recommendations for future restorations to ensure successful pollinator communities

Background: Prairies are a fundamental part of Minnesota's heritage. These native ecosystems provide critical habitat for wildlife, improve water quality, and supply plant products for our economy. Thriving prairies require diverse native bee pollinators. Effective restoration of diverse plant communities can only occur with the restoration of native bee communities.

Although once widespread, only 1% of Minnesota prairie ecosystems remain. Establishing new prairies as part of the Minnesota State Prairie Plan (2011) is an important investment in Minnesota's natural resources. A key to successful restoration is to first understand what bee diversity exists and how fragmentation has affected it. Second, we need to understand whether healthy pollinator communities are found in newly restored prairies. Many factors can influence bee pollinators. Some important ones in MN prairies include:

- size of the prairie
- isolation of the prairie from other prairies
- the composition of plants that provide food for bee pollinators

Our project will involve large-scale collections of bee pollinators and their food plants from two regions in western MN that contain both native remnants and newly-restored prairies.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1. Determine factors that influence bee pollinator diversity in NATIVE MN prairies. Budget \$260,000

We will quantify the diversity and abundance of bees in prairie fragments of two core prairie regions (see graphic) by collecting bees foraging on plants. We will focus on fragments that are embedded in agricultural land, such that the surrounding habitat is unsuitable for prairie plants. We will focus on four kinds of fragments:

- small prairie size and highly isolated
- small prairie size and less isolated
- large prairie size and highly isolated
- large prairie size and less isolated

Throughout our bee surveys, we will identify plants from which bees were collected. This will allow us to characterize the food plants necessary to support each bee species. The MN DNR has initiated work on bees in prairies. Our project will greatly expand upon this foundational work by identifying the attributes of prairies that support thriving bee pollinator communities, by increasing the number of prairies sampled, and by collecting bees while keeping track of their food plants. The DNR is highly supportive of this new project and we are actively coordinating efforts such that our project builds upon and does not duplicate past efforts. We will sample 40 prairie fragments (10 of each category listed above).

Outcome	Completion Date
1. Inventory of bee pollinator species in 40 native prairie fragments	December 2019
2. Determine the relationship of bee pollinator communities to prairie size, isolation from other prairies, and food plant availability	December 2019



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Activity 2. Determine factors that influence bee pollinator diversity in RESTORED MN prairies. Budget \$260,000

We will take the same approach for newly-restored prairies as we propose for prairie remnants (activity 1). This survey will focus on newly-restored prairies in the same general regions as activity 1. Newly-restored prairies do not include grasslands that are heavily influenced by grazing. Inventories of bee pollinator diversity in restored prairies will be compared to native prairie remnants. Moreover, we will evaluate the effect of prairie size, prairie isolation, and plant community composition on bee communities. These data will also allow us to examine how pollinator communities change through time since the initiation of restoration.

Outcome	Completion Date
1. Inventory of bee pollinator species in 40 restored prairies	December 2019
2. Comparison of pollinator communities and food plants in native versus restored prairies	December 2019

Activity 3. Management recommendations for restorations of bee pollinator communities. Budget \$78,569

Based on our findings, we will create a clear set of management recommendations for current and future prairie restoration efforts. First, we will determine how the vitality of bee pollinator communities could be improved by expanding or connecting existing prairie fragments. Second, we will determine which food plants need to be found in restored prairies in order to support healthy pollinator communities. These recommendations could include introducing or increasing the numbers of certain plant species.

Outcome	Completion Date
1. Recommendations for the size and isolation of prairie habitats that promote prairie pollinators	June 2020
2. Management strategy for introducing food plants into restored prairies to support healthy pollinator communities	June 2020

III. PROJECT STRATEGY

A. Project Team/Partners: The University of Minnesota team, led by Dr. David Moeller, will be entirely responsible for the project. The team will include a postdoctoral scholar, Dr. Ryan Briscoe Runquist, who has extensive experience with pollination biology and bees, and one UMN graduate student, who will be trained as part of the project. We are partnering with Crystal Boyd, DNR bee biologist, to plan this work and coordinate with past collecting efforts funded by LCCMR. We have also consulted with UMN faculty that have expertise with prairie plant communities including Dr. Ruth Shaw and with bees, Dr. Marla Spivak. Throughout the project, we will also consult with Minnesota Zoo Conservation Biologist, Dr. Erik Runquist, who has extensive experience with pollinators and the conservation of MN insects.

B. Project Impact and Long-Term Strategy: Information on native bee pollinators gathered in this study will provide crucial baseline information for long-term studies of the reassembly of bee communities in newly established prairies. Periodic funding over the following 10 years would provide a robust dataset for understanding MN bee diversity and the factors influencing the restoration of prairie communities. We also expect that the data generated by this project will fuel studies that focus on the effects of bee community variation on the reproduction of prairie plants. Our current and ongoing work will interact synergistically with Moeller's NSF-funded research on the ecology and genetics of plant diversification, especially as it is related to plant-pollinator interactions.

C. Timeline Requirements: Three full field seasons (summers of 2017, 2018, and 2019) are required to adequately sample bee diversity in the large number of fragments that we have proposed. Late summer through autumn of 2016 is needed to determine field sites and prepare sites for future sampling. This timeframe is important because bee abundances and community composition can vary enormously from year-to-year. A major effort will also be required to process all of the bee and plant collections, as well as conduct data analysis, which will occur primarily during years 3-4.

2016 Detailed Project Budget

Project Title: Promoting Prairie Pollinators: Bee Diversity In Fragmented Prairies

IV. TOTAL ENRTF REQUEST BUDGET 4 years

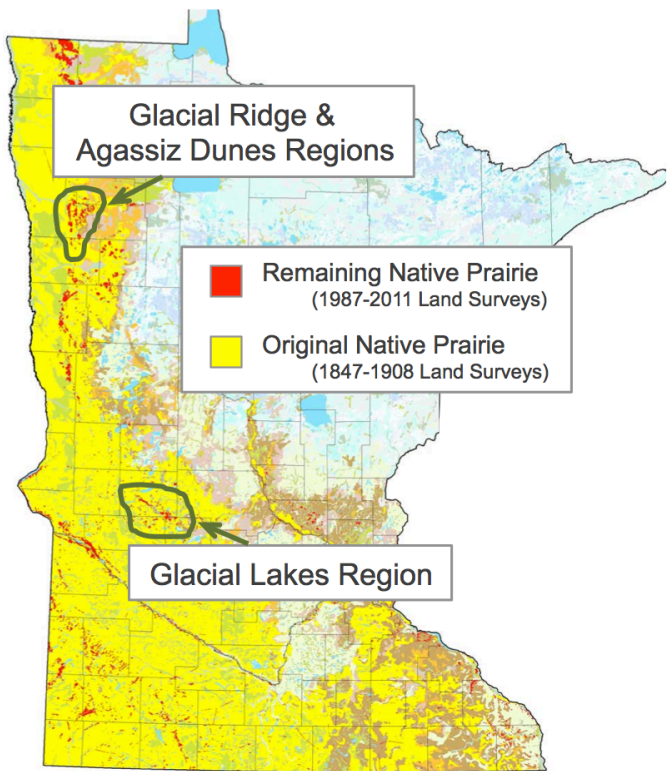
BUDGET ITEM	AMOUNT
Personnel: Dr. David Moeller, Project Manager. Salary is requested for one month per year for the first 3 years of the grant (July 2016-June 2019). Moeller will oversee project design, manage staff, participate in field work, and participate in data analysis. 8% of full-time employment; 75% salary; 25% benefits.	\$ 36,126
Personnel: Dr. Ryan Briscoe Runquist, Postdoctoral Associate. Full-time salary is requested for Dr. Runquist for 3 years (July 2016-June 2019). She will manage the field research team, participate in field work, curate bee collections, and conduct data analysis. 100% full-time employment; 82% salary; 18% benefits.	\$ 160,248
Personnel: Graduate Student. One graduate student will be paid a stipend for one semester per year plus one summer per year for 3 years (January 2017 - August 2019). The graduate student will participate in field work, bee collection curation, data analysis, and develop the management plan. 46% full-time employment; 57% salary; 10% benefits; 33% tuition.	\$ 125,697
Personnel: Research Technician. Salary is requested for one research technician for 3 years (July 2017-June 2020). The technician will conduct field work, curate bee collections, manage data sets, and participate in the development of the management plans. 100% full-time employment; 79% salary; 21% benefits.	\$ 121,248
Personnel: Undergraduate Research Assistants. Summer stipend is requested for 4 undergraduate students for 10 weeks per summer for 3 years (2017-2019). Each student will receive \$600 per week. Undergraduate assistants will be critical for collection efforts, which require enormous field effort. They will also be involved in bee collection curation. 18% full-time employment; 100% salary; 0% benefits.	\$ 72,000
Equipment/Tools/Supplies: Supplies for the curation of bee collections. Funding is requested for 2 large cabinets to house collections in the Insect Collection at the U. of Minnesota (\$2800 each). The remaining funds are needed for other supplies for insect curation (pins, pinning boards, etc.)	\$ 9,000
Equipment/Tools/Supplies: Supplies for field work. Funding is requested for supplies to collect bees (nets, chemicals, vials), for site characterization (GPS units), and basic supplies (flagging, stakes, meter tapes).	\$ 2,250
Travel: Housing. Funding is requested for one house rental for 10 weeks per year (for 3 years) at \$1500 per week. This will house all personnel during field work in western MN.	\$ 45,000
Travel: Transportation. Funding is requested to rent 2 vehicles for each of 3 summers for 12 weeks per year (\$300 per week) plus fuel (\$75 per week). Extensive travel is required to visit all prairie fragments in two regions of MN.	\$ 27,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 598,569

V. OTHER FUNDS

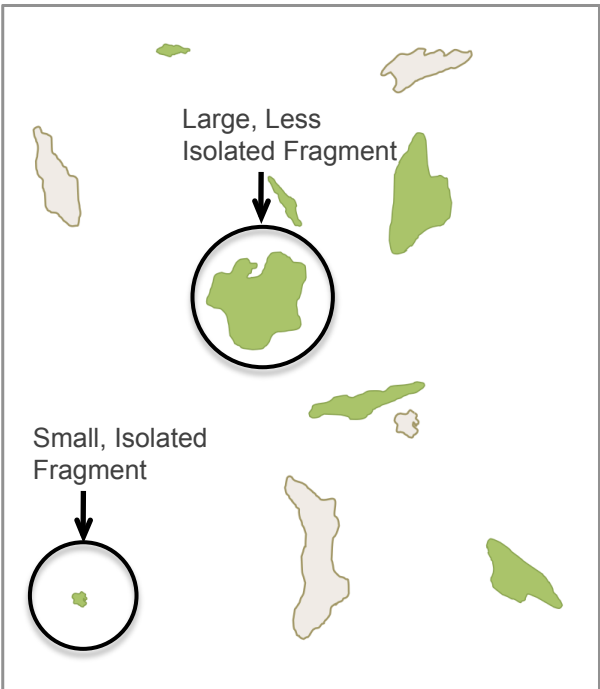
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period:	N/A	N/A
Other State \$ To Be Applied To Project During Project Period:	N/A	N/A
In-kind Services To Be Applied To Project During Project Period: The University of Minnesota does not charge the State of Minnesota its typical overhead rate of 52% of the total direct costs.	\$ 289,549	Secured
Funding History:	N/A	N/A
Remaining \$ From Current ENRTF Appropriation:	N/A	N/A

PROMOTING PRAIRIE POLLINATORS: BEE DIVERSITY IN FRAGMENTED PRAIRIES

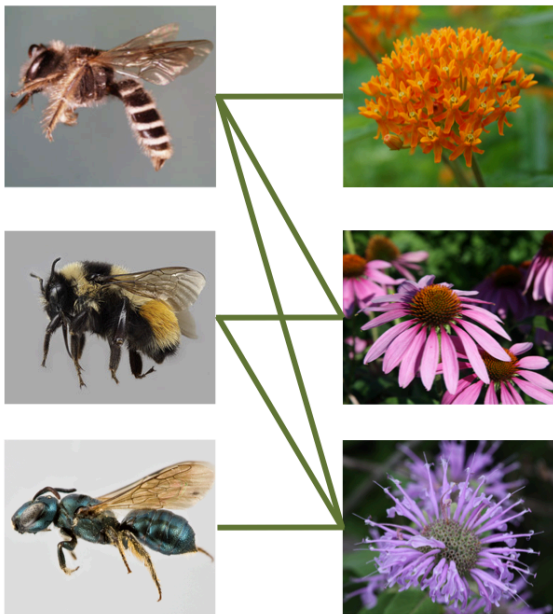
(A) Map of MN prairie remnants & the focal prairie regions for study



(B) Diagram of fragmented prairie with varying levels of fragment size and isolation for both native and restored prairies



(C) Network of Bee-Plant Relationships
In this example of a network, some bees rely on single food plants whereas others use multiple plants



Project Manager Qualifications: David Moeller

Associate Professor, Department of Plant Biology, University of Minnesota – Twin Cities

Education

B.A.	1997	Washington University, <i>Summa cum laude</i>
Ph.D.	2003	Cornell University
Postdoctoral	2004-2007	University of Minnesota

Research Accomplishments

I have been actively involved in research on pollination biology for 15 years. I have published 26 articles in leading journals and books in biology (selected references listed below). Some of my recent research on native pollinators was highlighted in the high-profile journal, *Science*, because of its timeliness related to plant and pollinator conservation. My publications have been cited > 1200 times. I currently serve on the editorial board of a leading journal in biology.

Funding Track Record

I have been a principal investigator (or co-PI) on grants totalling more than \$1 million. I have been funded continuously by the National Science Foundation since joining UMN > 5 years ago for work on native bee pollinators and their effects on plant populations. Methods and analyses developed in our past work directly connects to the work proposed under LCCMR funding.

Key Research Findings

My research has been especially focused on the role of native bees in the pollination of wild plant populations. Some of my most well-cited work has established the key role of native bees in the diversification of flowers, particularly transitions among plant reproductive strategies (e.g outcrossing to self-pollination). A central finding of this work is that reproductive failure occurs in plant populations that lack particular bee pollinators that are specialized on the plants. This has highlighted the fact that we must understand the details of bee-plant relationships because not all bees provide the same services to plants. As part of this work, I have conducted geographic-scale bee surveys to understand spatial variation in bee communities and how that variation influences plant populations. I have extensive experience collecting bees, identifying species, and curating collections. I also have extensive experience with the statistical analysis of data on biological communities.

Selected References

Moeller, D.A., M.A. Geber, V.M. Eckhart, & P. Tiffin. 2012. Reduced pollinator service and elevated pollen limitation at the geographic range limit of an annual plant. *Ecology* 93:1036-1048.

Editor's Choice, *Science*, June 1, 2012

Moeller, D.A. 2006. Geographic structure of pollinator communities, reproductive assurance, and the evolution of self-pollination. *Ecology* 87: 1510-1522.

Moeller, D.A. 2005. Pollinator community structure and sources of spatial variation in plant-pollinator interactions in *Clarkia xantiana* ssp. *xantiana*. *Oecologia* 142: 28-37.

Organization Description

The Department of Plant Biology and the University of Minnesota are dedicated to supporting biological research that integrates knowledge across levels of biological complexity. This includes field research, the development of collections, and the management of ecosystems. The institution is dedicated to teaching and research, especially as it pertains to biological issues that affect society.