



Environment and Natural Resources Trust Fund (ENRTF) M.L. 2016 Work Plan

Date of Report: December 4, 2015

Date of Next Status Update Report: January 1, 2017

Date of Work Plan Approval:

Project Completion Date: June 30, 2019

Does this submission include an amendment request? No

PROJECT TITLE: Data Driven Pollinator Conservation Strategies

Project Manager: Daniel P Cariveau

Organization: University of Minnesota, Department of Entomology

Mailing Address: 1980 Folwell Avenue

City/State/Zip Code: Saint Paul, MN 55108

Telephone Number: (612) 624-1254

Email Address: dcarivea@umn.edu

Web Address: <http://www.beelab.umn.edu>

Location: Western Minnesota (Tallgrass Prairie Region)

Total ENRTF Project Budget: 520,000

ENRTF Appropriation: \$520,000

Amount Spent: \$0

Balance: \$520,000

Legal Citation: M.L. 2016, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

I. PROJECT TITLE: Data driven pollinator conservation strategies

II. PROJECT STATEMENT:

1. *Why?* With billions of dollars to be spent on Minnesota prairie restoration in coming years, there is an urgent need for more information on how to best implement costly restoration actions to achieve a variety of goals. One goal is to enhance native bee communities. In fact, the decline of some native bees species has motivated government agencies, non-profit organizations, and private landowners to create thousands of acres of pollinator habitat throughout Minnesota. However, it is expensive to install and little information exists on how maximize investments to best support native bees. The primary objective of this project is to provide foundational data and information to guide land managers in Minnesota so they can effectively plan and design habitat for native bees. A second objective is to determine the pollination effectiveness of native bees within habitat restorations. A goal of restorations is to create functioning, self-sustaining ecosystems and this relies on seed production of native plants. Many plants need bees for seed production however bee species vary in pollination effectiveness. Understanding this variation is important, as it will enable land managers to optimize habitat for bees that are the most effective pollinators and maximize overall success of habitat restorations.

2. *Goals and outcomes.* Currently, there are no rigorous guidelines to help land managers best implement pollinator habitat. Given this lack of information, the project we propose has **four main goals**. The **first goal** is to determine the best placement of pollinator habitat to maximize value for native bees. Correct location of pollinator habitat is critical. If a habitat is too far from a source population, native bees will not be able to colonize the new habitat. However, if bees are able to colonize new habitats far from remnant prairies, this provides land managers more opportunities to create habitat for bees. The outcomes of this goal will be guidelines on how distance from remnant prairie sites affects success of pollinator habitat. The **second goal** is to determine which plant species are most preferred by native bees. Most information on plants for bees are based on best guesses by land managers. However, a more quantitative approach is needed. For example, different plants may benefit different bee species. One outcome of this goal is to determine whether certain plants benefit rare or declining bee species. In addition, spring is a critical time for a number of bee species. Some early spring species are considered rare and others such as bumble bees need spring plants when they are founding new nests. Seeds of early spring plants are expensive and difficult to establish and pollinator habitat is thus usually lacking in these plants. Therefore, a third outcome is to create a targeted list of plant species that are most effective in the early spring and this will help land managers focus on certain early plants that critical to bees foraging in this season. The **third goal** is to determine which bee species provide the greatest benefit to plants within plantings. The outcome of this goal will be a list of native bees species that quantifies pollination effectiveness for two to three native prairie plant species. The **fourth goal** is to disseminate findings to land managers. The outcomes of this goal will be talks, a workshop and printed outreach documents.

3. *How?* In collaboration with TNC, DNR and BWSR, we will select sites near the Minnesota Prairie Conservation Plan. To determine how placement affects success of pollinator habitat, we will collect bees within newly created forb-rich habitats at varying distances from remnant prairies. We will collect bees at remnant prairie sites and at newly created forb-rich habitat using bee bowls. To determine flower use, we will also collect bees from flowers using hand nets and record the flower species each bee was visiting. A botanist will conduct flower surveys and identify plants. To determine pollination effectiveness of bee species, we will measure pollen deposition of bee species to a sample of several prairie plants, focusing on 2-3 plant species.

4. *Project significance* – This project will collect vital data that will be used to effectively implement restoration goals that benefit native bees. It will lead to plant lists that are targeted to important groups of bees such as those that forage in the spring as well as rare and declining species. We will work closely with land managers and landowners throughout this project to disseminate our results and we will encourage feedback for improving this project. Finally, the results of this work will be shared with other prairie ecologists to improve management and conservation of the tallgrass prairies of Minnesota.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of January 1, 2017:

Project Status as of July 1, 2017:

Project Status as of January 1, 2018:

Project Status as of July 1, 2018:

Project Status as of January 1, 2019:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Determine most effective placement of pollinator plantings.

Description: The location of pollinator habitat plots is likely a critical factor for determining the establishment success of native bee communities. For example, if a newly created habitat patch is close to remnant prairie habitat that contains a rich and abundant native bees, it is more likely that this nearby site will be more readily colonized than a site that is distant from a remnant prairie. To examine this, we will first select 10-15 native, remnant prairie sites located in the tallgrass prairie region of western Minnesota (see Visual Component). These will serve as reference sites. At each of these remnant prairie sites, we will then select three to four forb-rich prairie restoration sites that vary in distances from the native, remnant prairie. These sites will be sites that are managed by The Nature Conservancy, United States Fish and Wildlife Service, the Department of Natural Resources, and/or the Minnesota Board of Water and Soil Resources. Cariveau has already been in contact with land managers and is in the process of choosing sites. The surrounding landscape can have a large impact on the local native bee community. Therefore, during each year of the study, we will characterize the land use surrounding each newly created habitat and native, remnant prairie. We will use GIS to quantify the amount of area in wetland, forest, soybean, corn, and Conservation Reserve Program surrounding the newly created habitat. We will use these factors as covariates in statistical models.

At the remnant prairie and restoration sites, we will place bowl traps with soapy water along a standardized transect three to four times each year. Bowls will remain in the field for 24 hours for each sampling event. Bees will be removed from bowls and placed in 70% alcohol and taken back to the lab where they will be processed, pinned and identified. After identification, pinned specimens will be housed in the University of Minnesota Insect Collection. Specimens will be added to a database that will be publicly accessible once peer-reviewed publications have been accepted.

While the full project will take place with sampling in the summer of 2017, we will begin sampling a subset of these sites in the summer of 2016 using funds from D. Cariveau’s start-up provided by the University of Minnesota. Therefore, some sites will be sampled for a total of 3 years (summer 2016, 2017, and 2018) while others will be sampled for two years (summers 2017 and 2018).

Summary Budget Information for Activity 1:

ENRTF Budget: \$ 194,409

Amount Spent: \$ 0
Balance: \$ 194,409

Outcome	Completion Date
1. All sites selected	October 2016
2. GIS completed for each site (completed in fall of each sample year)	June 2019
3. Bee collections completed and identified. Entered into database and analyzed	January 2019
4. Travel to meeting to present results to land managers and general public	June 2019
5. Workshop to disseminate results to land managers	June 2019

Project Status as of January 1, 2017:

Project Status as of July 1, 2017:

Project Status as of January 1, 2018:

Project Status as of July 1, 2018:

Project Status as of January 1, 2019:

Final Report Summary:

ACTIVITY 2: Quantify plant use by bees in remnant prairies and pollinator habitat.

Description: In addition to distance from remnant prairie, the local native plant community may also have an important impact on the establishment and persistence of native bees in newly created habitat. Therefore we will sample bees that are visiting flowers in both the remnant prairie and the new habitat. We will collect bees that are visiting flowers using a hand net and then record the plant species that the bee was visiting. These collections will take place along standardized transects at each site four times each season. Collections will begin in late April and early May. Each site will be sampled four times each year. After identification, pinned specimens will be housed in the University of Minnesota Insect Collection. Specimens will be added to a database that will be publicly accessible once peer-reviewed publications have been accepted.

There is little information on the floral needs of this early spring bee community. Of particular interest is determining which plant species are used by early spring native bees. Early spring plants are expensive and difficult to establish in new prairie habitat. In addition, we will determine which plant species are most preferred by rare and declining bee species. Therefore our results will highlight particular plants that are highly attractive to these bees and help land managers to focus on these plant species. After identification, pinned specimens will be housed in the University of Minnesota Insect Collection. Specimens will be added to a database that will be publicly accessible once peer-reviewed publications have been accepted.

We will also characterize the local flower community by placing 1m² quadrats along the collection transect. In each quadrat, we will identify each plant species and count the number of flowers blooming. One of the field technicians will be dedicated to identifying plants and collecting botanical information.

As noted in Activity 1, this project will begin with a subset of sites in the summer of 2016 using funds from D. Cariveau's start-up funds provided by the University of Minnesota. Therefore, some sites will be sampled for a total of 3 years (summer 2016, 2017, and 2018) while others will be sampled for two years (summers 2017 and 2018).

Summary Budget Information for Activity 2:

ENRTF Budget: \$ 195,409
Amount Spent: \$ 0

Balance: \$ 195,409

Outcome	Completion Date
1. Bee collections completed and identified. Entered into database and analyzed	January 2019
2. List of flowers most preferred by rare and declining bee species.	June 2019
3. List list of flowers most preferred by spring bee species.	June 2019

Project Status as of January 1, 2017:

Project Status as of July 1, 2017:

Project Status as of January 1, 2018:

Project Status as of July 1, 2018:

Project Status as of January 1, 2019:

Final Report Summary:

ACTIVITY 3: Determine most effective native bee species for pollinating prairie plants

Description: While new habitat may be important for native bees, little is known about the importance of native bees for new habitat. We will examine this question by determining how effective different bee species are in pollinating native prairie plants. We will focus on newly created habitats as this is a likely stage at which seed production is critical. We will choose two or three species of native plants in the new prairie habitat. For each plant species, we will bag a subset of flowers while they are still in the bud stage to prevent visits from pollinators. Once they open and the stigma becomes receptive, we will present these non-visited flowers to foraging bees. We will record the bee species or bee species group that visited the flower. Once a flower has been visited, we will cover the flower and bring it back to the lab. In the lab, we will stain the stigmas and count the number of conspecific pollen grains. This will allow us to determine the number of pollen grains that each bee species or species group deposits on each plant species.

In the summer of 2016, we will experiment with a number of native plants and determine the exact methodology for 2-3 plant species.

Summary Budget Information for Activity 3:

ENRTF Budget: \$130,182
Amount Spent: \$ 0
Balance: \$130,182

Outcome	Completion Date
1. Plant species selected	December 2016
2. Pollen deposition data collected and measured for 2 to 3 native plant species	June 2019

Project Status as of January 1, 2017:

Project Status as of July 1, 2017:

Project Status as of January 1, 2018:

Project Status as of July 1, 2018:

Project Status as of January 1, 2019:

Final Report Summary:

V. DISSEMINATION:

The funds from this proposal will result in a number of outreach deliverables. First, we will create well-documented native plant lists based on the results of bee-plant surveys. These lists will be useful to both the general public and land managers. These plant lists will be distributed throughout Minnesota and posted online. We will also give presentations for the general public. We will also present at professional meetings that are attended by land managers such as the annual meeting of the Minnesota chapter of The Wildlife Society.

These outreach activities will be done in close collaboration with a number of partners. Along with Crystal Boyd of the DNR, we will co-organize bee identification workshops. These workshops will also leverage funds and staff from ENTRF-ML14-6a: "Enhancing Pollinator Landscapes". We will also collaborate closely on workshops and coordinate speaking events. In addition, we will work with a number of established outreach programs and personnel at the University of Minnesota. Elaine Evans (PhD student at the University of Minnesota) conducts the Minnesota Bumble Bee Survey and is conducting outreach activities for ENTRF-ML-15-3g: "Minnesota Native Bee Atlas". She will share the plant lists and results of this study during outreach events. Finally, we will work with the University of Minnesota's Bee Squad to disseminate these results.

Description:

Project Status as of January 1, 2017:

Project Status as of July 1, 2017:

Project Status as of January 1, 2018:

Project Status as of July 1, 2018:

Project Status as of January 1, 2019:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	\$ Amount	Overview Explanation
Personnel:	\$ 38,140	<ul style="list-style-type: none"> Dan Cariveau (PI); 66.2% Salary, 33.8% fringe 7.7% FTE for 3 years; Supervision of all project activities, direct supervision of graduate students and postdoctoral research associate, analyze data, write peer-reviewed papers and reports, disseminate information
	\$157,599	<ul style="list-style-type: none"> Postdoctoral Research Associate; \$157,599, 78.6% Salary; 21.4% fringe 100% FTE for 3 years, Supervision of field technicians, lead field data

	\$112,430	<ul style="list-style-type: none"> collection, analyze data, write peer-reviewed papers, disseminate information 3 Field Technicians; \$37,477, 73.7% salary, 26.3% fringe, 15 weeks for 3 years, collect field data, pin and identify insects, enter and manage data
	\$112,813	<ul style="list-style-type: none"> University of Minnesota PhD Student,; 48% Salary, 52% fringe (including tuituion), 70% FTE for 3 years, conduct fieldwork, analyze data, write peer-reviewed papers, disseminate information
	\$10,880	<ul style="list-style-type: none"> 1 student worker; (32weeks/\$11hour/10 hours per week), pin insects, enter data
	\$10,200	<ul style="list-style-type: none"> 1 student worker; (30 weeks/\$11hour/10 hours per week), pin insects, enter data
Professional/Technical/Service Contracts:	\$16,000	<ul style="list-style-type: none"> Bee Identification by one or multiple specialists in bee taxonomy
Equipment/Tools/Supplies:	\$ 1,834	<ul style="list-style-type: none"> Equipment/Tools/Supplies: Insect collection supplies (nets, collecting jars, gps devices to find sites)
	\$ 4,605	<ul style="list-style-type: none"> Equipment/Tools/Supplies: Insect curation equipment (drawers, cabinets, insect pins, label paper, barcode software)
	\$ 2,000	<ul style="list-style-type: none"> Equipment/Tools/Supplies: Plant collection and curation for type specimens (herbarium, plant presses, herbarium supplies)
	\$ 2,000	<ul style="list-style-type: none"> Equipment/Tools/Supplies: Pollination quantification tools (pollen dye, microscope slides, flourscent UV cube)
Printing:	\$ 3000	<ul style="list-style-type: none"> Printing of outreach documents and scientific publication costs
Travel Expenses in MN:	\$ 48,500	<ul style="list-style-type: none"> Field crew travel: collect bees, identify and collect plants, collect single visit pollen deposition data, travel to present results of research

TOTAL ENRTF BUDGET:	\$520,000	
----------------------------	------------------	--

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than \$5,000: N/A

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: Postdoctoral Research = 3 (1 @ 100% FTE for 3 years); PhD Student = 2.3 (1 @ 70% FTE for academic year; 100% FTE for summer for 3 years); Field Technicians = 2.8 (3 @ 48 weeks or 92.3% FTE for 3 years); Student worker 1 = 0.46 (1 @ 32 weeks for 10 hours/week or 15.4% FTE for 3 years); Student worker 2 = 0.42 (1 @ 30 weeks for 10 hours/week or 14.4% FTE for 3 years); Cariveau = 0.22 (1 @ 7.7% FTE for 3 years) **TOTAL = 9.2 FTE**

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: N/A

B. Other Funds:

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
Non-state			
NA	\$NA	\$ NA	
State			
Start-up funds provided from the University of Minnesota Department of Entomology to begin project. In addition, Cariveau's start-up funds will cover 30% of PhD Student Salary during academic year for 3 years. All funding is secured.	\$ 53,513	\$ 0	Salary and fringe for field techs (\$20,461), crew leader (\$8,744), travel (\$4500), equipment (\$2061). To enable an earlier start of this project (April/May 2016), some of these will be spent prior to funding date of July 30, 2016. In addition, Cariveau's start-up funds will cover 30% of PhD Student Salary during academic year for 3 years (\$15,247)
TOTAL OTHER FUNDS:	\$ 53,513	\$ 0	

VII. PROJECT STRATEGY:

A. Project Partners: Daniel Cariveau (U MN) will lead the project. Dr. Cariveau is a newly hired Assistant Professor, funded for first three years by ENRTF through proposal "Enhancing Pollinator Landscapes" submitted by Marla Spivak in 2014. He will directly supervise a PhD student and postdoctoral research associate. The PhD student and postdoctoral research associate will directly supervise the field technicians and student workers. Marissa Ahlering (TNC), Dan Shaw (MN BWRS), and Greg Hoch (MN DNR) will assist in selecting sites, acquiring permits, and provide technical guidance. M. Spivak (U MN) will provide scientific and administrative advice.

B. Project Impact and Long-term Strategy: This project will provide valuable information to help maximize success of prairie habitat restoration projects. This project will focus on the tallgrass prairie region of Minnesota, as this is the primary area of new pollinator habitat. It will inform efforts such as the Minnesota Prairie Conservation Plan, a \$3.5 billion effort with a major focus on restoration. The results from the project will provide valuable information to local, state, federal and non-profit agencies that are creating pollinator habitat. Finally, through collaborative and data-sharing efforts at the University of Minnesota and state agencies such as the Minnesota DNR, this project will be part of a larger effort to understand and better implement restoration in the tallgrass prairie region of Minnesota.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	\$ Amount
---------------------------------	-------------------	-----------

D. Cariveau's 9-month academic year salary is covered by ENRTF award to M. Spivak in 2014, "Enhancing Pollinator Landscapes"	August 31, 2015 – September 1 st 2018	\$ 329,144
--	--	------------

IX. VISUAL COMPONENT or MAP(S): See attached

X. RESEARCH ADDENDUM: See research addendum to be submitted December 11th, 2015.

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than January 1, 2017, July 1, 2017, January 1, 2018, July 1, 2018 and January 1, 2019. A final report and associated products will be submitted between June 30 and August 15, 2019.

**Environment and Natural Resources Trust Fund
M.L. 2016 Project Budget**



Project Title: Data Driven Pollinator Conservation Strategies

Legal Citation: M.L. 2016, Chp. Xx, Sec. cc, Subd. Xx

Project Manager: Daniel P. Cariveau

Organization: University of Minnesota

M.L. 2016 ENRTF Appropriation: \$ 520,000

Project Length and Completion Date: 3 Years, June 30, 2019

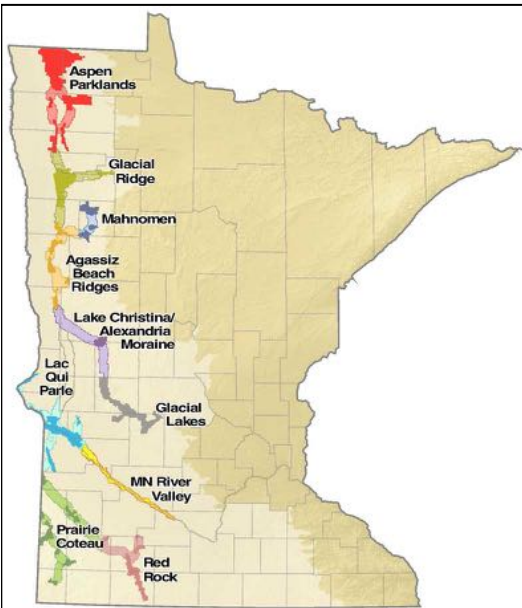
Date of Report: December 4, 2015

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	<i>Determine most effective placement of pollinator plantings</i>			<i>Quantify plant use by bees in remnant prairies and pollinator habitat</i>			<i>Determine most effective native bee species for pollinating prairie plants</i>				
Personnel (Wages and Benefits)	\$165,773	\$0	\$165,773	\$165,773	\$0	\$165,773	\$110,515	\$0	\$110,515	\$442,061	\$442,061
Dan Cariveau (PI); \$38,140, 66.2% Salary, 33.8% fringe 7.7% FTE for 3 years											
Postdoctoral Research Associate; \$157,599, 78.6% Salary; 21.4% fringe 100% FTE											
Field Technician 1; \$37,477, 73.7% salary, 26.3% fringe, 16 weeks for 3 years											
Field Technician 2; \$37,477, 73.7% salary, 26.3% fringe, 16 weeks for 3 years											
Field Technician 3; \$37,477, 73.7% salary, 26.3% fringe, 16 weeks for 3 years											
University of Minnesota PhD Student, \$112,813; 48% Salary, 52% fringe (including tuition), 70% FTE for 3 years											
Student worker 1; \$10,880; (32weeks/\$11hour/10 hours per week)											
Student worker 2; \$10,200; (30weeks/\$11hour/10 hrs per week)											
Professional/Technical/Service Contracts											
Professional/Technical/Service Contracts: Bee identification at ~\$2 per bee for 8000 bees; Contractor will be determined based on ability, availability, and cost. In addition, multiple contractors will likely be used to identify different groups of bees.	\$8,000	\$0	\$8,000	8,000	\$0	\$8,000				\$16,000	\$16,000
Equipment/Tools/Supplies	\$3,219	0	\$3,219	\$4,219	0	\$4,219	\$3,000	0	\$3,000	\$10,438	\$10,438
Equipment/Tools/Supplies: Insect collection supplies (nets, collecting jars, gps devices to find sites) - \$1834										\$0	\$0
Equipment/Tools/Supplies: Insect curation equipment (drawers, cabinets, insect pins, label paper, barcode software) \$4605										\$0	\$0

Equipment/Tools/Supplies: Plant collection and curation for type specimens (herbarium, plant presses, herbarium supplies) \$2000											\$0	\$0
Equipment/Tools/Supplies: Pollination quantification tools (pollen dye, microscope slides, flourscent UV cube) \$2000											\$0	\$0
Capital Expenditures Over \$5,000												
Printing												
Travel expenses in Minnesota												
Travel to and from field sites, renting fleet vehicles, hotel/camping, travel to share information with agencies and land managers, \$48,500 total	\$16,167	\$0	\$16,167	\$16,167	\$0	\$16,167	\$16,167	\$0	\$16,167	\$48,501	\$48,501	
Other												
Workshop for land managers - spread across three activities as the workshop will include information from all entire project \$1,500; Plant list and outreach printing for workshops and broader use - spread across activities 1 and 2	\$1,250	\$0	\$1,250	\$1,250	\$0	\$1,250	\$500	\$0	\$500	\$3,000	\$3,000	
COLUMN TOTAL	\$194,409	\$0	\$194,409	\$195,409	\$0	\$195,409	\$130,182	\$0	\$130,182	\$520,000	\$520,000	

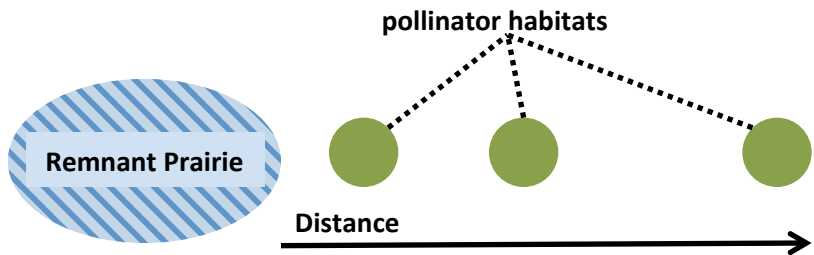
Data Driven Pollinator Conservation

Daniel Cariveau, UMN

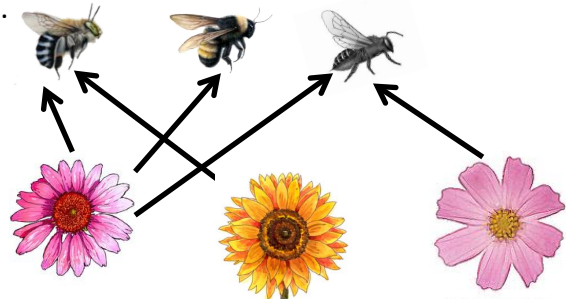


Map showing areas of MN Prairie Conservation Plan. Sites for this project will occur in this region.

Activity 1. We will determine how distance of pollinator habitat from remnant prairie affects successful colonization of pollinator habitats by native bees.

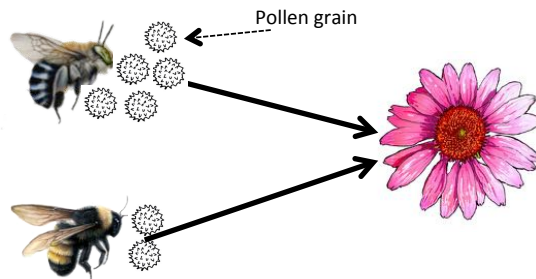


Activity 2. We will identify which plants are preferred by native bees. We will also determine whether certain plants are preferred by rare or declining bee species. Finally, we will focus on early spring species as these are important but often lacking in new pollinator habitat.



Example of pollinator habitat planting

Activity 3. Native bee species vary in the amount of pollen they deposit on flowers. We will record the the number of pollen grains deposited by various bee species to rare and declining plants.



Activity 4: We will disseminate our results to land managers throughout the state with printed materials and presentations.

