# Final Abstract

Final Report Approved on December 17, 2025

## M.L. 2020 Project Abstract

For the Period Ending June 30, 2025

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

**Project Manager:** Ruth Shaw

**Affiliation:** U of MN - College of Biological Sciences

**Mailing Address:** 1479 Gortner Ave., 140 Gortner Laboratory University of Minnesota

**City/State/Zip:** St. Paul, MN 55108

**Phone:** (612) 624-7206

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**Website:** https://cbs.umn.edu/

**Funding Source:**

**Fiscal Year:**

**Legal Citation:** M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 03j and M.L. 2024, Chp. Sec. 2, Subd. 18

**Appropriation Amount:** $500,000

**Amount Spent:** $490,150

**Amount Remaining:** $9,850

**Sound bite of Project Outcomes and Results**

We increased the amount and diversity of locally sourced seed available to conservation practitioners and, through multiple studies, found climate and distance to be weak predictors of plant performance. Thus, our findings support using regionally sourced seed for restoration. We disseminated our results through published manuscripts, conference presentations, and symposia.

**Overall Project Outcome and Results**

The widely supported goal of preserving and restoring the extraordinarily diverse plant and microbial life harbored in MN prairies presents serious, pressing challenges. Our 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 that 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 persistence of beautiful, sustainable landscapes on private and public lands. Land managers working to restore and preserve prairie need greater availability of seed and the knowledge base to understand how diverse plants and beneficial microbes adapt to the varied landscape of MN prairies. To address this problem we: gathered seed of many species, retaining their source

origin, and made them available to seed producers; studied microbial effects on plant survival; estimated the geographic scale of adaptation; and communicated our results to aid restoration and propagation. Over 50 volunteers 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. This seed was distributed to four seed producers and regional The Nature Conservancy and DNR offices for use in prairie reconstruction. The results of our field studies found climate and distance to be weak predictors of population performance. These results support using regionally sourced seed for restoration. A symposium we hosted with The Nature Conservancy was attended by 50 MN conservation practitioners. In it, we discussed how the results of our work bear on prairie conservation. This project supported five PhD students, three postdoctoral researchers, and over 20 undergraduate students who learned how to conduct large-scale field based evolutionary genetic research.

**Project Results Use and Dissemination**

We have published five papers in peer-reviewed scientific journals (Peschel et al. 2025, Pozzi et al. 2025, Rushing et al. 2022, Goldsmith et al. 2021, DeMers et al. 2021) and presented our work at multiple conferences. We conducted a focus group to understand the factors limiting the availability of native seed for prairie reconstructions with conservation practitioner stakeholders. We hosted a symposium with The Nature Conservancy showcasing how our research informs conservation, led hands-on activities at farmers markets to teach prairie ecology and the importance of its conservation, and worked with undergraduate students starting their careers in conservation biology.

# Environment and Natural Resources Trust Fund

M.L. 2020 Approved Final Report

## General Information

**Date:** December 19, 2025

**ID Number:** 2020-030

**Staff Lead:** Noah Fribley

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

**Project Budget:** $500,000

## Project Manager Information

**Name:** Ruth Shaw

**Organization:** U of MN - College of Biological Sciences

**Office Telephone:** (612) 624-7206

**Email:** shawx016@umn.edu

**Web Address:** https://cbs.umn.edu/

## Project Reporting

**Final Report Approved:** December 17, 2025

**Reporting Status:** Project Completed & Additional Update Approved

**Date of Last Action:** December 17, 2025

**Project Completion:** June 30, 2025

## Legal Information

**Legal Citation:** M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 03j and M.L. 2024, Chp. Sec. 2, Subd. 18

**Appropriation Language:** $500,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to improve Minnesota prairie resiliency by increasing locally sourced seed availability and diversity, evaluating use of beneficial microbes in prairie restorations, and assessing adaptation and adaptive capacity of prairie plant populations.and (a) The availability of the appropriations for the following projects is extended to June 30, 2025: (4) Laws 2021, First Special Session chapter 6, article 5, section 2, subdivision 3, paragraph (j), Healthy Prairies III: Restoring Minnesota's Prairie Plant Diversity;

**Appropriation End Date:** June 30, 2025

## Narrative

**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.

**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? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & 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.

## 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

## Activities and Milestones

### Activity 1: Preserving prairie plant diversity for conservation and restoration

**Activity Budget:** $57,483

**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 | Approximate Completion Date |
|---|---|
| Expand availability of source-identified seed by collecting 10 additional species from geographically widespread locations. | October 31, 2022 |
| Continue to establish material transfer agreements with producers and to transfer seeds to them. | October 31, 2022 |
| Develop propagation methods for species that are currently difficult to propagate. | June 30, 2023 |

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

**Activity Budget:** $200,010

**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 mangagers 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 | Approximate Completion Date |
|---|---|
| Compare early seedling survivorship and establishment in Dalea spp. with and without beneficial microbe inoculation. | October 31, 2022 |
| Compare drought and inundation tolerance of little bluestem grass with and without beneficial fungal inoculation. | June 30, 2023 |

### Activity 3: Evaluating adaptive genetic diversity of prairie plants

**Activity Budget:** $242,507

**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 | Approximate Completion Date |
|---|---|
| Monitor survival, growth, and reproduction in established experiments with 6 species and over 6000 plants. | June 30, 2023 |
| Evaluate pedigreed little bluestem populations in field experiments to assess their genetic capacity to adapt. | June 30, 2023 |

## 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 |

## Dissemination

**Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.**
We will communicate to Minnesota seed producers the availability of new seed collections, as we have in the past, and transfer to them seeds they request. We will publish results of our research in the scholarly literature. As in the past, we will consult with government agencies (MN DNR, MN DOT) and non-governmental organizations, such as The Nature Conservancy to offer insights that emerge from this research. We will present findings from the research informally as opportunities arise, for example, at Market Science events. Acknowledgement of ENRTF support will be included in all promulgation of our work

## 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 work be funded?**
Given the long lifespans of prairie plants and complexity of microbial plant communities, continuing the established project through further field seasons (2021 – 2023) is required to accomplish all its goals.
After the project is no longer funded by the ENRTF, findings, results, and products will be disseminated by Shaw and May, who will be supported by their salaries at the University of Minnesota-TC, along with their collaborators, as their capacities allow.

## 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 |

## Budget Summary

| Category / Name | Subcategory or Type | Description | Purpose | Gen. Ineligible | % Benefits | # FTE | Classified Staff? | $ Amount | $ Amount Spent | $ Amount Remaining |
|---|---|---|---|---|---|---|---|---|---|---|
| **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 | | $162,398 | - | - |
| 2 Graduate Students | | 50% FTE graduate students - Support is requested for the summer in year 1 plus one semester 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. | | | 46.88% | 1.06 | | $89,749 | - | - |
| 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** | **$461,984** | **$461,875** | **$109** |
| **Contracts and Services** | | | | | | | | | | |
| Consultant | Professional or Technical Service Contract | Northern MN seed collections | | | | 0 | | $1,000 | $374 | $626 |
| UM Genomics Center | Internal services or fees (uncommon) | Lab Services - Analysis. Sequencing, 4 analyses (of 200 samples) @ $2,000 each | | | | 0 | | $8,000 | $3,059 | $4,941 |
| UMN Greenhouses | Internal services or fees (uncommon) | For planned experiments: 800 sq. ft for 12 months over 2 years, at $0.8 per sq. ft. per month, per current UMN greenhouse rental rates | | | | 0 | | $3,616 | $2,027 | $1,589 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Sub Total** | **$12,616** | **$5,460** | **$7,156** |
| **Equipment, Tools, and Supplies** | | | | | | | | | | |
| | Tools and Supplies | field and lab supplies | seed collection, censuses, microbial culturing | | | | | $10,711 | $9,288 | $1,423 |
| | | | | | | | **Sub Total** | **$10,711** | **$9,288** | **$1,423** |
| **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. | | | | | $7,877 | $7,863 | $14 |
| | | | | | | | **Sub Total** | **$7,877** | **$7,863** | **$14** |
| **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 | $4,853 | $1,147 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Sub Total** | **$6,000** | **$4,853** | **$1,147** |
| **Other Expenses** | | | | | | | | | | |
| | | Mailing or Courier Fees | Send seeds collected by collaborators at outstate sites to UMN. | X | | | | $812 | $811 | $1 |
| | | | | | | | **Sub Total** | **$812** | **$811** | **$1** |
| | | | | | | | **Grand Total** | **$500,000** | **$490,150** | **$9,850** |

## 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 | $ Amount Spent | $ Amount Remaining |
|---|---|---|---|---|---|---|
| **State** | | | | | | |
| In-Kind | Indirect costs associated with this project. | Indirect costs | Secured | $256,931 | $256,931 | - |
| | | | **State Sub Total** | **$256,931** | **$256,931** | **-** |
| **Non-State** | | | | | | |
| | | | **Non State Sub Total** | **-** | **-** | **-** |
| | | | **Funds Total** | **$256,931** | **$256,931** | **-** |

# 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)....

## Supplemental Attachments

### *Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other*

| Title | File |
|---|---|
| Background check certification form | 578033ba-9cd.pdf |

### *Media Links*

| Title | Link |
|---|---|
| Genetic divergence in population mean fitness is weakly associated with environmental and geographic distance in four prairie perennial forbs. Evolution Letters | doi: 10.1093/evlett/qraf018 |
| The geographic scale of population-level variation in growth and nodulation differs for two species of prairie clover. | doi: 10.1002/ajb2.16450 |
| Sourcing seed for restoration in an era of climate change: conceptual frameworks and available evidence. Restoration Ecology | doi: 10.1111/rec.70187 |
| Prairie Research Symposium: 7 scientists were hosted by The Nature Conservancy to share their research and prairie-related findings in a two-hour online event. | https://youtu.be/Gd8tcNw6VlE?si=ZsExX96yDyBYWfdz |
| Latitude of seed source impacts flowering phenology and fitness in translocated plant populations | https://doi.org/10.1111/rec.13464 |
| Factors limiting the availability of native seed for reconstructing Minnesota's prairies: stakeholder perspectives | https://doi.org/10.1111/rec.13554 |
| Habitat-scale heterogeneity maintains fungal endophyte diversity in two native prairie legumes | https://doi.org/10.1080/00275514.2020.1813487 |
| Functional diversity of fungal symbiont communities and the impact of biotic and abiotic factors on their composition and assembly | https://conservancy.umn.edu/server/api/core/bitstreams/01ff7d4d-d4f9-470c-92a1-aae5ff2f094c/content |
| A history of both clonality and recombination governs the population structure of Alternaria endophyte communities on prairie Dalea | https://hdl.handle.net/11299/225905 |

# Difference between Proposal and Work Plan

### *Describe changes from Proposal to Work Plan Stage*

The support for graduate student on Activity 2 was reduced somewhat. This does not compromise the work, because the student has been awarded a fellowship for the coming academic year.

## Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

**Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?**

N/A

**Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?**

Yes, I understand the UMN Policy on travel applies.

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

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

# Work Plan Amendments

| Amendment ID | Request Type | Changes made on the following pages | Explanation & justification for Amendment Request (word limit 75) | Date Submitted | Approved | Date of LCCMR Action |
|---|---|---|---|---|---|---|
| 1 | Completion Date | Previous Completion Date: 12/31/2023<br>New Completion Date: 06/30/2024 | This change is needed to complete the work. | January 29, 2023 | Yes | February 1, 2023 |
| 2 | Amendment Request | • Budget<br>• Budget - Professional / Technical Contracts<br>• Budget - Capital, Equipment, Tools, and Supplies<br>• Budget - Travel and Conferences<br>• Budget - Printing and Publication<br>• Budget - Other<br>• Budget - Non-ENRTF Funds Contributed | We request transfer of $114 from Travel to Other to cover our excess costs of shipping seeds to seed producers and land managers. We anticipate further shipping costs and therefore request additionally $186 transferred from Travel to Other. | June 7, 2024 | Yes | August 30, 2024 |
| 3 | Completion Date | Previous Completion Date: 06/30/2024<br>New Completion Date: 06/30/2025 | The covid pandemic imposed delays early in the funding period. Since Feb 2022, when we hired a new postdoc, progress has been excellent. This postdoc will be on maternity leave for 15 weeks, beginning early January 2024, and, due to other obligations, we will make little progress during her absence. Upon her return, we have strong reason to expect to complete all our planned work by the end of June 2025. | December 15, 2023 | Yes | June 6, 2024 |
| 4 | Amendment Request | • Other<br>• Budget - Travel and Conferences<br>• Budget - Other | We moved $114 from Travel to the Other category to account for the cost of shipping seeds to our producers as the amount we spend on shipping seeds exceeded the allotted $200 in the "Other" category. | October 4, 2024 | Yes | November 19, 2024 |
| 5 | Amendment Request | • Budget<br>• Budget - Professional / Technical Contracts<br>• Budget - Travel and Conferences<br>• Budget - Other | We overspent the 'Other' category by $497. These charges were largely associated with mailing seeds to producers. We have funds remaining in the 'Travel' category, which we no longer | April 1, 2025 | Yes | July 9, 2025 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | • Budget - Non-ENRTF Funds Contributed | expect to require. We request to transfer $497 from 'Travel' to 'Other' . | | | |
| 6 | Amendment Request | • Budget<br>• Budget - Personnel<br>• Budget - Professional / Technical Contracts<br>• Budget - Capital, Equipment, Tools, and Supplies<br>• Budget - Travel and Conferences<br>• Budget - Printing and Publication<br>• Budget - Non-ENRTF Funds Contributed<br>• Attachments | We request transfer of funds from travel and other categories to personnel to cover modestly greater costs in this category. At the University of Minnesota as well as many other universities, salaries were recently increased for all postdoctoral scholars. This largely accounts for the shorfall in personnel funds. | August 14, 2025 | Yes | October 24, 2025 |

# Additional Status Update Reporting

## Additional Status Update December 1, 2025

**Date Submitted:** December 1, 2025

**Date Approved:** December 4, 2025

**Overall Update**

* We distributed seeds of diverse prairie plants to seed producers and returned remaining seeds to DNR and TNC, respectively, to be sown back onto the lands from which we gathered them.
* We found that microbial symbionts of prairie plant species are widely distributed across Minnesota prairies but vary in abundance within the local environments of sites and plant species (Ndinga-Muniana, 2023, Demers, 2021). Microbial symbionts have small, positive impacts on Dalea candida and D. purpurea seedling recruitment, and these positive impacts are not limited to local plant-microbe combinations (Pozzi et al. 2024).
* We found considerable variation among populations of 4 prairie plant species in their average fitness, as expressed when growing in two different sites. There were significant relationships between the average fitness of populations of particular species and the distance they were growing from their source location but also considerable idiosyncratic deviation from these relationships, as reported in Peschel et al. 2025. Evolution Letters. Our results suggest limited effectiveness of geographic distance and temperature difference in predicting population mean fitness.

**Activity 1**

This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Activity 2**

This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Activity 3**

This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Dissemination**

We have added links to materials that have resulted from this project, including papers published in scholarly journals and two doctoral dissertations, as well as a video of a two hour symposium reporting on our research, hosted by The Nature Conservancy.

# Additional Status Update Reporting

## Additional Status Update October 21, 2025

**Date Submitted:** October 21, 2025

**Date Approved:** October 24, 2025

**Overall Update**
Our stated outcomes were to 1) Preserve diverse seed from 10 of the rarer prairie species, and develop methods for propagating them, 2) Develop protocols for the use of beneficial microbes to improve plants' survival in conversion of marginal agricultural land to resilient prairie and 3) Evaluate the distance over which prairie plants or seeds can be translocated into restorations without severely compromising survival and reproduction. As of the last update we finished activity 1 which entailed collecting and disseminating seeds of rare plant species to producers and conservation practitioners. We also completed activity 2 which involved evaluating the contribution of soil microbes to plant population adaptation. We have now completed evaluating the geographic scale of adaptation of six prairie perennials, which was the main aim of activity 3.

**Activity 1**
This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Activity 2**
This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Activity 3**
This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Dissemination**
We have published three papers based on this project. Links to these papers are given in the dissemination section. A doctoral dissertation will soon be completed, and at least one more paper is planned for publication..

# Status Update Reporting

## Final Status Update August 14, 2025

**Date Submitted:** October 21, 2025

**Date Approved:** October 24, 2025

**Overall Update**
Our stated outcomes were to 1) Preserve diverse seed from 10 of the rarer prairie species, and develop methods for propagating them, 2) Develop protocols for the use of beneficial microbes to improve plants' survival in conversion of marginal agricultural land to resilient prairie and 3) Evaluate the distance over which prairie plants or seeds can be translocated into restorations without severely compromising survival and reproduction. As of the last update we finished activity 1 which entailed collecting and disseminating seeds of rare plant species to producers and conservation practitioners. We also completed activity 2 which involved evaluating the contribution of soil microbes to plant population adaptation. We have now completed evaluating the geographic scale of adaptation of six prairie perennials, which was the main aim of activity 3.

**Activity 1**
This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Activity 2**
This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Activity 3**
We have completed data collection, analysis, and reporting and dissemination of the results for evaluating the geographic scale of adaptation of our six target plant species. We have been dismantling our research sites. Evaluating the presence of genetic variance between populations of little bluestem, and the effect of inbreeding on genetic variance for populations of little bluestem is ongoing, as part of a student's doctoral dissertation. The student is expected to complete his doctoral dissertation and submit it for his defense this Fall.
*(This activity marked as complete as of this status update)*

**Dissemination**
Since our last report we have published a manuscript evaluating the geographic scale of adaptation for our four target forbs in the peer-reviewed scientific journal Evolution Letters (Peschel AR, Flint SA, May G, Shaw RG 2025. Over the scale of our study within Minnesota, we have detected genetic divergence among populations of four prairie perennial forbs with respect to their mean fitness, as expressed in two experimental sites. Further, we found that mean fitness of these populations is weakly associated with environmental and geographic distance. We also have presented the case against broad application of assisted migration in a paper that is accepted for publication in Restoration Ecology. We organized a symposium with the Nature Conservancy of Minnesota that was attended by over 50 conservation practitioners in Minnesota affiliated with governmental and non-governmental agencies, as well as interested community members. We presented our findings evaluating seed sourcing, the magnitude of genetic diversity within fragmented populations, and the capacity for response to natural selection in Minnesota's tallgrass prairie. We are preparing two more manuscripts for publication. Additionally, this summer two undergraduate students assisted us in dismantling our research sites for activity 3 and, in the process, learned about this research.

# Status Update Reporting

## Status Update April 1, 2025

**Date Submitted:** April 1, 2025

**Date Approved:** July 9, 2025

**Overall Update**

Our original stated outcomes were to: 1) Preserve diverse seed from 10 of the rarer prairie species, and develop methods for propagating them. 2) Develop protocols for the use of beneficial microbes to improve plants' survival in conversion of marginal agricultural land to resilient prairie and 3) Evaluate the distance over which prairie plants or seeds can be translocated into restorations without severely compromising survival and reproduction. After consulting with seed producers and native plant growers we collected species from multiple targeted populations of rare and common species across the prairie region. We have distributed all of our collections to seed producers and conservation practitioners which has helped to increase the availability of locally sourced seed. We established four experimental sites in the prairie region, where we planted 12 populations each of six perennial plant species. We evaluated differences in the fitness response between populations for each species and the relationships between population response and differences in climate and distance. At these experimental sites we also evaluated the relationship between plant growth and nodulation from beneficial rhizobia for two of the forbs, Dalea candida and Dalea purpurea. We have finished all field work and most of our data analysis.

**Activity 1**

This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Activity 2**

This activity was previously marked complete.
*(This activity marked as complete as of this status update)*

**Activity 3**

We have finished our field experiment with the aim of evaluating the geographic patterns of adaptation with respect to differences in climate and distance for six prairie perennials. We had four experimental field sites, and in all sites, each of the six species were represented by twelve populations originally sampled from throughout the prairie region late in 2014. We assessed survival and reproduction of all individuals planted. We used aster models to produce fitness estimates from these data for each population at each experimental site. For each species we evaluated the relationship between population fitness and the geographic and climatic distance between its source site and the experimental site to assess geographic patterns of adaptation. In a second major study, we are focusing on the little bluestem grass and are evaluating, for two populations, genetic variation for survival and reproduction, and assessing effects of interbreeding between them. Our results will better inform methods of prairie conservation and restoration that maintain genetic diversity and optimize use of genetic resources.

**Dissemination**

We have produced multiple papers published in peer-reviewed journals that we have reported on in previous updates. We have recently submitted a revision of a paper reporting our field experiment to evaluate the geographic patterns of adaptation for the four forb species. We are now preparing a manuscript for submission from the same study which focuses on the two grass species. We presented findings based on our Activity Three research at the Plant Resilience and Conservation for a Changing Climate Symposium, hosted by the Botanical Society of America in November of 2024, the Prairie Enthusiasts Conference in February 2025, and at the Native Seed Stakeholders Meeting in March of 2025, hosted

and organized by the Tallgrass Prairie Center. We are also preparing to present this work to practitioners in June of 2025.

# Status Update Reporting

## Status Update October 1, 2024

**Date Submitted:** October 4, 2024

**Date Approved:** October 4, 2024

**Overall Update**
We have made great progress in achieving our aims for the Healthy Prairies Project which are to conduct research in support of preserving and restoring the tallgrass prairie ecosystem in Minnesota. Our project is composed of three activities. For the first activity we set out to increase the diversity and abundance of locally sourced seed available to seed producers and land managers. We solicited input about what species would be desirable and hand harvested and distributed site sourced seed over multiple years. This aim is complete. Our second research aim was to investigate the relationship between prairie plant populations and beneficial microbes, and to see if this relationship changes when plant populations are moved varying distances from their home site. This project is complete and we have published two papers. Our last research aim is to evaluate the geographic scale of adaptation of common prairie plant species to inform seed sourcing decisions in restoration. The results of this research for four of the forb species have been submitted and are undergoing peer-review. We are analyzing the data on the grass species.

**Activity 1**
This project was completed at the last reporting cycle. There is nothing new to report as all seed has been distributed to Minnesota seed producers and state management agencies.
*(This activity marked as complete as of this status update)*

**Activity 2**
to be completed in Oct 2024
*(This activity marked as complete as of this status update)*

**Activity 3**
We have completed field work and data collection for this research aim. We collected data on the geographic scale of adaptation for four forbs and two grasses. We have submitted a manuscript to the peer reviewed journal, Evolution Letters, which detail our findings on the relationship between population fitness and the distance from which they are planted from their home site for the four forb species. We found the responses to be idiosyncratic between species and within species. We did not find climate and distance to be strong predictors of plant population fitness, and thus their capacity for persistence. Our results do not support long distance seed transfers or predictive provenancing (when seed is sourced from a site whose current climate matches that predicted for the restoration site). We are currently analyzing the data for the two grass species and plan to collate those findings into a manuscript to be submitted for peer review.

**Dissemination**
We have submitted a paper from Activity 3 to the peer-reviewed journal Evolution Letters and it is currently being reviewed. We submitted a paper from Activity 2 to the peer-reviewed journal, The American Journal of Botany and it was accepted for publication.

# Additional Status Update Reporting

## Additional Status Update August 14, 2024

**Date Submitted:** August 30, 2024

**Date Approved:** August 30, 2024

**Overall Update**
to be completed in August 2024

**Activity 1**
to be completed in August 2024

**Activity 2**
to be completed in August 2024

**Activity 3**
to be completed in August 2024

**Dissemination**
to be completed in August 2024

# Status Update Reporting

## Status Update April 1, 2024

**Date Submitted:** August 30, 2024

**Date Approved:** August 30, 2024

**Overall Update**

The originally stated Outcomes were: 1) Preserve diverse seed from rare prairie species 2) Develop protocols for the use of beneficial microbes to improve plants' survival in conversion of marginal agricultural land to resilient prairie. 3) Evaluate the distance over which prairie plants or seeds can be translocated into restorations without severely compromising survival and reproduction. Regarding outcome one, we have distributed plant seeds to producers and practitioners that were collected from specific sites across the prairie region. For outcome two we implemented experiments to address these questions and are preparing manuscripts for publication. We have completed data collection for outcome three and are writing and revising manuscripts for dissemination.

**Activity 1**

We have finished our seed collection efforts to preserve the diversity of prairie plant species and offer site-sourced seed to producers and conservation practitioners. We collected seed from sites across the prairie region and kept species and their source location distinct from one another. Each accession comprises a single species from a single site. We sent 39 collections of 31 species to two seed producers who requested them. With the remaining seed we sent 510 collections comprising 95 species to agency partners involved in prairie restoration. These collections were sent to regional conservation offices that corresponded to the collections location so the practitioners could use locally sourced seed in their restoration efforts.

**Activity 2**

We completed two experiments to evaluate effects of naturally occurring microbes in the prairie on survival and drought tolerance of prairie plants. To evaluate the effect of microbes on plant persistence in varying precipitation regimes we sampled roots of little bluestem plants from 10 sites across a precipitation gradient. We found that fungal endophyte community composition in sites with high mean annual precipitation were distinct from sites with low mean annual precipitation. These findings suggest that endophytic fungi can support plant population persistence in dry environments, and this could aid plants' adaptation to changing climates. To evaluate the effect of plant microbes on plant survival we used prairie clover (Dalea candida, D. purpurea). We found that nodulation with nitrogen-fixing rhizobia only slightly decreased with distance of the source population to the experimental site and that the growth of Dalea generally benefited from associations with rhizobia. The results of these studies are being prepared for publication. These results will inform land managers about the role of beneficial microbes for successfully establishing new, resilient prairies.

**Activity 3**

We have successfully completed data collection from our eight year field study to evaluate the geographic scale of adaptation of prairie perennials. We monitored survival, growth, and reproduction in three field sites with 6 species and over 6000 plants. With these data we evaluated the distance over which prairie seeds can be translocated into restorations without severely compromising survival and reproduction. We are in the final stages of preparing manuscripts for publication. Our research evaluating the genetic variation in survival and reproduction for little bluestem, and the effects of interbreeding between populations is ongoing, as are our analyses for sideoats grama.

**Dissemination**

Since our last report we have no new dissemination updates. Upon being awarded a grant extension, we are continuing our work to prepare three manuscripts for publication. We plan to share the results of our research with land managers.

# Status Update Reporting

## Status Update October 1, 2023

**Date Submitted:** September 28, 2023

**Date Approved:** November 9, 2023

**Overall Update**

We have made significant progress in our project aims which are to contribute towards the preservation of MN prairie plant diversity and provide essential resources and information for prairie restoration. We have distributed site sourced prairie plant seed to native seed producers in Minnesota and to Minnesota agencies involved in prairie restoration. We have gained novel insights into the geographic scale of adaptation for commonly used native perennial prairie plant species and have begun to disseminate this knowledge to practitioners. We have contributed insights into how the microbes associated with prairie plant species vary across the prairie landscape in MN, and are in the final stages of data collection for a follow up study. Two published manuscripts, one manuscript submitted, and two in prep will disseminate information to the scientific community and to those involved in prairie restoration in MN.

**Activity 1**

We worked with seed collection partners across Minnesota to increase the availability of source-identified seed to agencies and native plant seed producers. Since 2019 we have distributed, with authorization, 648 collections to seed growers and MN land management agencies. In 2023 we extended our collecting efforts to gather additional seeds, focusing on groups of species that are most desired, but least available, for restorations. In consultation with seed producers, our 2023 seed collections targeted 10 prairie species less commonly used in restorations because they are rarer, however still ecologically important. We are currently developing seed germination protocols for some of these rare species which we will share with seed producers. This activity has afforded us the opportunity to mentor several undergraduates six of whom have pursued careers in conservation.

**Activity 2**

1.Evaluate the impacts of environment on Dalea purpurea and D. candida survivorship and growth in relationship to their association with beneficial nitrogen-fixing bacteria (rhizobia). We find high levels of variation within and among populations for both Dalea species consistent with their adaptation to local conditions but that plant growth is not strongly negatively correlated with geographic distance to the seed source. Growth of plants was positively correlated with their association with rhizobia in nodules, and results also suggest that the plants need not be associated with their local rhizobia. Results have been submitted to the Am. J. Botany for publication and suggest that Dalea species and their beneficial bacterial partners need not be closely "local" for first year survival. Conservationists and practicioners should focus on maintaining high levels of genetic variation still remaining in these remnant populations.

2.Compare drought and inundation tolerance of little bluestem grass (lbs; Schizachyrium scoparium) with and without beneficial fungal inoculation. The experiment to assess the impact of fungi associated with the roots of lbs in drought conditions is complete and results are being analyzed by Cedric Ndinga-Muniania, graduate student. After completing his PhD, Cedric will continue as a postdoctoral researcher with this project.

**Activity 3**

We have completed field work on experiments to characterize the spatial scale of local adaptation for six prairie perennials. This work involved four field sites. In all sites, each of the six species are represented by twelve populations originally sampled from throughout the prairie region late in 2014. We censused survival and reproduction of these populations each year through 2022. From these data we have characterized the geographic scale of adaptation for these species across the prairie region in Minnesota. We have produced one published study focusing on the scale of adaptation in SE Minnesota and are in the final stages of producing a manuscript reporting our findings from evaluating

the geographic scale of adaptation of the four forb species over five years. The results of this study provide empirical evidence that will aid seed sourcing decisions for prairie conservation in Minnesota. A second aim of this activity was to evaluate the effects of interbreeding between little bluestem populations, and that work is ongoing.

**Dissemination**

We have produced three manuscripts published in peer-reviewed scientific journals from this project. The citations for these papers are:

1) Goldsmith, Nicholas E., Shelby A. Flint, and Ruth G. Shaw. "Factors limiting the availability of native seed for reconstructing Minnesota's prairies: stakeholder perspectives." Restoration Ecology 30.3 (2022): e13554.

2) Rushing, Naomi S., Shelby A. Flint, and Ruth G. Shaw. "Latitude of seed source impacts flowering phenology and fitness in translocated plant populations." Restoration Ecology 29.8 (2021): e13464.

3) Adrien Pozzi, Ruth G. Shaw, Georgiana May "Evidence of local adaptation to environment and nitrogen fixing rhizobia differs for two species of the prairie clover, Dalea candida and D. purpurea". American Journal of Botany. 2023. submitted 6/23 and in review.

We also presented findings from Activity 3 to the 2023 Prairie Reconstruction Initiative symposium in January 2023.

# Status Update Reporting

## Status Update April 1, 2023

**Date Submitted:** April 11, 2023

**Date Approved:** April 26, 2023

**Overall Update**
We collected native seed throughout Minnesota's prairie region and established material transfer agreements with native seed producers. We are finishing a study optimizing germination for six rare and hard to germinate prairie plant species. We have completed our field study investigating the scale of adaptation of tallgrass prairie perennials and are in the planning stages of a field experiment to study the effect of distance on the association of rhizobia with five populations of Dalea candida and Dalea purpurea.

**Activity 1**
We are continuing to conduct germination tests for six tallgrass prairie plant species. Learning how to germinate these species is of interest to plant producers because these species are desirable but challenging to germinate. The goal of this study is to optimize their germination to facilitate propagation for native plant producers and increase the diversity of plants they have available for land managers. In addition, we have collected seed from eight species across the tallgrass region and are preparing them for distribution to growers, with the goal of increasing the availability of site-sourced seed for use in restoration.

**Activity 2**
1. Goal: Compare early seedling survivorship and establishment in Dalea spp. with and without beneficial microbe inoculation. We have completed a field study that largely accomplishes this goal. The results suggest that Dalea plants have improved growth with increased numbers of beneficial associations with nitrogen-fixing microbes. We also found that Dalea from sites across MN are capable of forming beneficial microbial associations.

2. Goal: Compare drought and inundation tolerance of little bluestem grass with and without beneficial fungal inoculation. We have characterized the fungal communities associated with little bluestem across MN, and how these communities change across a gradient of mean annual precipitation. We are currently evaluating the impact of beneficial fungi on plant drought tolerance in a greenhouse study.

**Activity 3**
We have completed field work and data analysis for our study investigating the spatial scale of adaptation of six tallgrass prairie perennial plant species. Our work focused on three field sites where we assessed survival and reproduction of all species planted. We have a draft of a manuscript and are preparing it for publication in a peer-reviewed scientific journal. Our second major study focuses on evaluating the fitness effects of interbreeding two populations of little bluestem. Data collection is ongoing for this project.

**Dissemination**
The results of our germination study will be collated and distributed to interested native plant growers. We have a manuscript in preparation assessing the effects of beneficial microbes for growth of Dalea candida and Dalea purpurea and plan to submit to a peer-reviewed scientific journal April 2023. We are also preparing a manuscript for submission which presents results on the spatial scale of adaptation in four perennial tallgrass prairie species. The results of this study were presented to the group Prairie Reconstruction Initiative, which is a regional group of academics and land managers in the Midwest who study and conduct prairie restorations, for their spring seminar series.

# Status Update Reporting

## Status Update October 1, 2022

**Date Submitted:** October 21, 2022

**Date Approved:** October 25, 2022

**Overall Update**

This summer we collected seed from rare prairie species in western Minnesota and conducted germination trials on species which producers have communicated to us are hard to grow. We are preparing seeds for transfer to seed producers through material transfer agreements. We collected our sixth season of census data on six prairie perennials and are currently analyzing the data to evaluate the scale of local adaptation. Results from our work on local adaptation published in 2021 suggests for two species, population latitude is an important factor in seed sourcing decisions for restorations. We have completed an experiment assessing the effect of local and foreign microbes on early survivorship in white and purple prairie clover and are preparing a manuscript for publication. We will communicate the results of our germination experiments and field trials which give insight into microbial treatments and germination procedures that could promote plant survival in a plant production facility.

**Activity 1**

This season we focused our seed collection efforts on species that are desirable for restorations but either have very limited availability because they are challenging to collect (such as Viola pedatifida, prairie violet) or are difficult to germinate once seeds have been obtained (such as Lathyrus venosus, veiny pea). After consulting with land managers and native seed producers, with several of whom we have established material transfer agreements, we developed a list of 14 species to target for collection. We are in the process of transferring seeds from our 2022 seed collection to producers using our material transfer agreements. We are also conducting germination trials on several recalcitrant species and will share our findings with growers.

**Activity 2**

We have completed the goal of comparing early seedling survivorship and establishment in Dalea spp. (white and purple prairie clover) with and without beneficial microbe inoculation and are preparing the data for publication. Our results suggest that Dalea are broadly tolerant of variation in their symbiotic partners, and that the association with symbiotic nitrogen-fixing bacteria may increase early survivorship. We plan to conduct a follow up experiment in spring 2022 to better examine the effects of microbes on early plant survivorship. Experiments are underway comparing drought and water inundation tolerance of little bluestem grass with and without beneficial fungal inoculation. These will be completed by summer 2023. We have isolated a large number of beneficial fungi associated with roots and will contact growers to see if they are interested in incorporating fungi in their production protocols.

**Activity 3**

This fall we completed our sixth year of data collection for our field experiment which aims to characterize the spatial scale of local adaptation of six prairie perennial plant species. We collected data on survival and reproductive status for all individuals planted for each species in our common gardens in western Minnesota. These data have been checked and entered, and we are in the process of data analysis and preparing manuscripts for publication. We have continued our field and greenhouse studies evaluating genetic variation for survival and reproduction of two populations of the grass little bluestem, and our study assessing effects of interbreeding between these two populations.

**Dissemination**

We are communicating with land managers and seed producers and will convey to them the results of our germination trials and microbial experiments that may improve propagation. We have published and will continue to publish results of our research in peer reviewed journals. For activity 1 we published Goldsmith et al. (2021) in the journal Restoration

Ecology which addressed obstacles to native plant production using native seed. For activity 2 we are preparing a manuscript for publication which addresses the effect of the microbial community on early seedling survivorship and establishment in Dalea spp. For activity 3 we published Rushing et al. (2021) in Restoration Ecology which evaluated effects of distance of the source population to the restoration site on population fecundity. We are currently preparing a manuscript for publication that evaluates the scale of local adaptation of six Minnesota prairie perennial species. On October 12, Ruth Shaw participated in a public outreach event during which she described the efforts, findings and implications of this project to a live audience and responded to their questions. Acknowledgement of ENRTF support has been and will be included in all promulgation of our work.

# Status Update Reporting

## Status Update April 1, 2022

**Date Submitted:** May 13, 2022

**Date Approved:** May 13, 2022

**Overall Update**

We received funding for the third phase of this project in mid-August of 2021. This timing precluded collection of seeds (Activity 1) that season, but we have made substantial progress on Activities 2 and 3. This includes an August 2021 field campaign to gather the sixth year of fitness data on our major transplant experiment to assess the geographic scale of adaptation (Activity 3). Over the 8 months, research evaluating the role of microbes in fitness of prairie plants has progressed steadiyl. In March, we succeeded in enlisting a new postdoc, Anna Peschel, to join us in advancing the project. Anna has highly relevant experience. She has worked on designing new experiments and analyzing our accumulated data.

**Activity 1**

To advance our goal of preserving diverse seed from 10 of the rarer prairie species, and develop methods for propagating them, Kuchenreuther, May and Shaw have discussed plans for collecting seeds in summer and fall of 2022. Kuchenreuther has enlisted UM-Morris undergraduates to work with her collecting seeds and testing propagation methods. We have continued consultation with producers of native seeds to identify species and regions of greatest interest to them.

**Activity 2**

• Cedric Ndinga-Muniania (graduate student), Emma Daily (lab assistant) and Georgiana May (coPI) have developed a protocol for screening beneficial root fungi for their ability to improve little bluestem growth and tolerance to differing soil moisture environments.

• We have designed a field experiment to evaluate early seedling survival and establishment of Dalea purpurea and Dalea candida. Seeds of the two Dalea species, from 4 different source populations will be planted into the existing experimental plots at Lake Bella WMA and Twin Valley WMA in Fall 2022. Because these two sites provide differing soil microbial environments and are sites of ongoing prairie restoration, the results will be relevant to the overall Activity 2 goal of determining the role of microbial partners in prairie plant establishment, growth and reproduction in restorations.

**Activity 3**

Continuing our efforts to evaluate the distance over which prairie plants or seeds can be translocated into restorations without severely compromising survival and reproduction, we gathered data from our transplant experiment in August of 2021. Preparation for data analysis is under way.

**Dissemination**

Two manuscripts in preparation will describe the results for interactions between Dalea and beneficial nitrogen fixing bacteria. Results show that the beneficial bacteria are widespread and prevalent in the environment, suggesting that inoculation may not be necessary to establishment of Dalea in prairie restorations.