# Environment and Natural Resources Trust Fund
# 2019 Request for Proposals (RFP)

**Project Title:** **ENRTF ID: 231-FH**

Supporting Pollinators and Prairie Restorations with Beneficial Fungi

**Category:** H. Proposals seeking $200,000 or less in funding

**Sub-Category:** F. Methods to Protect, Restore, and Enhance Land, Water, and Habitat

**Total Project Budget: $** 187,362

**Proposed Project Time Period for the Funding Requested:** June 30, 2022 (3 yrs)

**Summary:**

We will help managers improve habitat quality of reconstructed prairies for imperiled Monarch butterflies and other declining pollinators by increasing plant access to soil resources via beneficial fungi.

**Name:** Nicholas Jordan

**Sponsoring Organization:** U of MN

**Title:** Professor

**Department:** CFANS/Agronomy and Plant Genetics

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St. Paul MN 55108

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**Web Address**

**Location**

**Region:** Central, Northwest, Southwest

**County Name:** Statewide

**City / Township:**

**Alternate Text for Visual:**

Plant (a) is small, has one flower, and roots cannot reach most available nutrients. Plant (b) is large, supports many flowers and pollinators, and fungi access resources unreachable by roots.

| | | | |
|---|---|---|---|
| _____ Funding Priorities | _____ Multiple Benefits | _____ Outcomes | _____ Knowledge Base |
| _____ Extent of Impact | _____ Innovation | _____ Scientific/Tech Basis | _____ Urgency |
| _____ Capacity Readiness | _____ Leverage | _____ TOTAL | _____% |
| ____ If under $200,000, waive presentation? | | | |

PROJECT TITLE: Supporting Pollinators and Prairie Restorations with Beneficial Fungi

## I. PROJECT STATEMENT

Our goal is to develop practical methods by which land managers can harness beneficial soil fungi, to improve the cost-effectiveness and reliability of restorations of native prairies in agricultural areas, thereby improving conservation of endangered pollinators, and also providing highly-cost effective approaches to improve conservation of soil, water, and wildlife.

Why this is important. In agricultural regions of Minnesota, restored prairies can provide critical reservoirs of habitat for highly-valued species, including the imperiled Monarch butterfly, declining pollinators, and predators of agricultural pest insects. Reconstructed prairies in agricultural lands, long valued by natural resource managers, are becoming very popular with farmers because they provide benefits to soil and water conservation and habitat for beneficial insects that may more than pay for land taken out of production. However, many of these valuable benefits depend on establishing a diverse range of prairie plant species. At present, establishing this range is difficult, expensive, and often fails; better methods are urgently needed. There is increasing evidence that active management of soil microorganisms is important to reliable and cost-effective prairie reconstruction on former agricultural lands, similar to the well-known value of inoculation of crops with beneficial microbes. In particular, beneficial soil fungi colonize the roots of native prairie plants and aid the plant by improving access to water and nutrients, resources which allow the plant to thrive and to produce large floral displays that strongly support pollinators and other valued wildlife. Such beneficial soil fungi can be quite specific to particular plant species, so that a mismatch can lead to not only reduced benefit, but in some cases parasitism of the plant by the fungus.

How we will achieve the goal. Taking advantage of an existing multi-site prairie reconstruction experiment to greatly lower project costs, we will survey beneficial soil fungi that colonize native plant species in reconstructed and remnant prairies in western Minnesota. We will identify fungi associated with successful reconstructions and healthy remnants. We will then test the effects of these fungi on native prairie plant species transplanted into prairie reconstructions, measuring fungal effects on key plant traits of germination, growth, and flowering.

## II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Identify beneficial soil fungi associated with successful prairie reconstructions and healthy remnant prairies.*

We will compare fungi from roots of native prairie plant species in reconstructions that a) thrived, b) failed to thrive, or c) declined over time with fungi in roots of the same species collected from nearby healthy remnant prairies, thereby identifying fungi that are consistently associated with successful reconstructions and healthy remnants. To do so, 10 randomly chosen individuals of each of 20 plant species will be collected from five reconstructions established in 2005 and periodically monitored by the Larson lab and from five nearby remnants. DNA will be extracted from the roots of each plant and sequenced by the University of Minnesota Genomics Center to enable identification of beneficial soil fungi in each root sample. We will assess the effect of location, reconstruction vs remnant, and plant species on the nature of beneficial soil fungi that are present, as revealed by the sequencing data. This study will assess whether certain kinds of beneficial soil fungi are associated with thriving reconstructions and healthy prairies.

ENRTF BUDGET: $82,975

| Outcome | Completion Date |
|---|---|
| *1. Root collection, extraction, and DNA sequencing* | Feb. 2019 |
| *2. Identify soils with beneficial soil fungi that promote growth of prairie species* | June 2020 |

Activity 2: *Field-test the value of beneficial soil fungi for enhancing reliability and cost-effectiveness of prairie reconstruction.*

We will test effects of fungi, identified in Activity 1, on germination and establishment of key plant species in restored prairies. Soils from remnant prairies will be harvested and beneficial fungi per Activity 1) amplified in July 2020 in a glasshouse by

preparing fungal inocula. These inocula (chopped roots and soils) will be mixed with sand and planted with a known high-performing prairie species to further amplify soil fungi, producing inocula for field-scale use. After 4 months, this inoculum will be dried and stored until March 2021, when it will be added to soils to create a medium for seedling germination and growth of 20 native prairie plant species that are highly-valued in reconstructions. Seedlings will be grown in small cones with inocula containing fungi identified as beneficial to that species or in a basic potting mix (which will not contain those fungi) for 12 weeks, then planted in prairie reconstructions in early-mid June 2021 and monitored for survival, growth and flower production throughout the summer-fall of 2021. Root samples will be collected at the end of the season to confirm fungal identity.

ENRTF BUDGET: $104,386

| Outcome | Completion Date |
|---|---|
| *1. Preparation of inocula* | Feb. 2021 |
| *2. Grow native prairie plant seedlings with and without inocula* | June 2021 |
| *3. Field planting and monitoring of target species* | Sept 2021 |
| *4. Identify beneficial soil fungi that provide most benefit to key prairie species in field conditions* | January 2022 |
| *5. Final report* | June 2022 |

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

| Name | Title | Affiliation | Role |
|---|---|---|---|
| Nicholas Jordan | Professor | University of Minnesota | Project management, idenfication of fungi, field testing of beneficial fungi |
| Diane Larson | Research Wildlife Biologist | U.S. Geological Survey, St. Paul, Minnesota | Oversee field collections, monitoring, participate in interpretation |
| Laura Aldrich-Wolfe | Assistant Professor | North Dakota State University | Interpretation of sequence data |
| Stefanie Vink | Postdoctoral Researcher | University of Goningen | Methods and interpretation of sequence data |

IV. LONG-TERM- IMPLEMENTATION AND FUNDING:

The results from this project will greatly improve our understanding of the role that beneficial soil fungi play in establishment and persistence of native prairie plants. If our results confirm that beneficial soil fungi can be used to enhance the reliability and cost-effectiveness of prairie reconstruction, then implementation work will begin, focused on identification of the most cost-effective way to use these fungi as inoculants in prairie reconstruction. Inoculation options include inoculation of individual seedlings, or creation of inoculated “islands” from which beneficial fungi can spread to nearby seedlings, which may greatly lower costs. This study complements the UMN Healthy Prairies Initiative, currently supported by an ENRTF grant, by addressing soil microbial communities and focusing on the key challenge of cost-effective prairie reconstruction.

V. TIME LINE REQUIREMENTS:

Roots will be collected and processed in late summer 2019 and sequenced that fall/winter. Sequence data will be analyzed during spring-summer 2020. Soil microbe increases will occur Fall 2020; seedlings will be grown in these soils Spring 2021. These plants will be planted in the restorations in June 2021 and monitored summer-fall 2021. A final report will be completed and results disseminated to land managers by July 2022; follow-up implementation research, if warranted, will begin at that time.

# 2019 Proposal Budget Spreadsheet

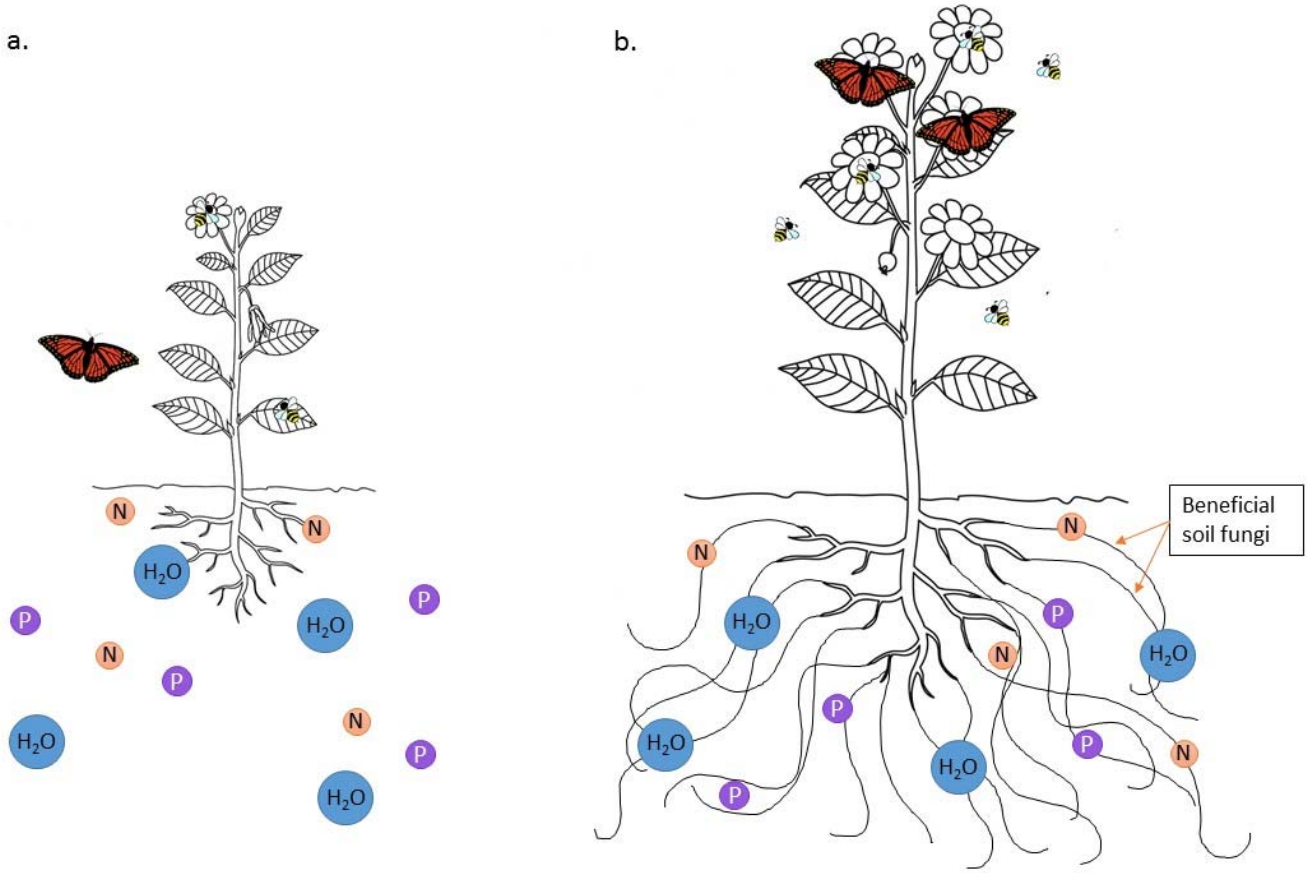
**Project Title: Supporting Pollinators and Prairie Restorations Beneficial Fungi**

**IV. TOTAL ENRTF REQUEST BUDGET** *3* **years**

| **BUDGET ITEM** (See "Guidance on Allowable Expenses") | **AMOUNT** |
|---|---|
| **UMN Personnel:** | |
| Nick Jordan (Co-PI);1 wk/yr@ $3181, 66.6% salary, 33.4% benefits, 2% FTE/year; 3% inc/yr. Project management and coordination of field and greenhouse work, data interpretation, and report writing. | $ 9,832 |
| Sheri Huerd (Professional and Administrative at U of M, plant root and seed collection and DNA extraction) $10,020, 66.6% salary, 33.4% benefits, 15% FTE/yr; 3%inc/yr | $ 30,971 |
| Jennifer Larson (Civil Service at U of M, plant root and seed collection and DNA extraction) $10,020, 72.8% salary, 27.2% benefits, 15% FTE/yr; 3%inc/yr | $ 30,971 |
| **Professional Contracts:** | |
| Diane Larson (Co-PI, U.S. Geological Survey); 3 wks/yr@$9,456; 3%inc/yr. Oversee field collections, monitoring, participate in data interpretation, and report writing. | $ 29,228 |
| Laura Aldrich-Wolfe (Co-PI, North Dakota State University); 1.5 wk/yr, flat rate $5000/yr. Interpretation of sequence data and report writing. | $ 15,000 |
| Stefanie Vink (Co-PI, University of Groningen); 1.5 wk/yr, flat rate $5000/yr. Methods and interpretation of sequence data and report writing. | $ 15,000 |
| **Equipment/Tools/Supplies:** | |
| Field and molecular work consumables, $1000/yr (plastic bags, paper bags, Ziplocks, labels, silica gel packs, 2ml tubes, flags, pipette tips, field gloves, lab gloves, markers) | $ 3,000 |
| Dneasy Plant Mini Kit for DNA extraction ($1,024/250 samples; 2000 samples Yr1, 500 samples Yr3 ) | $ 10,240 |
| **Travel** | |
| Field site travel: 2 people x 2 trips x 5 days each trip, $1,550/yr | $ 4,650 |
| Field site travel; internal UMN project vehicle costs, $400/yr | $ 1,200 |
| **Additional Budget Items:** | |
| Lab services at UMN: Greenhouse space in Yr2&3; 4.5mo/yr @$100/mo | $ 900 |
| Lab services at UMN: Soil analysis of each site for Nitrogen and Phosphorus Yr1 @$30/sample($300) | $ 300 |
| Lab services at UMN: University of Minnesota Genomics Center (DNA barcoding and sequencing of 2500 samples) | $ 36,070 |
| **TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =** | $ 187,362 |

**V. OTHER FUNDS** *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

| **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:** | *N/A* | *N/A* |
| **Past and Current ENRTF Appropriation:** | N/A | N/A |
| **Other Funding History:** | *N/A* | *N/A* |




Plants growing without beneficial fungi (a) can only reach resources such as nitrogen (N), phosphorous (P), and water ($H_2O$) that are in the immediate vicinity of their roots. Plants whose roots are colonized by beneficial fungi (b) have access not only to those resources adjacent their roots, but also to those adjacent to the fungi. As a result, colonized plants can grow larger and produce more flowers with more nectar and pollen, providing more food for butterflies and bees. Larger populations of butterflies, bees and other pollinators can be supported by the same amount of prairie. Through supporting a larger population of pollinators, these plants will also produce more fruits and seeds, which will benefit other wildlife.

Project Manager Qualifications

*The Project Manager is Dr. Nicholas Jordan. He is trained in plant ecology, and specializes in the ecology of agricultural ecosystems. He is highly experienced with project management, including complex, large-budget projects. He will provide project direction, management, and fiscal oversight. The University of Minnesota is the project organization; it is capable of conducting all project activities through its research and outreach capacities. In particular, all equipment and facilities needed to perform project activities are currently possessed by the organization or by our collaborators. Project accounting and fiscal administration will be done by the University of Minnesota's Department of Agronomy and Plant Genetics, housed in the College of Food, Agricultural, and Natural Resource Sciences (CFANS).*