Environment and Natural Resources Trust Fund
2020 Request for Proposals (RFP)

Project Title: **ENRTF ID: 233-F**

Supporting Pollinators and Prairie with Beneficial Soil Fungi

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

Sub-Category:

Total Project Budget: $ 331,079

Proposed Project Time Period for the Funding Requested: June 30, 2023 (3 yrs)

Summary:

Develop methods to restore native prairies in agricultural areas with beneficial soil fungi, improving conservation of pollinators, soil, water, and other wildlife, and increasing resistance to invasive non-native plants

Name: Nicholas Jordan

Sponsoring Organization: U of MN

Job Title:

Department: Agronomy & Plant Genetics

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Location:

Region: Statewide

County Name: Isanti

City / Township: St. Paul

Alternate Text for Visual:

Beneficial soil fungi help native prairie plants to produce many flowers for pollinators and to grow rapidly, thereby suppressing invasive weeds.

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

PROJECT TITLE: Supporting Pollinators and Prairies with Beneficial Soil Fungi

I. PROJECT STATEMENT

Our goal is to develop practical methods by which land managers can harness beneficial soil fungi to lower costs and improve reliability of native prairie restorations in agricultural areas. If successful, this will improve conservation of endangered pollinators and other wildlife, control non-native grasses that ruin restorations, and provide cost-effective conservation of soil and water.

Why this is important. Restored tallgrass prairie can provide excellent habitat for imperiled Monarch butterflies and rapidly declining native bees. Restored prairie also supports economically valuable wildlife that controls crop pests, enabling reductions in pesticides that harm pollinators. To attain these benefits, however, the restored prairie must be diverse enough to provide season-long bloom and vigorous enough to resist invasive species. Restorations that lack early season blooms cannot support bumblebees, for example, that begin establishing nests in early spring; likewise, without vigorous growth of early-season grasses and forbs, non-native grasses easily invade, ruining pollinator habitat. To address this problem, better establishment methods for spring-flowering native prairie species are critically needed. Establishment of these species is typically poor, which is a major problem because seeds of these species are scarce and expensive. Evidence suggests that better establishment could be achieved on these lands by active management of beneficial soil microorganisms, just as crops benefit from inoculation with beneficial microbes. In particular, beneficial soil fungi colonize the roots of native prairie plants and improve access to water and nutrients, resources which allow the plant to thrive, compete with invasive grasses, and to produce many flowers for pollinators and other valued wildlife. However, beneficial soil fungi can be quite specific to particular plant species. It is critical that the correct soil fungi for native prairie species are present when a restoration begins; otherwise, mismatches can lead to reduced benefits to, or harmful effects on, native prairie plant species.

How we will achieve the goal. Greatly lowering project costs by taking advantage of several long-term multi-site prairie restoration experiments, we will survey beneficial soil fungi that colonize native plant species in reconstructed and remnant prairies in western Minnesota and in prairies established over the past 40 years at Three Rivers Parks. We will identify fungi associated with successful restorations and healthy prairie remnants (in a recently-funded companion study) and examine the timeline of colonization in the restored prairies of different ages (this study). We will then test the effects of these fungi on native prairie plant species including hard-to-establish cool-season forbs and native cool-season grasses in competition experiments with invasive grasses. We will measure fungal effects on the key plant traits of growth, leaf area and flower number with and without competition.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Identify beneficial soil fungi associated with prairie plants in restorations established 5 – 45 years ago.*

To efficiently use beneficial fungal inoculum to improve prairie restorations, we need to identify not only which fungal species are beneficial, but the length of time it takes them to colonize their host plants; those that colonize rapidly on their own can be excluded from managed inoculations. Ten individuals of 20 species (emphasis on early blooming species) will be collected at a total of 10 restorations planted in the early 1970's, 2010 and 2014 and from 4 nearby remnant prairies. DNA will be extracted from the roots of each plant and sequenced by the University of Minnesota Genomics Center to enable identification and determine abundance of beneficial soil fungi in each root sample. We will assess the effect of location, reconstruction age, and plant species on the identity and abundance of beneficial soil fungi present.

ENRTF BUDGET: $128,532

Outcome	Completion Date
1. Root collection, extraction, and DNA sequencing	**Feb. 2021**
2. Identify beneficial soil fungi that are associated with prairie species at each location	**June 2021**

Activity 2: *Test the value of beneficial soil fungi for enhancing resistance of native forbs and grasses to invasion by non-native grasses (smooth brome and Kentucky bluegrass).*

We will test effects of fungi, identified in Activity 1 and in a separately funded (USGS) companion study, on ability of spring-blooming native forbs and grasses to resist invasion by smooth brome and Kentucky bluegrass. In July 2021, soils from remnant prairies will be harvested and beneficial fungi amplified in a glasshouse; fungal inocula (chopped roots and soils) will be mixed with sand and planted with a high-performing prairie species to further amplify soil fungi. After 4 months this inoculum will be used in a competition experiment. Seedlings of 20 highly-valued native prairie species will be grown in pots containing basic potting mix with and without inoculum (of species-appropriate fungi) for 12 weeks, after which seeds of smooth brome and Kentucky bluegrass will be added. Size, leaf area, and flowering of all species will be monitored throughout the growing season, then above-ground production will be collected, dried and weighed and root samples will be collected to confirm fungal identity. If fungi improve competitive ability of native species, we expect the planted invasive grasses to be smaller and native plants larger and to produce more flowers in inoculated pots than in pots without fungi. This study will assess the effect of beneficial fungi on the ability of native prairie species to compete against non-native invasive grasses.

ENRTF BUDGET: $202,547

Outcome	Completion Date
1. Preparation of inocula	**Feb. 2022**
2. Grow native prairie plant seedlings with and without inocula	**June 2022**
3. Competition experiment	**Sept 2022**
4. Identify beneficial soil fungi that provide most benefit to key prairie species	**January 2023**
5. Final report	**June 2023**

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, data analysis
Laura Aldrich-Wolfe	Plant Ecologist	Consultant, Moorhead, Minnesota	Interpretation of sequence data, data analysis
Stefanie Vink	Microbial Ecologist/ Bioinformatician	Consultant, Groningen, The Netherlands	Methods and interpretation of sequence data, data analysis

IV. LONG-TERM- IMPLEMENTATION AND FUNDING:

We will share our results with practitioners via multiple channels, including webinars (e.g., the Prairie Reconstruction Initiative series) and podcasts (e.g., MN DNR's Prairie Podcast). This study complements University of Minnesota's Healthy Prairies Initiative, currently supported by an ENRTF grant, by addressing soil fungal communities and focusing on the key challenge of cost-effective reconstruction of highly diverse prairies that resist degradation by exotic grasses in the long-term.

V. TIME LINE REQUIREMENTS:

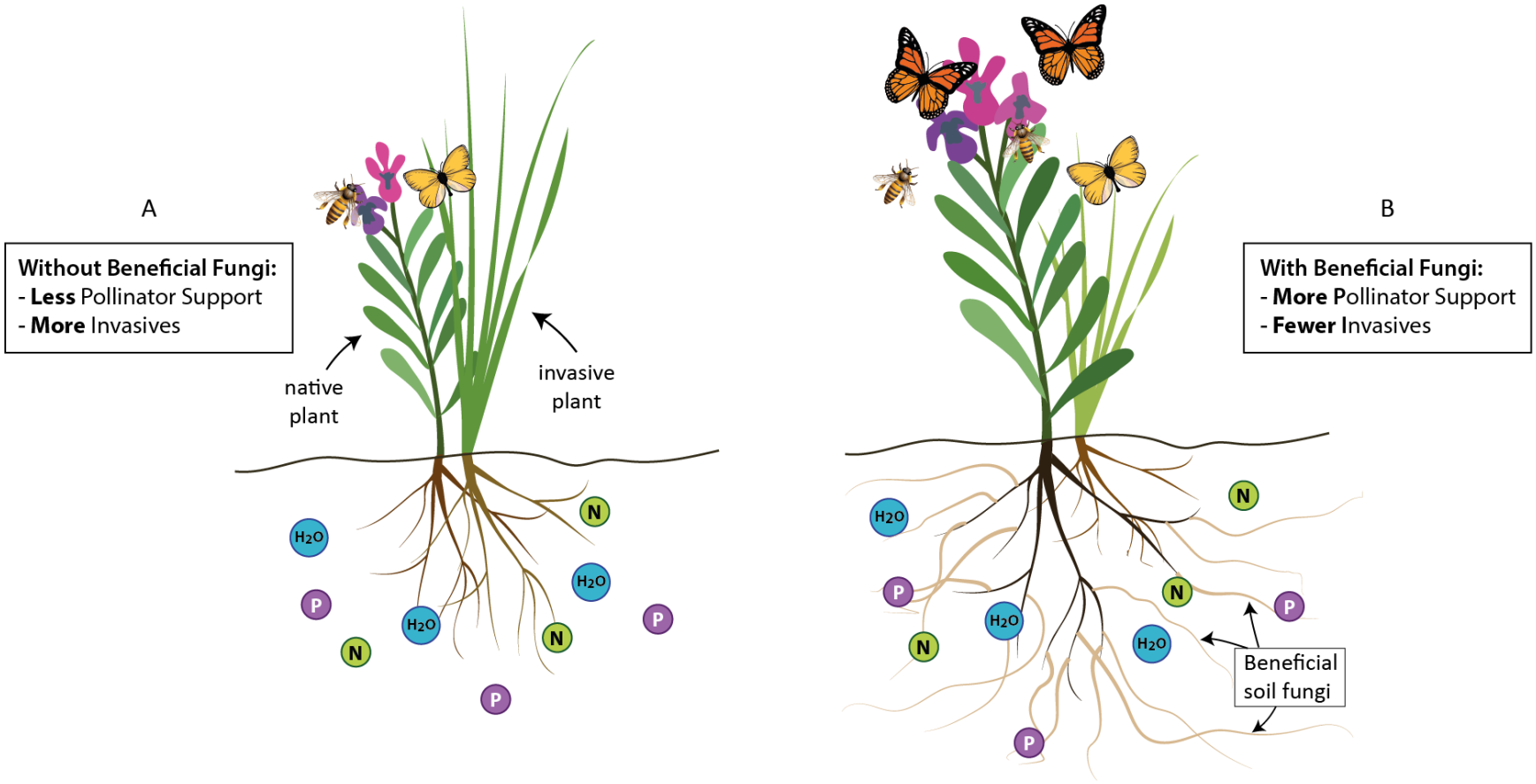
Roots will be collected and processed in late summer 2020 and sequenced that fall/winter. Sequence data will be analyzed during spring-summer 2021. Beneficial soil fungal increases will occur Fall 2021; seedlings will be grown in these soils Spring 2022, planted in a competition experiment in June 2022, and monitored summer-fall 2022. A final report will be completed and results disseminated to land managers by July 2023; follow-up implementation research, if warranted, will then begin.

Attachment A: Project Budget Spreadsheet
Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet
Legal Citation:
Project Manager: Dr. Nicholas Jordan
Project Title: Supporting Pollinators and Prairies with Beneficial Soil Fungi
Organization: University of Minnesota
Project Budget: $331,079
Project Length and Completion Date: 3 years ending 30 June 2023
Today's Date: 4/9/2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 206,936	$ -	$ 206,936
Nick Jordan (Co-PI, UMN); $9,644 (36% fringe rate); 2% FTE/yr; Yr1 $3,120 (S $2294/ F $826); 3% inc/yr			
Sheri Huerd (P&A, UMN); plant root collection, DNA extraction,greenhouse, soil collection) 30% FTE/yr; 36% fringe rate; 3%inc/yr; Yr1 $24,673 (S $18,142+ F $6,531), Total $76,262			
Jennifer Larson (CSBU, UMN); plant root collection, DNA extraction, soil collection, greenhouse, metadata) 50% FTE/yr; 29.5% fringe rate; 3% inc/yr; Yr1 $39,157 (S $30,237 + F $8,920) ; Total $121,030			
Professional/Technical/Service Contracts			
Diane Larson (Co-PI, U.S. Geological Survey, St. Paul MN); 3 wks/yr, Yr1= $9,740; 3%inc/yr $30,105	$ 30,105	$ -	$ 30,105
Laura Aldrich-Wolfe (Consultant, Moorhead, MN) Interpretation of sequence data, data analysis; flat rate $5000/yr; $15,000	$ 15,000	$ -	$ 15,000
Stefanie Vink (Consultant, Groningen, The Netherlands); Method and interpretation of sequence data, data analysis; flat rate $5000/yr; $15,000	$ 15,000	$ -	$ 15,000
Equipment/Tools/Supplies			
Dneasy Plant Mini Kit for DNA extraction (2000 samples in Yr1; 1000 in Yr3; $1052/250 samples)	$ 12,624	$ -	$ 12,624
Field and molecular work consumables, Yr1 $750; Yr2 $300; Yr3 $750 (plastic bags, paper bags, flags, pipette tips, field gloves, lab gloves, markers)	$ 1,800	$ -	$ 1,800
Capital Expenditures Over $5,000			
	$ -	$ -	$ -
Fee Title Acquisition			
	$	$	$
Easement Acquisition			
	$	$	$
Professional Services for Acquisition			
	$	$	$
Printing			
	$	$	$
Travel expenses in Minnesota			
Field site travel (2 people x 2 trips x 5 days/ trip) Yr1=$3,000, Yr2=$1000; internal UMN vehicle costs Yr1=$400, Yr2=$100	$ 4,500	$ -	$ 4,500
Other			
University of Minnesota Genomics Center (DNA barcoding and sequencing of 3000 samples); Yr1 $28,856, Yr3 $14,428	$ 43,284	$ -	$ 43,284
Glasshouse space in Yr2&3; 6mo/yr @$100/mo ($1200); Soil analysis of each site for Nitrogen and Phosphorus Yr1 and Yr3 @$30/sample($630)	$ 1,830	$ -	$ 1,830
COLUMN TOTAL	$ 331,079	$ -	$ 331,079

SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Budget	Spent	Balance
Non-State:	$ -	$ -	$ -
State:	$ -	$ -	$ -
In kind:	$ -	$ -	$ -

Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS	Budget	Spent	Balance
	$ -	$ -	$ -



Without beneficial fungi, native plants are outcompeted by invasive plants (A), while in the presence of plant-specific beneficial fungi they grow larger (B). This is because these fungi are able to access nutrients such as Phosphorus (P), Nitrogen (N) or water (H_2O) beyond the immediate vicinity of the roots, leading to plants with more flowers and 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. By supporting a larger population of pollinators, these plants will also produce more fruits and seeds, which will benefit other wildlife.

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 fulfilling all project activities through its research and outreach capacities.