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

Project Title: **ENRTF ID: 253-FH**

Identifying Prairie Mixes to Reduce Pollution

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: $ 199,917

Proposed Project Time Period for the Funding Requested: June 30, 2022 (2 yrs)

Summary:

We will identify which mixtures of prairie plant species best remove nitrates in vulnerable sandy soils, using existing long-term plantings under multiple environmental conditions.

Name: Jessica Gutknecht

Sponsoring Organization: U of MN

Job Title: Dr.

Department: Department of Soil, Water, and Climate

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Web Address:

Location:

Region: Central

County Name: Anoka

City / Township:

Alternate Text for Visual:

In this proposal we ask 1) Which prairie mixes best reduce nitrate leaching in sandy soils? 2) Which prairie mixes perform when under high N or changing rainfall?

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

PROJECT TITLE: Identifying prairie mixes to reduce nitrate pollution

I. PROJECT STATEMENT

Knowing which mixtures of prairie plants perform best, under varying climatic conditions, to remove nitrates in vulnerable sandy soils would contribute to the quality of Minnesota's waters. We have the opportunity to test for nitrate removal from an established prairie plant diversity experiment where rainfall will have been altered for three years at the start of this LCCMR project. Because we leverage an existing experiment, we will be able to make recommendations to land mangers quickly as a result of this project.

Sandy and degraded soils are widespread throughout the state. Indeed, several of Minnesota's wellhead protection areas, high in nitrate levels, are in regions with sandy soils. The Minnesota Department of Agriculture (MDA) has recognized that even improved fertilizer recommendations may not be adequate to cope with the problem of nitrate leaching in sandy soils, and that alternative practices such as cover crops or other plantings may be needed (MDA nitrate report, 2016). Native prairie plantings in some areas may be a multi-benefit solution. They are deeply rooted, and adapted to effectively take up nitrate into vegetation or soils, while adding valuable habitat for pollinators, deer, pheasants, song birds and other wildlife. Knowing the best prairie plant mixtures to remove nitrate in vulnerable sandy soils would contribute to these efforts through development of best management practices for buffer strips or saturated buffers created by farmers, land managers, and state agencies. Additionally, it is important to understand which prairie plant mixes perform well under conditions of altered rainfall patterns or high nitrogen inputs. Environmental fluctuations or high nitrogen loads could alter the functioning of prairies to effectively remove nitrate and prevent it from reaching waterways, and selecting plant mixtures that can withstand these fluctuations would be of great value.

We have a unique opportunity to study nitrogen uptake by plants and soils across a series of established long term prairie plots, with additional rainfall and nitrogen addition experiments, located at the Cedar Creek Ecosystem Science Reserve (CCESR), situated in the Anoka sand plain. These plots were first planted in 1994 and continue to be maintained with different plant species mixtures and diversity levels, including more than one dozen single plant species reference plots. Within species mixture plots, a rainfall manipulation experiment was implemented in 2017 with roofs placed over a portion of each plot to simulate a 100-year drought. Infrastructure control plots are in place as well. The two mixtures with the highest number of species, expected to best function for nitrate removal, also have added experimental treatments of 50% added rainfall, increased nitrogen addition, or both. In total, we can leverage 238 experimental plots with which to collect robust data on nitrate conservation by prairies. We can leverage a significant investment of infrastructure and personnel in place to maintain species mixture plots, nitrogen addition treatments, rain exclusion shelters, and data collection instruments (an investment of $60,900). We have collected three years of baseline data, and funds proposed here will provide opportunity to understand implications for nitrate removal. Samples will continue to be collected in 2019 and will be archived for possible processing if funds become available. Because these plots will have been established for more than two decades, we will be able to provide concrete management recommendations regarding species mixtures that can effectively remove nitrate under different nitrogen loads or climatic conditions. Because the CCESR is in the groundwater recharge zone for the Twin Cities, this is an ideal site for considering nitrate mitigation from the water source of many Minnesotans.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Determine the nitrate removal potential by different prairie species mixtures, with or without changes in rainfall or added nitrogen **ENRTF BUDGET: $199,917**

We will measure leachable nitrate levels three times per year through collection into resin bags newly installed as an added value to the existing data collection efforts. To understand how nitrate is taken up by plants we will measure plant root and shoot growth as well as estimated cover of each plant species. To understand how

nitrate leaching relates to the soil nitrogen pool and to the microbial mediators of nitrogen removal, we will measure soil total and extractable, available nitrogen (nitrate and ammonium), soil moisture, and soil microbial activity throughout each of the two growing seasons. This comprehensive sampling and analysis effort in 238 experimental plots, over two years, will provide valuable training and education in applied ecological research for one postdoctoral researcher. We also provide research opportunities for young students considering careers in science or land management. Our project will contribute to the development of best management practices for mitigating nitrate leaching in vulnerable sandy soils through identification seed mixes that best perform to remove nitrate from groundwater sources across a range of climatic conditions. We will communicate with the scientific community through peer-reviewed publications. We will produce reports for interested stakeholders including farmers, land managers, and state and federal government and agencies.

Outcomes	Completion Date
1. Collect and analyze plant samples over 2 growing seasons	December 31, 2021
2. Collect and analyze soil, and nutrient samples over 2 growing seasons	December 31st 2021
3. Statistical analysis of data to determine treatment effects	March 31st 2021
4. Write and deliver reports to state agencies such as BWSR and MDA, and any interested legislators, detailing the effectiveness of each prairie mixture on nitrate leaching across environmental conditions.	June 30 2022

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Dr. Jessica Gutknecht	Assistant Professor	University of Minnesota, Twin-Cities	Project Manager
Cristina Portales Reyes	PhD Candidate	University of Minnesota, Twin-Cities	Co-Manager

B. Partners NOT receiving ENRTF funding:

Name	Title	Affiliation	Role
Dr. Forest Isbell	Assistant Professor	University of Minnesota, Twin-Cities	Co-Manager

Gutknecht and Reyes will oversee and participate in all project activities and ensure the success of each outcome. Isbell will oversee plot maintenance and CCESR support.

IV. LONG-TERM- IMPLEMENTATION AND FUNDING:

We anticipate the project to conclude in the fall of 2021 and do not plan to extend it beyond this date. During the project period, partners will maintain the infrastructure with a minimum total investment of 5% replacement or repair per year (approximately $2,500 labor and supplies). Costs for rainfall shelters, maintenance, nitrogen addition treatments, and plot management will be covered by co-manager Isbell. Based on outputs from this two year project, we will also be able to seek external funding for understanding longer term patterns of nitrate removal from sandy soils. For example, co-manager Isbell has applied for National Science Foundation funds to continue providing infrastructure costs into the future of this project.

V. TIME LINE REQUIREMENTS:

We propose a start date of July 1, 2020. We will sample field plots in summer of 2019 and 2020, and request funding for two full years of personnel, July 1 2020- June 30 2022, to allow for sample processing, data analysis, and reporting. We expect that all reports will be delivered by June 30, 2022. We are dedicated to additional ongoing dialogue to make our results as useful as possible to any interested party.

Attachment A: Project Budget Spreadsheet Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet Legal Citation:
Project Manager: Jessica Gutknecht
Project Title: Identifying prairie mixes to reduce pollution Organization: Regents of the University of Minnesota
Project Budget: $199,917
Project Length and Completion Date: 07/01/2020-06/30/2022
Today's Date: Monday, April 15th, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	**$ 182,898**	$ -	$ -
Summer field technicians: technicians will perform plant, soil, and resin bag sampling for all 238 plots . $12/hr, 67 day temp/casual appointment 100% time, 3 technicians per year for two years. 93% of cost is salary, 7% is benefits (FTE 1.0 for 67 days).	$ 38,592	*Leave Blank*	*Leave Blank*
Undergraduate hourly employment: hourly students will process soil and plant samples for all 238 plots. $12/hour, 15 hrs/week, (37.5% time), 9 mo (36 wk) academic year, 1 student per year for two years. 100% salary, 0% benefits for UMN undergraduate students (FTE 0.375).	$ 12,960	*Leave Blank*	*Leave Blank*
Technician (Carol Loopstra, Gutknecht lab): technician will overse sample processing and will run lab equipment. Technician will also assist with summer field work when needed. 6.25% of employment (2.5 hrs/wk on this project), 2% raise per year. 1 technician per each of 2 full calendar years (52 wks). 75% of cost is salary, 25% is benefits (FTE 0.0625).	$ 8,314		
Post-Doctoral Associate (Cristina Portales Reyes): will coordinate all activities with Gutknecht and Isbell, will oversee hourly workers, and will assist with all project activities. $49,000 salary/year plus 21.4% fringe. 24 months of 1 post-doctoral associate at 100% time, with a 2% raise in year 2. 82% of cost is salary 18% of cost is benefits (FTE 1.0)	$ 123,032	*Leave Blank*	*Leave Blank*
Travel expenses in Minnesota	**$ 835**		
Travel to field sites ($0.58/mile x 60 miles round trip x 12 trips per ear, x 2 years): Travel between UMN St. Paul campus and Cedar Creek Ecosystem Science reserve for field work, field sampling, and sample transfer, per UMN policy.	$ 835		
Other			
Laboratory consumables (price per sample x 238 plots x 2 years)	**$ 16,184**		
Microbial decomposition enzyme activity assay; $5/sample x 1 sample/yr = $5 sample/yr.	$ 2,380	$ -	$ -
Resin bag materials; $5/sample, 3 samples/yr = $15 sample/yr	$ 7,140		
Colormetirc nitrate analysis assay, $2/sample x 3 samples/yr = $6 sample/yr	$ 2,856		
C:N analysis consumables, $4/sample, 1 sample/yr each for soil and plants = $8 sample/yr	$ 3,808		
COLUMN TOTAL	**$ 199,917**	$ -	$ -

SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status	Amount	Spent	Balance
Non-State:				
		$	$ -	$ -
State:				
		$	$ -	$ -
In kind:				
Gutknecht salary match, 1% salary & fringe/year	secured	$ 2,292	$ -	$ -
UMN overhead (54%)	secured	$ 106,729		
	Amount legally	**Budget**	**Spent**	**Balance**
	$	$	$ -	$ -
NA	$	$	$ -	$ -

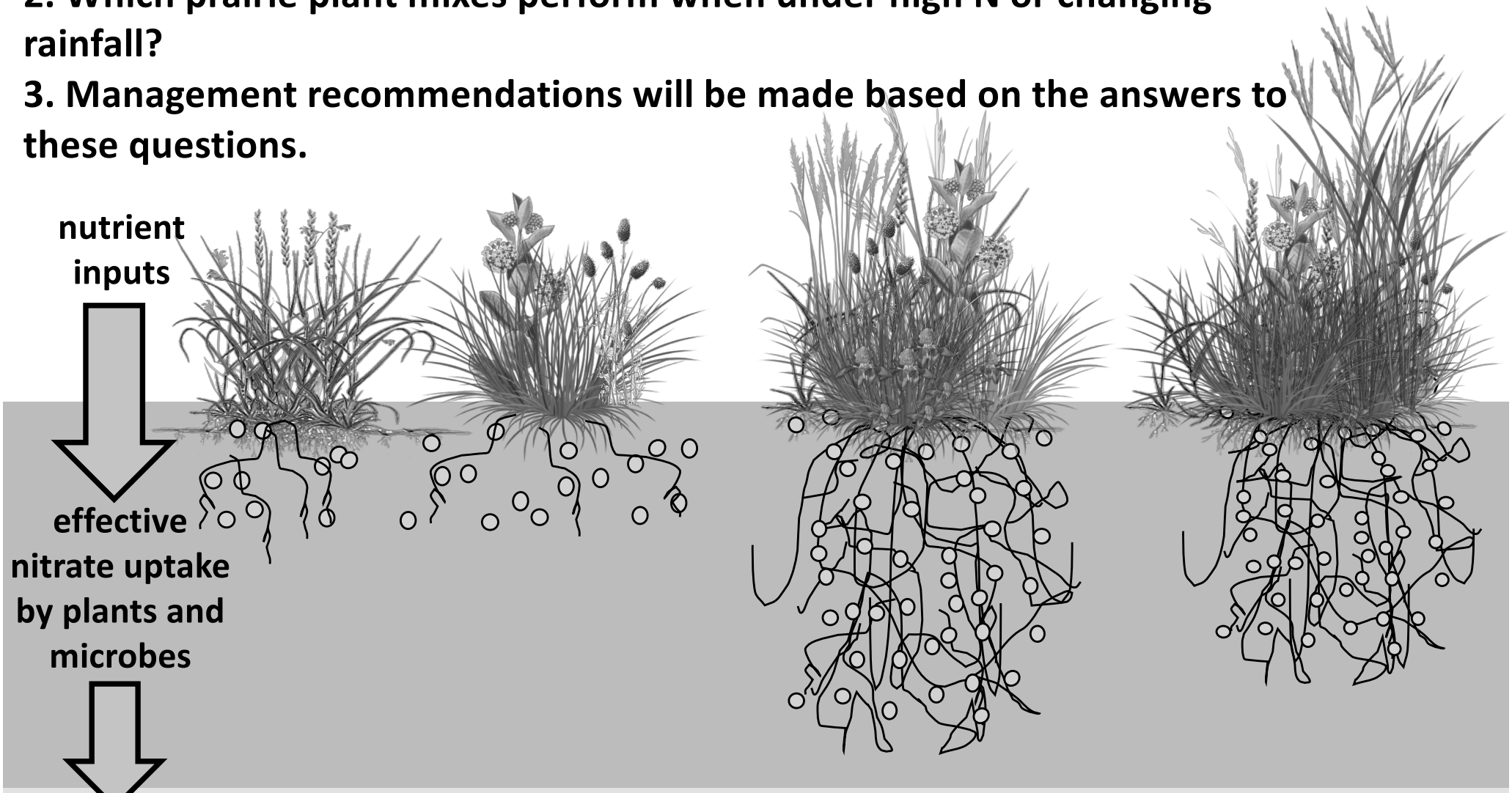
B. Visual Component, “Identifying prairie mixes to reduce nitrate pollution”

Project Manager: J. Gutknecht

1. Which prairie plant mixes best reduce nitrate leaching in sandy soils?

2. Which prairie plant mixes perform when under high N or changing rainfall?

3. Management recommendations will be made based on the answers to these questions.



F. Project Manager Qualifications and Organization Description

Dr. Jessica Gutknecht, "Identifying grassland plant mixes to reduce nitrate pollution"

Professional Experience

- University of Minnesota, Twin Cities, St. Paul, MN; Assistant Professor, Department of Soil, Water, and Climate (2014-present); responsible for leading an extramurally-funded research program in soil nutrient cycling and ecology, teaching undergraduate and graduate courses, advising graduate students.
- Helmholtz Centre for Environmental Research-UFZ, Halle, DE; Senior Scientist Department of Soil Ecology (2009-2013); responsible for leading an extramurally and intramurally funded departmental working group on microbial functional ecology, teaching undergraduate practical courses, and advising graduate students.
- University of California-Santa Cruz, Santa Cruz, CA; Postdoctoral Research Associate, Department of Environmental Science; (2008-2009)

Education

- University of Wisconsin-Madison, Madison, WI; Ph.D., Soil Science; (2004-2007)
- University of Wisconsin-Madison, Madison, WI; M.S., Soil Science; (2001-2003)
- Oregon State University, Corvallis, OR; B.S., Microbiology/cert. applied ethics; (1996-2000)

Research focus

I am a soil ecologist, and I use knowledge about soils and soil nutrient cycling to explore how our decisions about land management can lead to improved outcomes both for people and the environment, especially in the context of fluctuating climatic conditions. I am interested in facilitating collaborative groups to achieve integrated, high impact outcomes. As part of my focus on land management and water quality, I am actively involved in two complementary LCCMR projects: Assessing Release of Mercury and Sulfur on Aquatic Communities (Nater): ML2017, chp.96, sec.2, subd. 04i; and Preventing Nitrate Contamination of Groundwater Using Perennial Grains (Wagner): ML2018, chp.214, art. 4, sec.2, 04j.

Relevant Publications

Docherty, K. and **J. Gutknecht.** 2019. Microbial community structure alters the resilience of restored prairies to climate change. Ecological Applications. In press.

Schmidt, J., Fester, T., Schulz, E., Michalzik, B., Buscot, F., and **Gutknecht, J.L.M.** (2017) Effects of plant-symbiotic relationships on the living soil microbial community and microbial necromass in a long-term agro-ecosystem. Science of the Total Environment. 581-582: 756-765.

Liang, C., **Gutknecht, J.L.M**, and Balser, T.C. (2015) Microbial lipid and amino sugar responses to long-term simulated global environmental changes in a California annual grassland. Frontiers in Microbiology 6: 385.

Docherty, K.M, Bartling, J.M., Borton, H.A., Espinosa, N., Frost, G., Gebhardt, M., Gil-Loaiza, J., **Gutknecht, J.L.M.**, Maes, P., Mott, B., Parnell, J., Rodrigues, P., Walser, O., Gallery, R.E. (2015) Variation of soil microbial communities within the National Ecological Observatory Network. PLoS One. journal.pone.0135352

Organization description

Jessica is active in research and graduate and undergraduate education at the University of Minnesota and is an associate fellow with the UMN Institute on the Environment. The University of Minnesota is a hub for education and research in Minnesota, and entities within it such as the Institute for the Environment are dedicated to "a future in which people and the environment prosper together". UMN is also a land grant university, the land grant mission being to provide open state education. Dr. Gutknecht is dedicated to these missions and will target any work with LCCMR with this in mind.