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

Project Title: **ENRTF ID: 107-BH**

Identifying Grassland Plant Mixes to Reduce Nitrate Pollution

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

Sub-Category: B. Water Resources

Total Project Budget: $ 197646

Proposed Project Time Period for the Funding Requested: June 30, 2021 (2 yrs)

Summary:

We contribute to Minnesota's land management efforts by identifying which mixtures of grassland plant species best remove nitrates in vulnerable soils, using a series of long term species mixture plots.

Name: Jessica Gutknecht

Sponsoring Organization: U of MN

Title: Assistant Professor

Department: Department of Soil, Water, and Climate

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Location

Region: Statewide, Central

County Name: Statewide

City / Township:

Alternate Text for Visual:

In this proposal we ask 1) Which grass plant mixes best reduce nitrate leaching in sandy soils? 2) Which plant 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	_____%
____ If under $200,000, waive presentation?			

PROJECT TITLE: Identifying grassland plant mixes to reduce nitrate pollution

I. PROJECT STATEMENT

Knowing which mixtures of grassland species perform best to remove nitrates in vulnerable sandy soils would contribute to the quality of Minnesota's waters. 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. Native grassland communities are deeply rooted, and adapted to effectively take up nitrates into plant biomass or soils, while adding valuable habitat for pollinators and other species.

To address the issue of nitrate pollution, the Minnesota Department of Agriculture (MDA) has recommended vegetative cover near water ways (MDA nitrate report, 2016). The Board of Water and Soil Resources (BWSR) is implementing the State's riparian protection and water quality practices law. Knowing the best plant species 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 grassland 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 these grasslands 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 the opportunity to study nitrogen uptake by plants and soils across a series of established long term species mixture plots and 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 have 238 experimental plots, with treatments already established, from which we can sample to test for nitrate removal performance. Because these plots will have been established for more than two decades at the beginning of this project, our effort will provide valuable information about the long term functioning of these different species mixtures under different conditions. Furthermore, because the CCESR is in the groundwater recharge zone for the Twin Cities, this is an ideal site for considering how different plant species mixtures may help supply many Minnesotans with clean water.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Determine the nitrate removal potential by different grassland species mixtures, with or without changes in rainfall or added nitrogen **ENRTF BUDGET: $197,646**

Three times per growing season, we will measure leachable nitrate levels through collection into resin bags. To understand how nitrate is taken up by plants and soils, we will also measure plant root and shoot growth and nitrogen uptake, and will also measure soil microbial activity, and soil total nitrogen and carbon. From each plot, we will estimate percent cover of each plant species and take representative samples once per year in summer of 2019 and 2020 for measuring nitrogen content. Percent species cover, with analysis of single species plots, will inform us about how individual species contribute to the functioning of each mixture. In soil, we will measure microbial decomposition enzyme activity and soil carbon and nitrogen levels once per year at the same time as plant sampling. We will also measure soil nitrate levels in soil solution and soil moisture levels throughout the growing season. 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. The Board of Water and Soil Resources (BWSR) supports this project and has stated that it will be very beneficial (personal communication).

Outcomes	Completion Date
1. Collect and analyze plant samples over 2 growing seasons	December 31, 2020
2. Collect and analyze soil, and nutrient samples over 2 growing seasons	December 31st 2020
3. Statistical analysis of data to determine treatment effects	March 31st 2021
4. Write reports and disseminate information to collaborators and state agencies	June 31st 2021

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 2020 and do not plan to extend it beyond this date. This project will 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 needed for manipulating rainfall (an investment of $60,900). We have collected two years of baseline data, and funds proposed here will provide opportunity to understand implications for nitrate removal. Samples will continue to be collected in 2018 and will be archived for possible processing if funds become available. 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, and funding requested here will better position us to continue seeking additional funds to expand this project in the future.

Our project will contribute to the identification of best management practices, and which seed mixes, will best perform to remove nitrate from groundwater sources in sandy soils. We will communicate our findings with the broad scientific community through peer-reviewed publications. We will produce reports for interested stakeholders including farmers, land managers, and state and federal government and agencies.

V. TIME LINE REQUIREMENTS:

We propose a start date of July 1, 2019. We will sample field plots in summer of 2019 and 2020, and request funding for two full years of personnel, July 1 2019- June 30 2021, to allow for sample processing, data analysis, and reporting.

2019 Proposal Budget Spreadsheet

Project Title: Identifying grassland plant mixes to reduce nitrate pollution

IV. TOTAL ENRTF REQUEST BUDGET 2 years

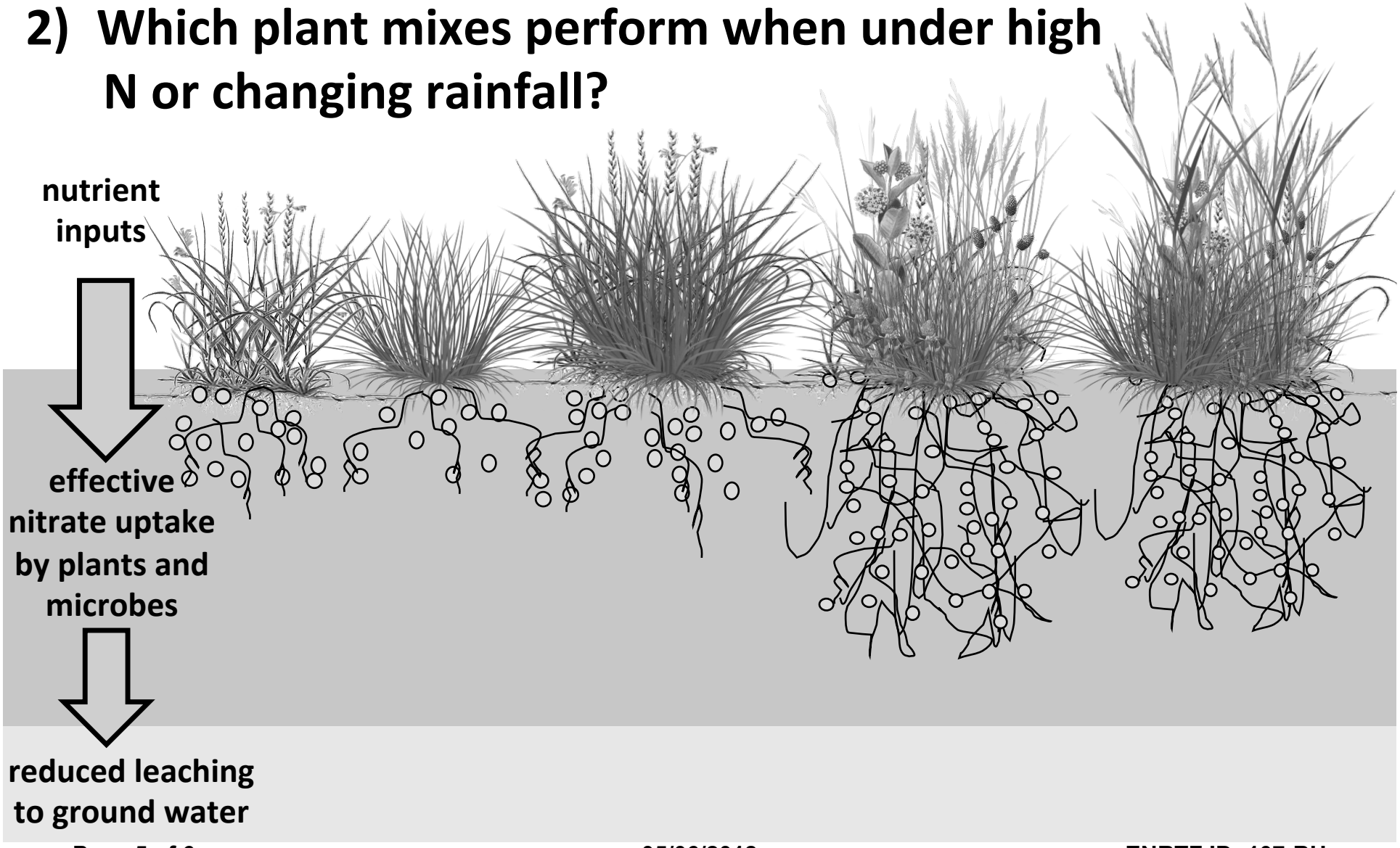
BUDGET ITEM	AMOUNT
Personnel:	**$ 180,598.00**
Summer field technicians: technicians will perform plant, soil, and resin bag sampling for all 238 plots	$ 55,418.00
$12/hr, 67 day temp/casual appointment 100% time, 4 technicians per year for two years	
93% of cost is salary, 7% is benefits	
Undergraduate hourly employment: hourly students will process soil and plant samples for all 238 plots	$ 25,920.00
$12/hour, 15 hrs/wk, (37.5% time), 9 mo (36 wk) academic year, 2 students per year for two years	
100% salary, 0% benefits for UMN undergraduate students	
Technician (Carol Loopstra, Gutknecht laboratory): technician will oversee sample processing and will run lab equipment. Technician will also assist with summer field work when needed	$ 8,004.00
$22.83/hr, 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	
Post-Doctoral Associate (Christina Portales Reyes): will coordinate all activities with Gutknecht and Isbell, will oversee hourly workers, and will assist with all project activities	$ 91,256.00
$47,476 salary/year plus 21.4% fringe	
19 months of 1 post-doctoral associate at 100% time, as Christina has funding for the first 5 months of this project	
82% of cost is salary, 18% of cost is benefits	
Supplies	**$ 16,184.00**
Laboratory Consumables (price per sample x 238 plots x 2 yrs):	
Microbial decomposition enzyme activity assay; $5/sample x 1 sample/yr = $5/sample/yr	2380
Resin bag materials; $5/sample, 3 samples/yr = $15/sample/yr	7140
Colormetric nitrate analysis assay, $2/sample x 3 samples/yr = $6/sample/yr	2856
C:N analysis consumables, $4/sample, 1 sample/yr each for soil and plants = $8/sample/yr	3808
Travel	**864**
Travel to field sites ($0.6/ mile x 60 miles round trip x 12 trips per year, x 2 years): Travel between UMN St. Paul campus and Cedar Creek Ecosystem Science reserve for field work, field sampling, and sample transfer	864
TOTAL ENVIRONMENT AND NATURAL RESOURCE FUND $ REQUEST=	**$ 197,646.00**

IV. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To be Applied to Project During Project Period		
NA	N/A	N/A
Other State $ To be Applied to Project During Project Period		
N/A	N/A	N/A
In-Kind Services To Be Applied To Project During Project Period		
Gutknecht salary match, 1% salary & fringe/year	$ 2,292.00	secured
UMN overhead (54%)	$ 106,729.00	secured
Past and Current ENRTF Appropriation		
Assessing Release of Mercury and Sulfur on Aquatic Communities (Nater)	$ 300,000.00	Legally Obligated
Preventing Nitrate Contamination of Groundwater Using Perennial Grains (Wagner)	$ 250,000.00	Pending
Other Funding History		
None	N/A	N/A

B. Visual Component, "Identifying grassland plant mixes to reduce nitrate pollution"

1) **Which grass plant mixes best reduce nitrate leaching in sandy soils?**
2) **Which plant mixes perform when under high N or changing rainfall?**



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 informally 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 have formal training in microbiology and in soil science, and use the expertise of these fields to ask how information such as soil carbon and nitrogen levels, and soil nutrient cycling, can inform our knowledge about land management in the context of fluctuating environmental conditions. In addition to my personal expertise, I am interested in facilitating collaborative groups that can achieve integrated, high impact outcomes.

Relevant Publications

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

Zhang, N., Wan, S., Guo, J., Han, G., **Gutknecht, J.L.M.**, Schmid, B., Yu, L., Liu, W., Bi, J., Wang, Z., and Ma, K (2015) Precipitation modifies the effects of warming and nitrogen addition on soil microbial communities in northern Chinese grasslands. Soil Biology and Biochemistry. 89: 12-23.

Organization description

Jessica is active in research and graduate and undergraduate education at the University of Minnesota and is a 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.