**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**

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| --- | --- |
| **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.

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| **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**

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| --- | --- | --- | --- |
| **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.