

Environment and Natural Resources Trust Fund

M.L. 2021 Approved Work Plan

General Information

ID Number: 2021-278 Staff Lead: Corrie Layfield Date this document submitted to LCCMR: July 21, 2021 Project Title: Exploring Minnesota's Wetlands: Our Resource For Future Medicine Project Budget: \$210,000

Project Manager Information

Name: Brian Dingmann Organization: U of MN - Crookston Office Telephone: (218) 280-6898 Email: dingm021@crk.umn.edu Web Address: https://www.crk.umn.edu/

Project Reporting

Date Work Plan Approved by LCCMR: July 20, 2021

Reporting Schedule: November 1 / May 1 of each year.

Project Completion: June 30, 2024

Final Report Due Date: August 14, 2024

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 03k

Appropriation Language: \$210,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota, Crookston, to work with White Earth Tribal and Community College to catalog bog microbe diversity in Minnesota's ecoregions, test for potential antibiotic-producing microorganisms, and establish methods to enhance any antibiotic cultures discovered.

Appropriation End Date: June 30, 2024

Narrative

Project Summary: Our Minnesota bogs are an essential resource. As we investigate inter-bog microbial diversity in these critical habitats, we could find the next antibacterial, antifungal, or antiviral medicinal product.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Our Minnesota bogs are unique and vital wetland resources because they are the most carbon-dense ecosystems on the planet. Bogs are an essential carbon sink since carbon is bound and sequestered in the peat layer. Microorganisms play an indispensable role in bog habitat geochemical cycling, and preparing sequencing libraries of the microbial communities from Minnesota's mid-latitude bogs would allow future studies to better analyze microbial structure and diversity. We will measure inter-bog functional community structure and diversity in this preliminary study.

Additionally, the University of Minnesota Crookston (UMC) and White Earth Tribal and Community College (WETCC) students participate in Tiny Earth. This antibiotic discovery initiative utilizes techniques to investigate various soils for potential antibiotic-producing microorganisms. Due to increased antibiotic resistance, there is a great need to discover and develop new antimicrobials. To our knowledge, the microbial communities of Minnesota's bogs have not been mined for potential antibiotic producers.

This project provides enriched educational opportunities for underrepresented students in Minnesota. Student learner outcomes will assess students' perceptions of science and gauge their understanding of the "nature of science." Through this process, this study would contribute to the overall understanding of Minnesota's peatlands.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

Almost all of our new antibiotics are remakes or variants on existing antibiotic architecture. For pharmaceutical companies, it is easier and more profitable to use existing antibiotic frameworks to design drugs instead of searching for novel antibiotics in nature. The need for new antimicrobials is self-evident in this time of growing antibiotic resistance. The Tiny Earth Studentsourcing Antibiotic Discovery project has standardized the methodology to isolate and characterize soil bacteria. By training undergraduates from two institutions, we would have a small army of investigators searching for antibiotic-producing bacteria in bogs. We hypothesize our Minnesota bogs contain a potentially unexploited reservoir of these bacteria. Specifically, the bogs are inhabited by the Actinomycetes bacterial group that has shown to provide antibacterial, antifungal, and antiviral medicinal natural products. Faculty and undergraduate students working on this project will develop sustainable protocols which characterize the microbial community functionality and diversity within bogs. Additionally, bacteria capable of producing novel antimicrobials will be targeted.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

The project would catalog the bog microbial functional diversity and community structure in Minnesota's ten ecoregions. The database/protocols will be widely disseminated to stakeholders for best management practices.

Enhancement sampling for the Actinomycetes bacterial group would lead to potential new sources for antimicrobials. These types of efforts are crucial for the health and wellbeing of not only Minnesotans but society in general.

The University of Minnesota Crookston and White Earth Tribal and Community College undergraduates will be trained in molecular and microbiological techniques for future careers in health and conservation (e.g., DNR, USDA, MPCA, and graduate schools).

Project Location

What is the best scale for describing where your work will take place? Statewide

What is the best scale to describe the area impacted by your work? Statewide

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Characterize the microbial community's ability to produce potential antimicrobials

Activity Budget: \$87,156

Activity Description:

The crisis of antibiotic resistance provides an immediate and critical need for new and novel antimicrobials. Natural products, such as secondary metabolites produced from microorganisms, constitute the majority of our antibiotics. The Tiny Earth, Studentsourcing Antibiotic Discovery project has standardized the methodology to isolate and characterize potential producers of antimicrobial bacteria. After isolation and purification of soil bacteria, we will conduct competition experiments against the so-called safe pathogens to identify likely antibiotic-producing cultures. Subsequently, chemical extraction/fractionation would lead to the identification of antimicrobial compounds. Faculty and undergraduate students at UMC and WETCC will employ both molecular techniques and microbiological methods to identify and selectively enhance the culture of Actinobacteria. This group of bacteria is known to exist in bogs and has demonstrated the ability to produce antibacterial, antifungal, and antiviral products. Molecular techniques will identify Actinobacteria genes that are responsible for the production of potential antibiotics. Additionally, we will establish empirically derived methods to enhance the cultures of these antibiotic-producing bacteria since most soil bacteria cannot usually be cultured. Aspects of this activity will be incorporated into suitable courses at UMC and WETCC. Ultimately, the result of this activity will produce "leads" for further antimicrobial processing.

Activity Milestones:

| Description | Completion Date |
|---|------------------|
| Field sampling: 2 summers of bog sampling with 4-5 students from UMC and WETCC | August 31, 2022 |
| Protocol development (e.g., sampling, safety, molecular and microbiology, etc.) in lab meetings and | October 31, 2022 |
| mentoring | |
| Microbiological and molecular techniques: 4-5 students each summer from UMC and WETCC); UMC | January 31, 2024 |
| microbiology. | |
| Chemical Analysis: summer (4-5 students from UMC and WETCC), microbiology class | January 31, 2024 |

Activity 2: Characterize the microbial community functionality and diversity in bogs

Activity Budget: \$122,844

Activity Description:

Bogs are found in all ten ecoregions of the state and are an essential carbon sink for global carbon cycling. Conservation and preservation of our Minnesota peatlands are critical as carbon dioxide levels continue to rise worldwide. The importance of wetlands in geochemical cycling and specifically the microbial community in these processes is well established. The proposed research investigates the microbial functional diversity and community structure within our Minnesota bogs. Using commercially available kits, faculty and undergraduates will analyze the diversity of the microbial community between bogs (inter-bog diversity). To facilitate a more efficient and effective understanding of our wetlands/bogs, we propose to establish a microbial diversity database that may be used in future assessment and best management practices by stakeholders. The databases and associated protocols would be widely disseminated to the various stakeholders (e.g., DNR, MPCA, etc.). Aspects of this activity will be incorporated into suitable courses at UMC and WETCC. Students engaged in this work will be well prepared for required internships and future employment. Ultimately, this activity will result in a sequencing library for further data "mining" regarding bog microbial diversity.

Activity Milestones:

Description

| Protocol development and review: summer undergrads (4-5 students from UMC and WETCC), | December 31, 2022 |
|--|-------------------|
| microbiology class | |
| Statistical Analysis: Summer (4-5 students from UMC and WETCC), descriptive and application statistics | August 31, 2023 |
| Scientific writing: Summer (4-5 students from UMC and WETCC); LCCMR documentation and | June 30, 2024 |
| publication | |

Project Partners and Collaborators

| Name | Organization | Role | Receiving Funds |
|--------------------|---|---|--------------------|
| Lorna Lague | White Earth Tribal and Community College | President of White Earth Tribal and Community College | No |
| Karl Anderson | University of Minnesota Crookston | Co-PI: managing students; microbiological and molecular technique guidance. | Yes |
| Venugopal Mukku | University of Minnesota Crookston | Co-PI: managing students; chemical extraction and fractionation guidance. | Yes |

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines. The results of the work outlined in this proposal will be disseminated in a number of formats and venues. Since undergraduate students will be heavily involved in this work, they will be presenting their results via poster and oral presentations at any number of local, regional, and national conferences and symposia. UM Crookston (UMC) hosts an undergraduate research day each year in which students discuss the research projects they work on to their peers and other faculty. WETCC will also be holding student research presentations. Students from UMC have regularly presented their research findings at both regional and national meetings (e.g., American Society for Microbiology, American Chemical Society, National Council of Undergraduate Research). At White Earth Tribal and Community College (WETCC), we hope to encourage similar presentations, however, students specifically plan to present their findings at the Annual Biomedical Research Conference for Minority Students. Similarly, UMC and WETCC faculty have been presenting at many of these and other conferences (e.g., American Society for Microbiology, Society of Environmental Toxicology and Chemistry). We plan to continue our attendance at these conferences in order to disseminate our findings for this project.

We also anticipate disseminating our results to various state agencies (e.g., DNR, MPCA) that may be interested in our work. Besides dissemination of results, we also anticipate informing the public of our work on this project through various media outlets. The Mahnomen Pioneer and Anishinaabeg Today and KROXAM and Crookston Times will be will be great outlets for WETCC and UM Crookston, respectively. As land-grant institutions, UMC and WETCC are obligated to engage in public outreach and education, thus we expect that this project will be utilized by our institution to achieve its land-grant mission.

While the scientific merit of this project has been thoroughly outlined, the educational impact of this work is just as important to UMC, WETCC, and our students. Having students engaged in meaningful research is known to help in student retention at both the academic institution and in STEM fields. Thus, we plan on incorporating this project into a number of our biology and chemistry courses to give as many of our students as possible the opportunity to engage in original research. We have already started this process by incorporating some of the concepts/methods outlined in this project into our general microbiology courses, as a way to introduced students to research-based methods in microbial sciences. One of our larger goals is to expose all of our students majoring in biological sciences to some original research with the hopes that a few of them will engage in more involved research projects and potentially related academic and/or career paths.

As a requirement of funding, we will acknowledge the Environment and Natural Resources Trust Fund through use of

the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENTRF Acknowledgment Guidelines.

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

We have used most of the techniques for several years in our teaching laboratories at the University of Minnesota Crookston and have the existing infrastructure to train the undergraduates as mentioned in this proposal. The proposed database and baseline data sets will be widely disseminated to the appropriate entities (e.g., DNR, MPCA, etc.). Once sampling and data analysis protocols are established the biomonitoring can be incorporated into existing citizen scientist resource management programs. If we find some promising or at least interesting leads for antibacterial, antifungal, or antiviral medicinal natural products we will aggressively seek additional funding opportunities.

Budget Summary

| Category / Name | Subcategory or Type | Description | Purpose | Gen. Ineli gible | % Bene fits | # FTE | Class ified Staff? | \$ Amount |
|--------------------------------------|------------------------|---|--|------------------------|-------------------|----------|--------------------------|-----------|
| Personnel | | | | | | | | |
| Undergraduate Researchers | | Undergraduate research; 4-5 students per summer from UMC and WETCC hired by UMC | | | 8% | 0.39 | | \$88,290 |
| co-Pl | | Venugopal Mukku (UMC research collaborator) | | | 36.5% | 0.26 | | \$11,484 |
| co-Pl | | Karl Anderson (UMC research collaborator) | | | 36.5% | 0.39 | | \$12,700 |
| Project Manager/PI | | Brian Dingmann (project manager) | | | 36.5% | 0.39 | | \$19,200 |
| | | | | | | | Sub Total | \$131,674 |
| Contracts and Services | | | | | | | | |
| | | | | | | | Sub Total | - |
| Equipment, Tools, and Supplies | | | | | | | | |
| | Tools and Supplies | Chemical reagents | Various chemical reagents will be used that are considered general chemical consumables. | | | | | \$3,000 |
| | Tools and Supplies | Chemical extraction | Extraction, and fractionation is necessary to identify potential antimicrobial products from the bog microbes. | | | | | \$12,000 |
| | Tools and Supplies | DNA sequencing lab supplies | DNA sequencing is necessary to identify microbial strains in the bog environment. | | | | | \$8,000 |
| | Tools and Supplies | Microbiolgical lab supplies | Microbiolgical culturing and manipulating soil microbes. | | | | | \$12,200 |
| | Tools and Supplies | QPCR on 200 samples | To analyze and quantify the microbial community structure and function we will investigate 200 samples across the state. | | | | | \$17,000 |
| | Tools and Supplies | General use Polymerase Chain Reaction (PCR) reagents | To analyze micobial structure and function we will investigate 200 samples across the state. General PCR | | | | | \$15,000 |

| | | | will allow us to gauge structure and | | | |
|----------------|---------------|--|---------------------------------------|------|----------|------------------|
| | | | funtion to focus research. | | | |
| | Tools and | BIOLOG Lab supplies | activity one: microbial diversity and | | | \$2,000 |
| | Supplies | | functional analysis | | | . , |
| | | | | | Sub | \$69,200 |
| | | | | | Total | <i>\$05)</i> 200 |
| Canital | | | | | Total | |
| Capital | | | | | | |
| Expenditures | | | | | Curk | |
| | | | | | Sub | - |
| | | | | | Total | |
| Acquisitions | | | | | | |
| and | | | | | | |
| Stewardship | | | | | | |
| | | | | | Sub | - |
| | | | | | Total | |
| Travel In | | | | | | |
| Minnesota | | | | | | |
| | Miles/ Meals/ | Travel to sample bogs with no overnight stays. Bog | Travel (\$0.575 per mile of travel, | | | \$8,626 |
| | Lodging | sampling will require 2 summers with the bog | 14.989 miles sampling around state) | | | . , |
| | | sampling "clustered" to reduce travel/trips. | ,,,,,,,,-,,-,,-,,-, | | | |
| | | | | | Sub | \$8.626 |
| | | | | | Total | <i>40,020</i> |
| Traval Outsida | | | | | Total | |
| Minnesete | | | | | | |
| winnesota | | | | | <u> </u> | |
| | | | | | | - |
| | - | | | | Total | |
| Printing and | | | | | | |
| Publication | | | | | | |
| | Printing | Printing at UMC and WETCC for students and | There will be required printing for | | | \$500 |
| | | dissemination student posters to promote project. | internal use by students and when we | | | |
| | | | want to promote our project to the | | | |
| | | | public (e.g., student posters, | | | |
| | | | pamphlets,etc.)) | | | |
| | | | | | Sub | \$500 |
| | | | | | Total | |
| Other | | | | | | |
| Expenses | | | | | | |
| | | | | | Sub | _ |
| | | | | | Total | |
| | | | | | Grand | \$210.000 |
| | | | | | Total | \$210,000 |
| | | | | | TULAI | |

8/22/2021 **11**

Classified Staff or Generally Ineligible Expenses

| | Category/Name | Subcategory or Type | Description | Justification Ineligible Expense or Classified Staff Request |
|--|---------------|------------------------|-------------|--|
|--|---------------|------------------------|-------------|--|

Non ENRTF Funds

| Category | Specific Source | Use | Status | Amount |
|-----------|-----------------|-----|-----------|--------|
| State | | | | |
| | | | State Sub | - |
| | | | Total | |
| Non-State | | | | |
| | | | Non State | - |
| | | | Sub Total | |
| | | | Funds | - |
| | | | Total | |

Attachments

Required Attachments

Visual Component File: <u>c032089e-535.pdf</u>

Alternate Text for Visual Component

The attached picture provides an overview of the proposed research. Preserving Minnesota's Wetlands: Our Resource for Future Medicine....

Optional Attachments

Support Letter or Other

| Title | File |
|---|-------------------------|
| White Earth Tribal and Community Support Letter | <u>675a24b5-44d.pdf</u> |
| Exploring Minnesota's Wetlands: Our Resource for Future | <u>1b61d04f-42c.pdf</u> |
| Medicine | |
| Children's Services Background Check Form | <u>9e5f854d-f6e.pdf</u> |

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Faculty salaries were reduced by eliminating two weeks per summer per faculty member. We reduced the number of undergraduates from both UM Crookston and White Earth Tribal and Community College each summer of the grant to lower student salaries. And finally, we reduced the amount of supplies that would correspond to the reduced workload from the faculty and undergraduates. Overall, the budget was reduced by \$37,000 to reflect the recommended grant total of \$210,000.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes? N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan? Yes, I agree to the UMN Policy.

- Does your project have potential for royalties, copyrights, patents, or sale of products and assets? No
- Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10? $$\rm N/A$$
- Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF? N/A
- Does your project include original, hypothesis-driven research? Yes
- Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Preserving Minnesota's Wetlands: Our Resource for Future Medicine

