Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)

Project Title: **ENRTF ID: 009-A**

Promoting Wild Rice Restoration Success by Examining Microbes

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 334,035

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 - June 2020

Summary:

This project will evaluate the microbial communities and nutrients associated with wild rice and competing vegetation, with the goal of promoting restoration success to increase the abundance of wild rice.

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Sponsoring Organization: U of MN - Duluth NRRI

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Location

Region: Northeast

County Name: Carlton, St. Louis

City / Township:

Alternate Text for Visual:

Images show wild rice plants and the root system of wild rice. Soil nutrients and microbial communities will be key determinants in the re-establishment of self-sustaining wild rice populations. Wild rice growth, adaptation and competitive success and above-ground plant community composition and ecology affects and is affected by the soil environment.

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

PROJECT TITLE: Promoting Wild Rice Restoration Success by Evaluating Microbes

I. PROJECT STATEMENT

Wild rice (*Zizania palustris*) is an ecologically and culturally important plant in Minnesota and its state grain. Wild rice was historically abundant in northern Minnesota but its abundance and distribution have been reduced due to environmental contaminants, habitat destruction, physical disturbance, and establishment of competitive or invasive plant species. In recent years, there have been collaborative efforts to restore wild rice wetlands, improving natural habitat of wildlife, reducing competitive or invasive plant cover, and supporting harvest of wild rice. Even with many ongoing restoration efforts, post-restoration monitoring is not common. When such monitoring does occur, the evaluation is mostly based on wild rice results, which may not be sufficient to understand other factors influencing restoration success. **We hypothesize that changes in sediment microbial communities and nutrients in wild rice beds will be key indicators for re-establishment of self-sustaining wild rice in that they are known as primary mediators of plants' growth, adaptation, and competitive success.** Particularly, plant-microbe interactions in the rhizosphere are directly associated with nutrient uptake and disease/stress tolerance, resulting in changes in above-ground plant community composition and ecology. Such associations, which are not well-characterized, can be important to restoration success as well as provide a promising opportunity to develop targeted control of competitive or invasive plants such as pickerel weed, arrowheads, and narrow-leaf cattails.

The overall goal of this project is to promote restoration activities that increase the abundance and distribution self-sustaining wild rice beds by

- Assessing re-establishment of wild rice stand in comparison with competitive or invasive plants species, and
- Evaluating changes in sediment microbial communities and nutrients in wild rice beds.

This project will examine total microbial (both fungal and bacterial) communities and nutrients in the rhizosphere of both wild rice and competitive or invasive plants in well-established wild rice wetlands as well as pre-restoration and post-restoration sites. The results of this work will identify microbial and nutrient associations in self-sustaining wild rice wetlands and apply the information to develop a management strategy to promote restoration success in the St. Louis River Estuary (SLRE) and wild rice lakes in Minnesota.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Collect vegetation data and sediment samples **Budget: $127,304**

Vegetation will be monitored in well-established wild rice wetlands as well as pre-restoration and post-restoration sites of the SLRE and wild rice lake and river habitats in northern Minnesota. Key information will include the density and cover of wild rice and presence of coexisting emergent and submerged plants. Concurrently, sediment samples associated with wild rice and other coexisting plants will be collected from the sites, and indicators of water quality (temperature, turbidity, pH, sulfates, water level, and land use) will be measured. We will select 7-10 sampling sites for three-year observation and sediment sampling. Potential sampling sites include areas with self-sustaining wild rice (such as northwest portions of Rask Bay in SLRE; Kettle Lake in Carlton County, and St. Louis River at Norway Point and/or Skibo landing in St. Louis County) and restoration sites (such as North Bay, south portions of Rask Bay, and Radio Tower Bay in SLRE; and Big Rice Lake in St. Louis County).

Outcome	Completion Date
1. Monitoring and compilation of vegetation data from sampling sites	November 2019
2. Collection of sediment associated with wild rice and other coexisting plants	November 2019
3. Water quality measurement	November 2019
4. Characterize restoration success based on wild rice and vegetation data	March 2020

Activity 2: Identification of microbial communities and nutrient associated with wild rice **Budget: $190,769**

We will characterize total microbial (both fungal and bacterial) communities and the level of nutrients (both macro- and micronutrients) in three fractions: bulk soil, rhizosphere soil, and the rhizoplane fraction of each sample. Total microbial communities of subset samples will be determined using culture-independent methods (16S rDNA- and ITS-based sequencing and real-time PCR) and microscopic analyses (Fluorescence microscopy and scanning electron microscopy). The comparison of rhizosphere microbiome and nutrients between wild rice and competitive or invasive aquatic plants will identify the contribution of plant-microbe interactions to restoration success as well as improve management strategies accordingly.

Outcome	Completion Date
1. Sample processing and DNA extraction	December 2019
2. Identify rhizosphere microbial communities associated with emergent aquatic plants using DNA sequencing	May 2020
3. Determine the level of nutrients and genes relating microbial nutrient cycling	December 2019
4. Correlation analysis of microbial communities/nutrient with restoration success	March 2020

Activity 3: Project data dissemination and public outreach **Budget: $ 15,962**

We will disseminate our results through personal presentations, fact sheets, and papers in the professional publications of organizations like MN Sea grant and the MN DNR. We will develop educational materials and community discussion about wild rice restoration efforts in collaboration with wild rice managers at Fond du Lac Natural Resources, 1854 Treaty Authority, and the Great Lakes Indian Fish and Wildlife Commission

Outcome	Completion Date
1. Development of educational materials and community discussions	April 2020
2. Dissemination of project data and results via seminars and workshops	June 2020

III. PROJECT STRATEGY

A. Project Team/Partners

The project team includes Chan Lan Chun, Randall Hicks, George Host and Carol Reschke at the University of Minnesota Duluth. Chun is an environmental microbiologist and has worked on microorganism-plant interactions. Hicks will provide his expertise on microbial ecology, and Host and Reschke will provide expertise on distribution of wild rice and other emergent plants in SLRE and inland lakes and streams, plant community sampling and analysis. Research partners include managers involved in restoration of wild rice: John Lindgren (MNDNR), Darren Vogt (1854 Treaty Authority), and Tom Howes (Fond du Lac Natural Resources). A letter of support for this project from MNDNR is being sent to the LCCMR.

B. Project Impact and Long-Term Strategy

This project will provide key information on the microbial communities and sediment nutrients associated with wild rice and competitive or invasive emergent plants and may promote restoration success for an increase in abundance and distribution of self-sustaining wild rice in the St. Louis River estuary and other wild rice habitats in Minnesota. Restoration of wild rice wetlands will improve long-term protection of native species and aquatic biodiversity, and support management of culturally and ecologically important natural resources in Minnesota.

C. Timeline Requirements

The project will be completed in 3 years. Three summer field samplings and analyses will allow us to determine the inter-annual variability of microbial communities and nutrients in rhizosphere.

2017 Detailed Project Budget

Project Title: Promoting wild rice restoration success by examining microbes

IV. TOTAL ENRTF REQUEST BUDGET: 3 years

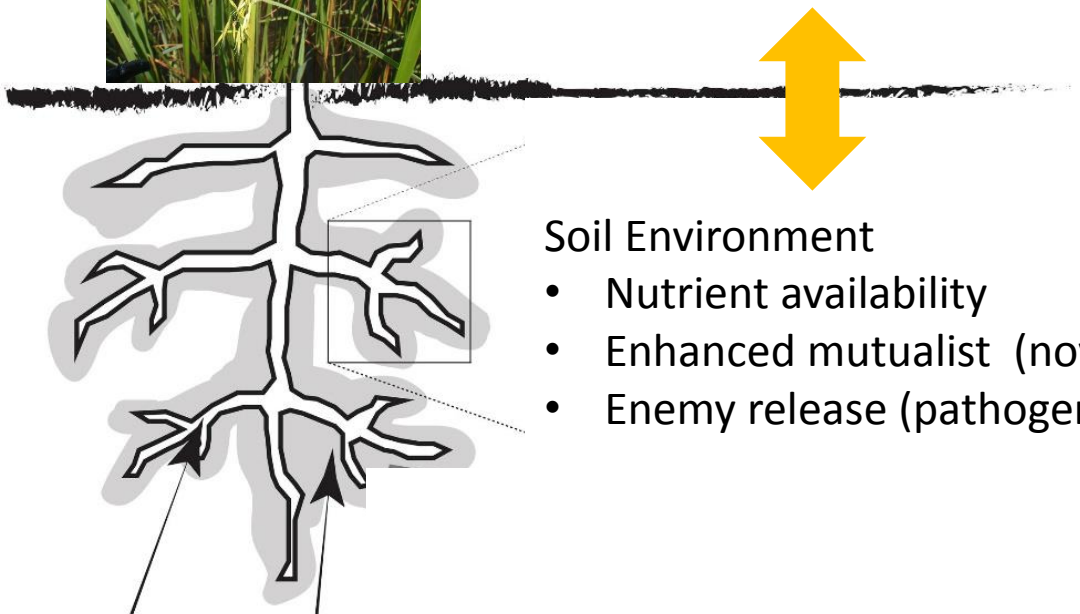
BUDGET ITEM	AMOUNT
Personnel:	
Chan Lan Chun, Principal Investigator (66.3% salary, 33.7% benefits); 7.4% each year for 3 years	$ 36,044
Randall E. Hicks, Co-Investigator (66.3% salary, 33.7% benefits) 3.7% each year for 3 years	$ 23,476
George Host, Co-Investigator (66.3% salary, 33.7% benefits); 4% FTE each year for 3 years	$ 18,743
Carol Reschke, Co-Investigator (72.6% salary, 27.4% benefits); 20% FTE each year for 3 years	$ 45,669
Adelle Schumann, Research Technician (72.6% salary, 27.4% benefits); 15% FTE each year for 3 years	$ 23,185
Graduate Research Assistant (82.4% salary, 17.6% benefits); 50% FTE each year for 3 years	$ 91,728
Professional/Technical/Service Contracts:	
Natural Resources department of the Fond du Lac Band of Ojibwe for boats and boat operators ($110/hour × 250 hours boating time=$27,500; $60/hour x 25 hours travel to sample sites=$1500; $2,430 mileage to sample sites; $801 field survey lodging and $765 per diem for boat operators.	$ 32,994
Equipment/Tools/Supplies:	
Plant and sediment sampling supplies	$ 2,500
DNA extraction and molecular biological agents	$ 12,000
Chemicals and expendable lab supplies	$ 8,000
Travel:	
In-state sampling: 10 samplings/yr*150mi/sampling* 3yrs*$0.54/mi =$2430 + vehicle rental use $10/day*45days=$450 + field survey lodging $89/night *3nights*2rooms* 3 summers=$1,602	$ 4,482
In-state conference attendance: Registration 2 people: $750; lodging $89/night *3nights*2rooms=$1,284; per diem/meals for 3 days $38.25+$51+$38.25=$127.50* 2people = $255)	$ 2,289
Additional Budget Items:	
Illumina sequencing and supercomputer usage fee: UMN Genomic Center (UMGC): Illumina Squencing and library preparation.~ $3975/lane + $10 library prep/sample: ~800 samples per project = $8,000 (sample prep) + 3 lanes ($11,925) = $19,925	$ 19,925
Chemical and nutrient anlayses $65/sample x 200 samples	$ 13,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST	$ 334,035

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	N/A	
Other State $ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period: Unrecovered indirect (53% MTDC 7/1/17-6/30/18; 54% MTDC 7/1/18-6/30/20)	$ 173,761	Secured
Funding History:	N/A	
Remaining $ From Current ENRTF Appropriation:	N/A	

Soil nutrients and microbial communities will be key determinants in the re-establishment of self-sustaining wild rice populations.

- Wild rice growth, adaptation and competitive success
- Above-ground plant community composition and ecology



Soil Environment
- Nutrient availability
- Enhanced mutualist (novel symbiosis)
- Enemy release (pathogen accumulation)

Rhizosphere microbiome
Symbiotic nodule
Root exudates

PROJECT MANAGER QUALIFICATIONS AND ORGANIZATION DESCRIPTION

Dr. Chun will have chief management responsibilities for overseeing the proposed project. She will be responsible for working with Dr. Randall Hicks, Dr. George Host, and research scientist Carol Reschke to ensure that project goals, results and timelines are met. Dr. Chun is an environmental microbiologist with research experiences in the analysis and use of microorganisms in natural and engineered environments. Dr. Chun has studied the distribution and diversity of microorganisms in aquatic and soil environments (particularly rhizosphere) to understand the role microbes play in water quality and human health using a combination of cultivation-dependent and cultivation-independent techniques (e.g. quantitative PCR and DNA sequencing approach). In addition, her work focuses on the development of management strategies to improve and restore ecosystem structure and function. She is currently Minnesota Aquatic Invasive Species Research Center faculty and has worked on the association of microbes with aquatic invasive species (zebra mussels and Eurasian water milfoil). She has published over 20 scientific journal articles and book chapters. The collective research and organizational experiences of the project team members and the resources available to this project from the University of Minnesota should ensure the successful completion of the proposed project goals.

ORGANIZATIONAL DESCRIPTION

The University of Minnesota is a non-profit, state-funded educational institution of the State of Minnesota. Dr. Chun's research laboratory is located in the Natural Resources Research Institute (NRRI) at the University of Minnesota Duluth campus. Dr. Chun's laboratory is equipped for research in the areas of microbial ecology, geochemistry, and molecular biology and includes computers and special software for genetic and phylogenetic analyses. Equipment specific to Chun's lab includes culturing, benchtop electron microscopy, incubators, thermocycler, real-time PCR, general DNA/RNA electrophoresis, autoclave, and centrifuges. In addition to her laboratory, UMD and NRRI also provide substantial shared laboratory space with state-of-the-art specific function-based core laboratories under the direction of a Core Laboratory Director with expertise in that research area. The shared space and its associated equipment are provided for the supervised use of all who reside at UMD-NRRI. Core laboratories at UMD and NRRI include: research instrumentation laboratory, central analytical laboratory, microscopy laboratory, aquaculture laboratory, natural product and modification laboratory, and paleolimnology laboratory. This project has access to DNA sequencing facilities at the University of Minnesota Biomedical Genomics Center and the Minnesota Supercomputing Institute for analysis of DNA sequence data generated by this project.

Co-investigators

Dr. Randall E. Hicks is a professor in the Department of Biology at the University of Minnesota Duluth. He completed a Ph.D. in Ecology at the University of Georgia and did postdoctoral work at Woods Hole Oceanographic Institution and the Illinois Natural History Survey before joining the faculty of the University of Minnesota. Dr. Hicks is an environmental microbiologist who studies the diversity and productivity of aquatic microbial communities, their role in the degradation and transformation of organic compounds, and the survival of potentially harmful microbes in these communities.

Dr. George Host is a landscape ecologist at NRRI and Director of the NRRI Geographic Information Systems Laboratory. His research focuses on watershed-scale assessments of human stressors to aquatic and terrestrial ecosystems, particularly those related to urban development and agricultural land use. He is currently working on a project to develop of remote sensing techniques for early detection of invasive aquatic plant species in lakes and stream systems of northern Minnesota.

Carol Reschke is a plant community ecologist at NRRI, and her recent work has focused on the ecology of aquatic plant communities in the St. Louis River estuary. She has conducted vegetation studies comparing restoration sites to reference sites within the St. Louis River Area of Concern; and she has conducted experiments comparing growth of aquatic plants in habitats with differing sediment and water chemistry. Carol has a Master's Degree in Botany from the University of Wisconsin Madison, and over 30 years experiences as a community ecologist.