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

Project Title: **ENRTF ID: 172-DH**

Mitigating Non-Native Plant Encroachment in Minnesota's Prairie Grasslands

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

Sub-Category: D. Aquatic and Terrestrial Invasive Species

Total Project Budget: $ 191,360

Proposed Project Time Period for the Funding Requested: June 30, 2022 (3 yrs)

Summary:

This project will quantify, identify, and remediate non-native and noxious species in Minnesotas grasslands. We will utilize a standard drone platform developing methods for rapid assessment prior to remediation.

Name: David Kramar

Sponsoring Organization: Minnesota State University - Moorhead

Title: Assistant Professor

Department: Dept. of Anthropology and Earth Sciences

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Moorhead MN 56563

Telephone Number: (218) 477-2832

Email david.kramar@mnstate.edu

Web Address

Location

Region: Northwest, Southwest

County Name: Big Stone, Blue Earth, Brown, Chippewa, Clay, Cottonwood, Faribault, Grant, Jackson, Kandiyohi, Kittson, Lac qui Parle, Lincoln, Lyon, Marshall, Martin, Murray, Nicollet, Nobles, Norman, Otter Tail, Pipestone, Polk, Pope, Redwood, Renville, Rock, Sibley,

City / Township:

Alternate Text for Visual:

The Image Shows the area of Minnesotas grasslands, and a representative sample of where we have classifed a plot down to individual species.

_____ 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: Mitigating Non-Native Plant Encroachment in Minnesota's Prairie Grassland Biome.

I. PROJECT STATEMENT

Minnesota's tall-grass aspen and prairie grasslands are a unique and ecologically significant biome that provide habitat and shelter to a multitude of different species, both avian and terrestrial. Historic alterations to the landscape of the prairie biome have led to drastic declines of the prairie across much of the historic range. Moreover, efforts to manage the encroachment of non-native species, particularly non-native grasses, requires extensive time, energy, and a-priori knowledge of the distribution of these species. To that end, management requires a significant time commitment surveying to find non-native species; a task that can be accomplished faster by exploiting the high-resolution capabilities of modern unmanned aerial systems (UAS – Drones) sensors.

In this context, we propose to further develop and implement geospatial methods and protocols identified in a pilot project that will facilitate the assessment, identification, and remediation of non-native plant species. Using high-resolution UAS imagery, and geospatial analysis techniques designed and developed specifically for UAS platforms, we will identify, mark, measure, and document information pertaining to non-native species encroachment in 15 sites comprising approximately 300 acres in Western Minnesota's prairie biome. Once mapped, remediation efforts can begin. We will also quantify the rate at which non-native species encroach in a native prairie environment and identify phenological characteristics that will lend themselves to identification of these species. Further development of object-oriented classification methods will provide a way to quantify and identify locations for remediation, while minimizing the "boots-on-the-ground" efforts currently required. Results and methods from this project can be utilized by counties and state agencies currently tasked with management and remediation of non-native species. Specific areas may include State Parks, public lands, and

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Identify grassland characteristics obtained from airborne sensors (drones) that will enable us to separate the different grassland species located in one or more pilot plots.*
ENRTF BUDGET: $68,248.00

Outcome	Completion Date
1. Identify and mark plants at the pilot site that represent the most common prairie species in the area, and measure parameters such as plant length, shoot, and leaf length. Measurements will be collected once every two weeks beginning in June and ending in November.	December 2019
2. Acquire Unmanned Aerial System Imagery (UAS-Drone) during each of the measurement cycles and post-process to insure geometric and radiometric correction prior to analysis.	December 2019
3. Use multi-sensor vegetation indices (e.g. Near-Infrared Band from NAIP with UAS-Drone bands), as well as, UAS-Drone derived vegetation indices for grassland species classification.	March 2020
4. Produce geospatial datasets, maps, and methods that represent the phenological changes in non-native species throughout the growing season. Identify remediation requirements.	May 2020

Activity 2: *Identify the optimal UAS based variables and remediation methods that allow for separation of grasslands species into native and non-native for remediation efforts.*
ENRTF BUDGET: $47,350.00

Outcome	Completion Date

1. Use statistical modeling techniques to determine the probability of a portion of a grassland be a non-native species versus native species. Identify optimal remediation technique based on the calculated probabilities.	December 2021
2. Apply modified object-based image classification methods to classify the pilot study area(s) into the most important native versus non-native grassland species present in the area.	December 2019
3. Produce geospatial datasets, maps, and methods that will allow for quantification of encroachment rate. Produce maps identifying areas in need of remediation.	May 2022

Activity 3: *Expansion of project methods to 15 additional prairie sites.*
ENRTF BUDGET: $75,762.00

Outcome	Completion Date
1. Identify and mark 15 additional sites (~300 acreas) in the Minnesota Prairie Biome that will be used to expand the methods and processes defined in Activities 1 and 2.	March 2021
2. Produce geospatial datasets, maps, and methods that will allow for quantification of encroachment rate across all sites and produce documented methods to facilitate application of these techniques throughout the prairie biome. Facilitate remediation efforts throughout the 15 sites.	May 2022

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
TBD	TBD	TBD	

IV. LONG-TERM- IMPLEMENTATION AND FUNDING:

This project will provide baseline data, geospatial methods, and remediation efforts that will support the rapid assessment and mitigation of non-native plant encroachment in Minnesota's Prairie Biome. The project partners will provide the finalized methods to the Minnesota DNR and other agencies that are tasked with identifying and managing non-native and noxious weeds. We will continue to refine and support these mapping, modeling, and methods such that they evolve as the technology evolves. We will also collectively share all data and methods (including standardized protocols) to provide the best possible method of rapidly identifying and quantifying non-native plant encroachment. Further, we will develop the methods such that they can be modified to suit potential future needs such as identifying large woody debris and potential fuel loads. Results provided in this manner will provide valuable management strategies for governmental agencies tasked with management of noxious and invasive plants.

V. TIME LINE REQUIREMENTS:

The project will require three years to complete, including 2 summer field seasons; one to develop and refine methods (2019), and the second to expand to the additional locations (2020). The remainder of the time will be dedicated to final data processing, data analysis, manuscript and report writing, and final results. The final report, which will include detailed methods and data sufficient to replicate the study, will be provided to LCCMR by June 30, 2022.

2019 Proposal Budget Spreadsheet

Project Title:

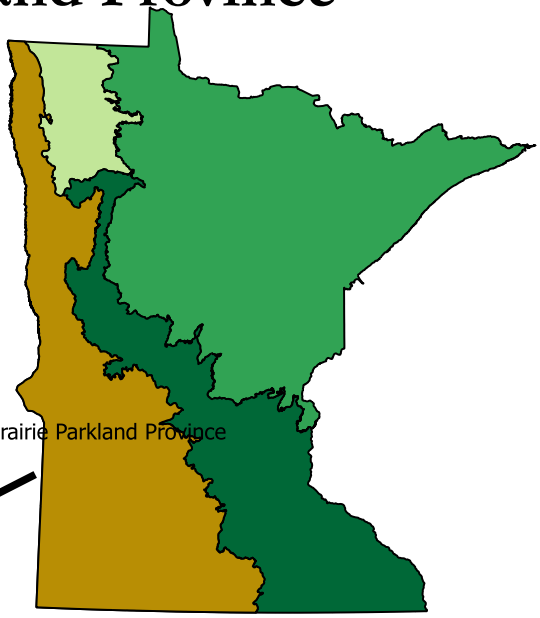
IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM (See "Guidance on Allowable Expenses")	**AMOUNT**
Personnel:	**$ 185,505**
David Kramar, Ph.D.: Project Manager: 1 month salary * 3 summers = 28,025.00. Dr. Kramar will oversee all project activities, manage the UAS portions of the project, and provide oversight and expertise in developing the geospatial statistical models, species classifications, reports, and deliverables.	$28,025
Valquiria Quirino, Ph.D.: Research Associate/Supervisor (Center for Geospatial Studies) 3 Years at 3/4FTE = 45,000/year. Dr. Quirino will actively supervise the day to day data collection effort, assist the project manager in developmant of analytical techniques, manage the vegetation marking, and provide written documentation and reports pertaining to the project.	$135,000
2 student Interns @ $13.00/hour (100% salary) * 20 hours/wk * 12 weeks * 2 summers. Student interns will provide data collection assistance, process and analyze the acquired aerial imagery, assist in methods development, and present findings at conferences within the State.	$12,480
Professional/Technical/Service Contracts:	$ -
To be determined through a competitive bid process.	$10,000
Equipment/Tools/Supplies: E-Cognition Remote Sensing Software: 1 perpetual software license + 1 year technical support and maintenance	**$ 3,715**
Travel: Mileage to and from the priarie study locations: $0.535/mile, 2 cars, 500 miles, 2 summers.	**$ 2,140**
Additional Budget Items:	$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	**$ 191,360**

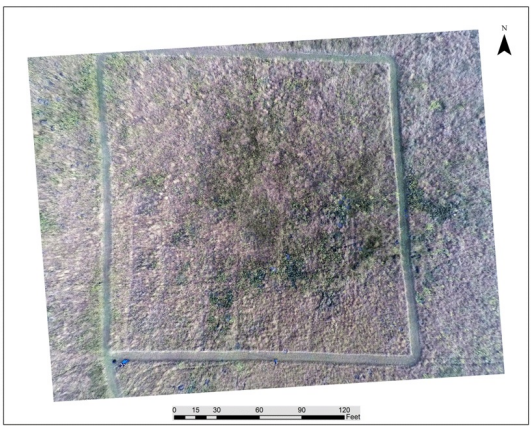
V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

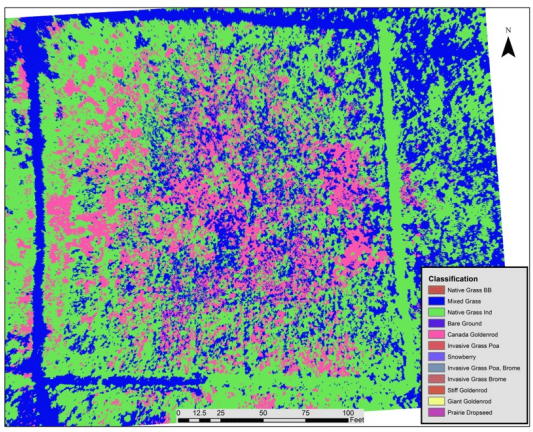
SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ To Be Applied To Project During Project Period: N/A	$ -	
Other State $ To Be Applied To Project During Project Period: N/A	$ -	
In-kind Services To Be Applied To Project During Project Period: David Kramar: Throughout the course of the project, David will be managing and assisting throughout each year. Budgeted at 2 months per year FTE = $56,050. Two (2) DJI Phantom 4 Advanced UA Systems with 20MP cameras @$3200.00 including maintenance.	**$ 59,250**	
Past and Current ENRTF Appropriation: N/A	$ -	
Other Funding History: N/A	$ -	

Minnesota Prairie Parkland Province



Example of a pilot site where we have marked out and surveyed the area for native and invasive plant species.





Example of an object-oriented classification of a surveyed sample plot.

A pilot study location in Western Minnesota. Here we show how we collected imagery at approximately 2cm pixel resolution, and were able to classify it down to individual clusters of plant species. Further refinement of the methods and processes will provide land managers a quick way to identify the locations of invasive species in hard to reach areas, and with less survey hours than traditional methods currently require.

Project Manager Qualifications:

David E. Kramar

Assistant Professor, Dept of Anthropology and Earth Science, Minnesota State University – Moorhead

1. **Education:**
   2014: Ph.D. - Geospatial and Environmental Analysis: Virginia Polytechnic Institute and State University, Blacksburg, Va.
   2004: M.Sc. – Geography: Virginia Polytechnic Institute and State University, Blacksburg, Va.
   1999: B.Sc. - Geography; Concentration in Geographic Information Systems. Appalachian State University, Boone, NC.

2. **Positions:**

2016 – Present:	Assistant Professor, Minnesota State University Moorhead. Moorhead, MN
2014 – 2016:	Visiting Assistant Professor, Southern Oregon University. Ashland, OR
2010 – 2014:	Research Associate, Conservation Management Institute, Virginia Tech. Blacksburg, VA

3. **Research Experience:**
   Throughout my academic career, my research has actively looked at the dynamics of landscape fragmentation and the role that landscape modification has played in research areas such as environmental contaminants, plant species distributions, and wildlife species distribution. Specifically, I use geospatial technologies coupled with parametric and non-parametric statistical modeling methods to explain how and why things occur where they do. Over the last several years I have been actively exploring the use of high-resolution UA systems to capture and quantify plant diversity. More recently, I have been working with object-oriented classification and non-nir vegetation indices to visualize species diversity within two nutrient network sites. This work represents the pilot research that has driven this proposal.

4. **Publications in Process and Presentations (2017):**

   Kramar, D.E. and Quirino, V. In Process. *Application of Non-NIR Vegetation Indices on a Standard UAS Platform: Current Practices and New Approaches.* Remote Sensing. In Process. (Manuscript)

   Quirino, V.F. and **Kramar, D.E.** 2017. *Object-Based Image Classification of Two Nutrient Network Sites from High Resolution UAS Imagery.* Remote Sensing. In Process. (Manuscript)

   Kramar, D.E. and Quirino, V.F. 2017. *Applications of Non-NIR Based Vegetation Indices to a Standard UAS Platform.* Minnesota GIS/LIS Conference. Bemidji, MN. (Presentation)

   Quirino, V.F. and **Kramar, D.E.** 2017. *Comparing Classification of NAIP and UAS Imagery Using Object-Based Image Analysis Methods*. Minnesota GIS/LIS Conference. Bemidji, MN. (Presentation)

Organization Description:

Minnesota State University Moorhead (MSUM) is a 4-year public university, and is accredited by the Higher Learning Commission. MSUM offers undergraduate four-year college programs leading to Baccalaureate degrees in a number of different disciplines.