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

Project Title: **ENRTF ID: 015-A**

Non-Invasive Moose Calf Surveys and Ecosystem Monitoring

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 348,151

Proposed Project Time Period for the Funding Requested: 1.5 years, July 2017 - December 2018

Summary:

Unmanned aerial vehicles will assist natural resource managers in providing better monitoring of ecosystems and non-invasively monitoring our moose population while reducing costs and safety risks relative to manned flights.

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Sponsoring Organization: U of MN

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Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Unmanned aerial vehicles will be used to monitor ecosystem changes (Action 1) and obtain data on moose calves non-invasively (Action 2)

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

PROJECT TITLE: Non-invasive Moose Calf Surveys and Ecosystem Monitoring with Unmanned Aerial Vehicles

I. PROJECT STATEMENT

Many species and ecosystems in Minnesota are facing a variety of threats ranging from changing patterns of natural disturbance and human land use to alteration in the timing and amount of precipitation. Broad-scale monitoring of populations and ecosystems is needed to improve conservation and management efforts; however, the required data are often expensive and time consuming to collect. Fortunately, technological advances in the fields of robotics and data processing are opening up new capabilities for natural resource biologists to better identify and understand when and where changes in management strategies are needed. Specifically, Unmanned Aerial Vehicles (UAVs) improve on current technologies and methodologies because they can access remote or difficult terrain, collect large amounts of data for lower cost with reduced risk for humans, and facilitate observations of species that are wary of human presence. The use of UAVs has tremendous potential to advance the quality, scale, and frequency of aerial imagery collection and will enable researchers to better monitor landscapes as they change through time and then understand how wildlife species respond to these changes.

The overall ***GOALS*** of the project are to develop UAV capabilities to **1) collect novel and important data on wildlife and ecosystems** using methods that **2) reduce or eliminate negative impacts on wildlife** by removing the need to drug and handle them. Specifically, we will utilize our developed UAV capability to home in on VHF signals from adult collared moose and count the number of calves using video imagery and infrared technology. This can be extended to other species and/or can be used to track the survival of the moose calves without ever needing to handle them; fixed-wing UAVs will fly at high altitudes to avoid affecting animal behavior. We will also produce easy to use software that works with a simple UAV system for the monitoring and analysis of imagery over threatened or sensitive ecosystems such as wetlands and bogs. This project will directly lead to better management and conservation ***OUTCOMES*** for **i)** the MN moose population without needing to collar calves, and **ii)** better monitoring and management action for natural areas by providing an approach that could be adopted by natural resource managers to collect finer temporal scale and higher quality land-cover data, enable a fast and effective way to assess results of management actions, and provide a user friendly means of processing the imagery data. These outcomes will provide a set of tools that will help advance conservation in Minnesota and will eventually save taxpayer dollars while simultaneously reducing risk to biologists and pilots.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Develop VHF tracking capabilities using UAVs **Budget: $173,151**

We will develop UAV capabilities to home in on VHF signals being emitted from collared animals. The UAV will be able to follow the animal if it moves and capture video and thermal videos/imagery. We will start by lab testing and then move to our FAA approved flight area to test in the field. We can then utilize the collars already on adult moose in Grand Portage to fly above the adults and utilize imagery to determine the number and survivorship of calves. Information collected non-invasively on moose calves is critical because moose cannot be handled or collared in MN.

Outcome	Completion Date
1. Lab testing to develop search capabilities of UAV software and receiver	July 2017
2. Field testing of UAV with empty collar at our FAA approved site in Columbus, MN	September 2017
3. Conduct moose calf surveys in Grand Portage using already collared adults – provide counts and survivorship to the Grand Portage Band and MN DNR.	Spring 2018

Activity 2: System to monitor and identify changes to sensitive ecosystems **Budget: $175,000**

We will utilize an existing UAV system but develop a user friendly flight planning system which will maximize visual coverage, imagery collection, and post-processing capabilities to summarize collected data across space and through time. We will demonstrate this ability at a sensitive wetland area. Finally we will work to train any interested natural resource managers on the system for implementation elsewhere in the state.

Outcome	Completion Date
1. Development of flight planning for easy utilization of UAVs	July 2017
2. Demonstration of ease of use by collecting data at wetland near Twin Cities	August 2017
3. Development of image processing capabilities using data from the wetland	March 2018
4. Training of natural resource personnel who monitor sensitive ecosystems	March – Dec '18

III. PROJECT STRATEGY

A. Project Team/Partners

Our research team is uniquely capable of developing cutting edge robotics and software with on the ground implementation of wildlife and environmental surveys using UAVs. **Dr. Mark Ditmer** is a research specialist at the Univ. of Minnesota. He has extensive experience obtaining FAA permits and utilizing UAVs in research of wildlife. He will act as project manager and lead researcher [receiving funds]. **Dr. Volkan Isler** is an Associate Professor at the University of MN and an expert in robotics with a focus on pursuit-evasion, search, coverage and sensor planning. His research lab developed and successfully deployed field systems for monitoring invasive fish and precision agriculture [receiving funds]. **Dr. James Forester** is an Assistant Professor at the University of MN and has a broad background in field ecology. He has extensive experience with quantitative and computational methods and his research is primarily focused on how large, mammalian herbivores respond to changing landscapes [receiving funds]. **Dr. Joseph Knight** is an Associate Professor at the University of Minnesota. Dr. Knight is a geographical information systems specialist and focuses on how changing land use affects natural resources and humans. He will act as a consultant [unpaid].

B. Project Impact and Long-Term Strategy

Our interdisciplinary research team will develop and implement changes to UAV systems that will have lasting benefits for the ongoing monitoring of any wildlife species large enough to be VHF-tagged (e.g. bat species of concern in MN) and will enable managers to collect much finer resolution data in an autonomous fashion to monitor changes in sensitive ecosystems. Initially, our results will lead directly to better understanding of the conservation and management needs of moose and highlight the ability of our system to identify changes in sensitive ecosystems. Embracing the new capabilities that UAVs have to offer will provide better data, more cost-effective and safer research, while making research less invasive. Our work will not only research these methods but create easy to use systems that make UAV use and analysis of imagery accessible to researchers and managers. We will train and offer processing support for imagery as a means to get the systems more fully integrated into management and research.

We already have support from the UMN's Institute on the Environment who previously purchased a UAV system for our research on wildlife. We currently have FAA approval for research in several areas of the state and are working with the UMN to obtain a permit from the FAA that will cover the entire state. Our research team has collaborated extensively with MN DNR researchers and managers in the past. We have access to previously collared animals (bear, bats, and moose), and strong working relationships with researchers throughout the state who have interest in this technology.

C. Timeline Requirements

The first stage of our research will be conducted in the lab and local testing areas as we develop and refine the UAV system during the course of the first 6 months – 1 year. We will demonstrate its ability at a testing site and wetland near the Twin Cities. The following spring we will utilize the system to count the number of moose calves in Grand Portage and begin working with managers and researchers interested in applying the UAV system.

2017 Detailed Project Budget

Project Title: Non-invasive Moose Calf Surveys and Ecosystem Monitoring with Unmanned Aerial

IV. TOTAL ENRTF REQUEST BUDGET 2 years

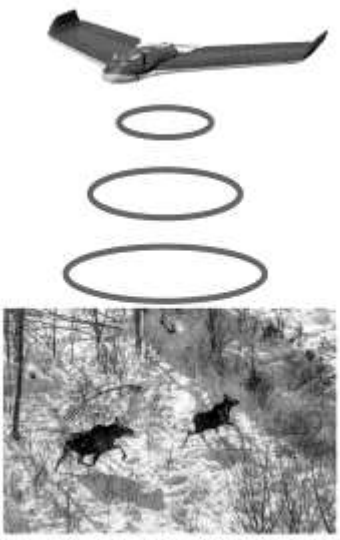
BUDGET ITEM *(See "Guidance on Allowable Expenses", p. 13)*	**AMOUNT**	
Project Manager (Mark Ditmer) - 50 %FTE for 2 years (81.7% salary ,18.3% fringe).	59,362	
Wildlife Biologist (James Forester) - 8% FTE for 2 years (75% salary, 25% Fringe)	26,155	
Engineer (Volkan Isler) - 11% FTE for 2 years ((75% salary, 25% fringe)	38,434	
Master's Student - U of M - Twin Cities for 2 years: 49.3% salary, 8.7% fringe, 42.1%	66,158	
Grad Research Student - UMN CS&E - 50% FTE for 2 years (59% salary, 10% fringe, 31%	91,296	
Professional/Technical/Service Contracts:	$	-
Peggy Callahan of the Wildlife Science Center will provide us with an area to test our UAV capabilities. This is part of our FAA approved area.	2500	
Equipment/Tools/Supplies:	$	-
1 Fixed Wing UAV: Ebee by Sensefly (includes infrared and high quality cameras). This UAV will continue to be used by DNR and U of M researchers in the future for both moose surveys and habitat/management monitoring.	18,000	
Backup 3DRobotics Iris+ quadcopters	900	
Potential replacement parts for UAVs	1,000	
Groceries for field work	3,000	
Computer supplies and materials such as ground workstation, onboard UAV micro-computer (odroid or raspberry pi) which will send data to a laptop on the ground , batteries, cables and other interfacing devices. These will continue to be used in the UAV for all future DNR and U of M research involving moose and ecosystem monitoring/management	14,000	
Travel:		-
Travel for field work to implement wildlife homing and image capture capabilities as well as travel to train other researchers and managers. This includes rental of DNR truck. All travel will be within the state of MN	10,000	
Funds for truck rental and travel to data collection sites	10,000	
Other Expenses:		
Networking and Computer Services (CS&E)	7,346	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$	348,151

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: National Science Foundation (Direct costs)	$ 801,000	*Pending*
Other State $ To Be Applied To Project During Project Period:	NA	*NA*
In-kind Services To Be Applied To Project During Project Period:	NA	*NA*
Funding History: University of Minnesota's Instituite on the Environment	$ 900	
Remaining $ From Current ENRTF Appropriation:	NA	*NA*

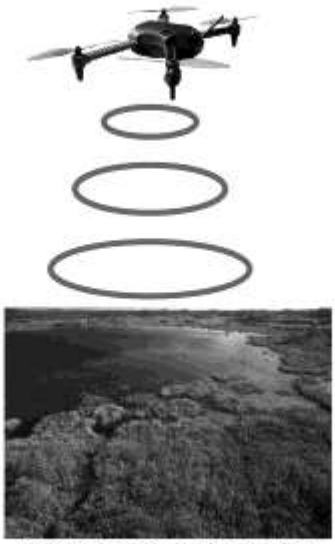
PROJECT TITLE: Non-invasive Moose Calf Surveys and Ecosystem Monitoring with Unmanned Aerial Vehicles

Action 1



Non-invasive moose calf counts
Estimates of moose calf survival
Fixed-wing flights at high altitudes

Action 2



Monitoring of ecosystems
Fine-scale, frequent imagery
Track changes over time

Non-invasive Moose Calf Surveys and Ecosystem Monitoring with Unmanned Aerial Vehicles

Mark A. Ditmer

I. QUALIFICATIONS

Professional Preparation

Villanova University	Economics	B.S., 2005
Villanova University	Finance	B.A., 2005
Charles Rivers Associates	Analyst – Finance/Litigation	2005−2006
OnLocation, Inc.	Energy Consultant, Modeler	2006−2008
University of Minnesota	Conservation Biology	Ph.D., 2014
University of Minnesota	Wildlife Biology	Post-doc 2014−2015
Univ.of MN Duluth	Research Specialist	Nov 2015 - Present

Expertise Related to the Proposed Research

Ditmer has experience in both the high-stakes corporate world of consulting and field biology/ecology. He completed a Ph.D dissertation focused on understanding how black bears in Minnesota can thrive in largely human-dominated, agricultural areas. He has extensive experience in rigorous quantitative methods, specifically working with spatial data from GPS-collars as well as physiology data from biologgers. He has successfully published results of his work in several peer-reviewed scientific journals including three regarding the use of unmanned aerial vehicles in ecological research. His research as a postdoctoral research specialist at the University of Minnesota's Dept. Fisheries, Wildlife, and Conservation Biology is primarily focused on how mammals respond both behaviorally and physiologically to human-related stressors. He currently works for the UMN-Duluth studying moose behavior.

II. RESPONSIBILITIES

Ditmer will manage and coordinate all research activities within the project. He will act as lead data analyst and work with the experts on the project in robotics (Dr. Isler) and wildlife ecology (Dr. Forester) and coordinate among the graduate students to ensure the proper collection and analysis of data and proper field implantation that follows Federal Aviation Administration guidelines. He will also be responsible for contacting and meeting with natural resource managers and Univ. of MN researchers to determine best practices and ideas for where the UAV system can best be used and how to help incorporate the new technologies in the field and the lab.

III. ORGANIZATION DESCRIPTION

The Department of Fisheries, Wildlife, and Conservation Biology (part of the University of Minnesota), has a mission "to foster a high quality natural environment by contributing to the management, protection, and sustainable use of fisheries and wildlife resources through teaching, research, and outreach."