Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **014-A**

Impacts of Forest Quality on Declining Minnesota Moose

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 394,496

Proposed Project Time Period for the Funding Requested: 3 Years, July 2014 - June 2017

Summary:

Link regional patterns of moose abundance through time to the distribution of food and cover. Determine if this distribution affects the diet and survival of individual moose.

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Sponsoring Organization: U of MN

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Location

Region: Northeast

County Name: Cook, Lake, St. Louis

City / Township:

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

PROJECT TITLE: Impacts of forest quality on declining Minnesota moose

I. PROJECT STATEMENT

The Minnesota moose population is declining dramatically and has become a growing concern for conservation. In addition to being an iconic species of northern Minnesota, moose are keystone herbivores that are an important component of Minnesota's forested ecosystems. The specific mechanism causing their rapid decline has not been fully uncovered because many factors affect how well moose survive and reproduce. Ultimately, the most important tool available to natural resource managers is their ability to manipulate the spatial distribution and diversity of high-quality habitats (Figure 1). Management decisions will clearly benefit from scientific guidance to ensure manipulations have maximum impact on stabilizing the moose population in Minnesota.

The Minnesota Department of Natural Resources (MNDNR), the Grand Portage Band of Lake Superior Chippewa (GPBLSC), and the University of Minnesota began a moose tracking effort in 2013 to determine cause-specific mortality within the moose population (100 GPS collars were funded by LCCMR, 15 by the Forester Lab at UMN, and 14 by GPBLSC; these collars will collect animal locations for 5 years, so no additional collars are required). In addition, Dr. Ron Moen (NRRI) is working on a moose habitat restoration project in which he is assessing how food availability, quality, and consumption by moose changes in forests with different disturbance histories. **We propose to build upon both of these LCCMR-funded research projects to explore how the landscape context in which individual animals live can directly affect the animals' diet and their subsequent body condition and mortality risk.** Understanding how forest age, structure, and composition can affect the distribution of food and cover (and thus impact the movement patterns of moose) is critical to inform broad-scale management efforts that are aimed to improve the forest landscape for moose and thus stabilize the population.

Our *broad aim* is to link the behavior, diet, and survival of moose to the spatial distribution of food and cover. Our team will build upon existing moose research in the state to address two primary *research goals*:

1) *Regional Scale*: Link regional patterns of moose abundance through time to the geographic distribution and relative forage quality of different land-cover types and forest stand ages.

2) *Local Scale*: Determine if the distribution of resources affects the diet of individual moose and whether dietary differences among animals are associated with variation in body condition or mortality risk.

This will be the first study to link the movement behavior and landscape context of individual moose (e.g., the distribution of food and cover within an animal's home range) to the animals' diet, body condition, and mortality risk. It will allow us to place the moose movement, mortality, and forage quality data already being generated by LCCMR funding into a detailed ecological and behavioral framework that will provide critical and timely insight into the causes of the moose population decline.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Linking moose abundance to distributions of food and cover that change across space and through time. **Budget: $ 174,632**

We will use a combination of USFS Forest Inventory and Analysis (FIA) data and Landsat satellite data (both collected repeatedly over the last decade) in conjunction with data from the MNDNR moose survey to examine how the moose population has responded to changes in distributions of resources across its Minnesota range. In addition to 61 plots we established in 2012, we will characterize the forest community within 100 additional sites that represent a range of cover types and known disturbance histories (these sites will Dr. Moen's forage quality project). For all common browse species, we will measure species-specific biochemical attributes that act as tracers of moose dietary composition. We will relate these community and biochemical results to land-surface attributes (e.g., soil type, aspect, land cover) and report whether coarse distributions of food and cover are correlated to local estimates of moose abundance – this will directly aid forest management planning.

Outcome	Completion Date
1. Analyze data from 1,258 FIA plots and the moose survey data to determine how broad-scale patterns of landscape change are linked to moose population dynamics.	December 2014
2. Develop a stable isotopic signature for moose forage species commonly found in NE MN.	December 2014
3. Produce a new classification of satellite data for NE MN to show how the distribution of high-quality moose habitat has changed over the last 15 years.	February 2015
4. Identify how the species composition of moose forage changes among land-cover types and in response to stand age (data from 161 vegetation plots distributed across the region).	December 2015
5. Publish a spatially-explicit analysis of how moose population density changes in response to availability and arrangement of forage in the landscape.	January 2016

Activity 2: Linking the distribution and quality of food and cover to moose diet, body condition and mortality risk. **Budget: $219,864**

We will use stable isotope analysis to determine how the distribution of food and cover affects diet and whether individual movement behavior allows some individuals to have higher quality diets in landscapes with lower quality habitat. By analyzing the carbon and nitrogen isotopic ratios of moose body tissues collected at capture and after death, we can assess individual moose diet and habitat use on timescales from several weeks to several years. We will combine these data with GPS locations of the same animals to test if the moose are eating what is available to them. This will allow us to determine the degree to which landscape context (e.g., the abundance, spatial distribution, and biochemical signature of land-cover types within an animal's home range) is driving the movement pattern and diet of the animal. We will then determine if dietary differences among individuals can explain variation in mid-winter body condition or mortality risk. Finally, we will develop a spatially explicit moose population model that relates the distribution of resources to moose survival and reproduction. These results will provide suggestions on how to change forest management to benefit moose.

Outcome	Completion Date
1. Assess the nutrient quality and stable isotopic concentration of forage available in each collared animal's home range.	November 2015
2. Develop a time series of diet over the past several years for each collared moose (n=129) using stable isotopic analysis of hair, teeth and hooves collected at capture and after death.	December 2015
3. Assess whether forage availability or diet affect the rates of survival or reproduction.	June 2016
4. Provide specific forest management recommendations to experimentally improve the landscape for moose in the areas of their range where the animals are most vulnerable.	June 2017

III. PROJECT STRATEGY

A. Project Team/Partners

The research team will be led by scientists at the University of Minnesota Departments of Fisheries, Wildlife and Conservation Biology (Dr. James Forester), Earth Sciences (Dr. David Fox), and Forest Resources (Dr. Anthony D'Amato). Partners include the UMN (Dr. Alan Ek), MNDNR (Dr. Erika Butler, Dr. Michelle Carstensen, Dr. Glenn DelGiudice), TNC (Mark White), and the Grand Portage Band of Lake Superior Chippewa (Dr. Seth Moore).

B. Timeline Requirements

The duration of the project is three years. This time is required to identify additional sites and to develop and analyze a sufficient time series of plant, animal, and satellite data.

C. Long-Term Strategy and Future Funding Needs

The proposed project will build upon a pilot study funded by the Forester Lab and LCCMR funded research carried out by the MNDNR and Dr. Ron Moen. The results of this project will provide specific management recommendations. We will also seek additional funding from the USFS and National Science Foundation to expand the spatial extent of the project and extend monitoring through additional years.

2014 Detailed Project Budget

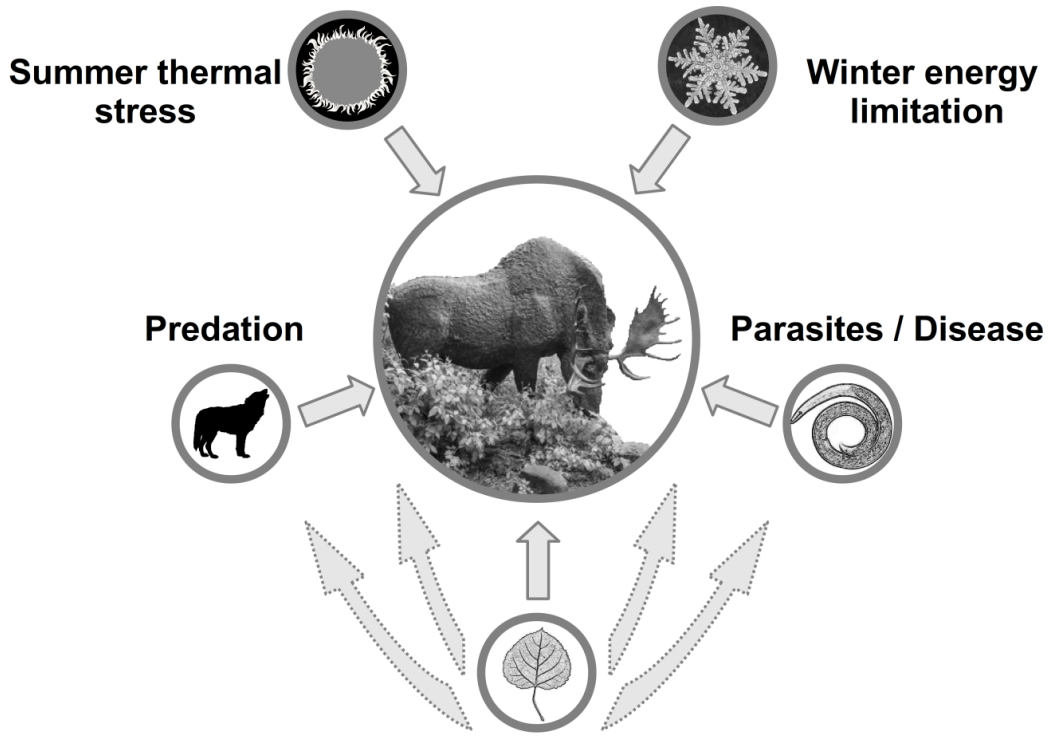
Project Title: Impacts of forest quality on declining Minnesota moose

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM *(See "Guidance on Allowable Expenses", p. 13)*	**AMOUNT**
Personnel:	
Field manager - 50% FTE ($55,636) plus 36.8% fringe ($20,474): will lead vegetation sampling effort over three years	$ 76,110
Faculty (Forester) - 8%FTE = 3mo summer salary over 3yr ($24,040) plus 19.83% fringe ($4,767): will manage project, and take lead on analysis of moose movement data.	$ 28,808
Faculty (Fox) - 4% FTE = 1.5 mo summer salary over 3 yr ($13,072) plus 19.83% fringe ($2,592): will supervise the stable isotope analyses	$ 15,664
Lab technician - 8%FTE = 3 mo over 3 yr ($9,559) plus 36.8% fringe ($3,518): will maintain stable isotope lab equipment and assist with analyses.	$ 13,076
Postdoctoral Fellow (David Wilson) - 8%FTE = 1 mo salary in first year ($3,673) + 36.8% fringe ($1,352): will take lead on collecting and analyzing the FIA data for the moose range.	$ 5,025
Undergraduate field and lab assistants - 4 students, 40h/wk, 10 wks over 3 yr, $10-15/h ($57,491): will aid graduate student, field manager, and lab technician with data collection and entry.	$ 57,491
PhD student $21/hr 55% FTE 13 wks summer salary ($18,564) plus 23.1% health and FICA ($4288): will collect plants for stable isotope analysis within animal home ranges, will collect moose browse, hair, and fecal pellets during winter, and will take lead on the analysis of moose isotope concentrations.	$ 22,852
Contracts:	
Isotope analysis (University of Minnesota Stable Isotope Lab, 7368 samples of moose and plant tissue at $8/sample)	$ 58,944
GIS and Statistical Consultant, ($35,075 over 3yr) classify historic and current satellite imagery and conduct spatially explicit statistical analyses.	$ 35,075
Equipment/Tools/Supplies:	
Lab supplies (reagents, weigh tins, gas canisters, and other consumable supplies used for stable isotope analysis)	$ 9,000
field equipment (measuring tapes, compasses, flagging tape, sample bags, stakes, etc)	$ 1,200
Map-grade GPS unit for precise location of field samples and accurate ground truthing of satellite imagery	$ 4,291
Travel:	
Travel to study area by project management staff and technicians 4 months/yr for 3 years (2 fleet trucks @$779/month, $0.37/mi, 10000 miles/ yr)	$ 34,080
Room and board for field crew (3 yr of summer and winter field sessions, 4 months/yr, 2-6 crew members at a time, rent @ $1,500/mo, board@$1,240/mo)	$ 32,880
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 394,496

V. OTHER FUNDS

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ Being Applied to Project During Project Period:	none	
Other State $ Being Applied to Project During Project Period:		
Purchace and maintainence of 15 moose GPS collars (Forester startup)	$ 89,463	*secured*
Graduate Lab Manager (Fox Stable Isotope Lab, 1mo summer salary + 23.1% health and FICA)	$ 2,400	*secured*
Computer equipment dedicated to data analysis and simulation for this project (Forester startup)	$ 3,158	*secured*
Foregone ICR funding (52% MTDC, excluding graduate fringe)	$ 202,908	*secured*
In-kind Services During Project Period: *Salaries for Forester (1% match), D'Amato (1% match)*	$ 6,550	*Secured*
Remaining $ from Current ENRTF Appropriation (if applicable):	none	
Funding History:	none	



The *distribution* of high-quality food and cover can critically affect animals' susceptibility to predation, parasites, and thermal stress.

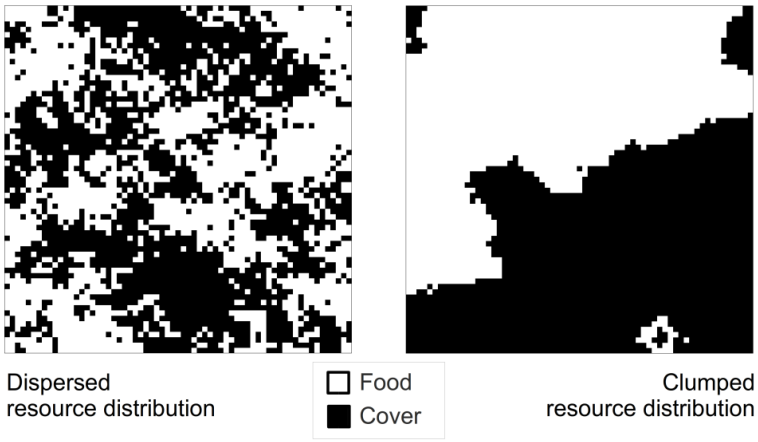


Figure 1. Moose can suffer in the summer heat, run out of food in the winter, fall prey to wolves, or succumb to parasites or disease. The distribution of high-quality food and cover can affect how susceptible animals are to these threats. When resources are dispersed, food and cover are readily available and moose are able to easily find enough to eat while avoiding wolves and the summer sun. When resources are clumped, animals will be farther from cover while feeding, and farther from food while using cover thus increasing the daily cost of survival. **We will: 1) Determine the distribution and relative amounts of resources that are most likely to increase moose survival, and 2) Provide forest management recommendations aimed to effect this change.**

Impacts of forest quality on declining Minnesota moose

Project Manager Qualifications

James D. Forester

I. QUALIFICATIONS

Professional Preparation

Frostburg State University	Wildlife/Fisheries, Biology	B.S.,1997
University of Wisconsin – Madison	Zoology	M.S., 2002
University of Wisconsin – Madison	Zoology	Ph.D., 2005
University of Chicago	Ecology & Evolution, Statistics	Post-doc 2005-2008
Harvard University	Organismic & Evolutionary Biology	Post-doc 2008-2010

Professional Appointments

Asst. Prof., Dept. Fisheries, Wildlife & Cons. Biol., Univ. of Minnesota July 2010 – present

Expertise Related to the Proposed Research

Forester has a broad background in field ecology, having worked on projects related to intertidal community dynamics, terrestrial plant community composition, amphibian population distributions, and the resource selection and movement patterns of large mammals. He has extensive experience with quantitative and computational methods and has published numerous peer-reviewed articles that cover a range of spatial and temporal scales. His research is primarily focused on how large, mammalian herbivores respond to changing landscapes.

II. RESPONSIBILITIES

Forester will coordinate and manage the overall project, supervise the graduate student who is collecting and analyzing the vegetation and moose tissue samples, and will work directly with statistical and GIS consultants to collect and analyze satellite data (Activity 1). He will coordinate quarterly meetings with the co-PIs, graduate student, and technicians in addition to biannual meetings that include all partners of the project. His research will focus on developing spatially explicit models of the moose population and will take the lead in producing research products that will guide future landscape management of the moose population (Activity 2).

III. ORGANIZATION DESCRIPTION

The Department of Fisheries, Wildlife, and Conservation Biology is part of the University of Minnesota, one of the largest and most recognized public research universities in the United States. Its mission is to conduct high-quality research and scholarship that can then be shared, extended and applied to challenges faced by organizations and individuals in the community.