

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

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**Project Title:**

Moose Decline and Air Temperatures in Northeastern Minnesota

**Category:** A. Foundational Natural Resource Data and Information

**Total Project Budget:** \$ 743,648

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

**Other Non-State Funds:** \$ 0

**Summary:**

Studying physiology and behavior of adult moose and effects of female condition on calf production and survival to determine the impact of air temperature on moose population performance and decline.

**Name:** Mike Larson

**Sponsoring Organization:** MN DNR

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Grand Rapids MN 55744

**Telephone Number:** (218) 999-7933

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**Web Address:**

**Location**

**Region:** Northeast

**County Name:** Cook, Lake, St. Louis

**City / Township:**

**MP:** 0613-2-130-proposa

**Budget:** 0613-2-130-bud

**Qual:** 0613-2-130-qualifi

**Map:** 0613-2-130-map-2

**Resolution:**

**List:**

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



**PROJECT TITLE: Moose Decline and Air Temperatures in Northeastern Minnesota**

**I. PROJECT STATEMENT**

Increasing air temperatures may be a primary factor contributing to the decline of the moose population in northeastern Minnesota. A 7-year study (2002-2008) conducted by the MN DNR, Fond du Lac Natural Resources, and partners reported an inverse relationship between air temperatures and survival rates of adult moose, similar to findings of another study conducted in northwestern Minnesota. Although low adult survival was the major factor influencing the downward trend in both populations, it is unclear whether increasing air temperature was the cause. Nonetheless, “heat stress” may be affecting survival, reproduction, and the population decline. Data documenting adverse effects of high air temperatures on moose physiology, survival, or reproduction are limited, so we propose to GPS-collar and implant 30 adult moose with internal temperature loggers and to implant heart rate monitors in a subset of these. Air temperature data and body temperature, heart rate, and activity levels of these moose and captive moose (controls) at the Minnesota Zoo will be used to quantify their physiological and behavioral responses to different air temperatures. We will estimate the seasonal survival of implanted moose, determine specific causes of mortality, and assess calf production. We will also estimate survival and determine the causes of mortality of calves by GPS-collaring 30-50 newborns. Presently, less is known about calf productivity, survival, and mortality factors than for adult moose in northern Minnesota. Examination of this critical mechanistic thread from air temperature to adult moose physiology, behavior, and fitness (condition, survival, and reproduction) and to calf survival will yield the first data directly addressing the hypothesis of air temperature’s potential role in the decline of the northeastern moose population. This aggressive study is a first of its kind only now made possible by cutting-edge GPS technology.

**Goals of the project**

**1) Determine physiological and behavioral impacts of air temperatures on moose**

We will quantify moose physiological (body temperature, heart rate) and behavioral (movement rates, habitat use) responses to changing air temperatures. Effects of temperature may be direct (e.g., death due to “heat stress”) or indirect (e.g., reduced foraging to seek thermal cover, leading to poor body condition). Poor nutritional condition may lead to increased vulnerability to diseases or parasites. A greater understanding of these direct and indirect effects will be integral to developing and assessing the value of alternative long-term population and habitat management strategies and actions (e.g., forest alterations).

**2) Determine how impacts of air temperatures on adult moose may affect numbers and viability of calves produced, their survival, and annual recruitment into the population**

We will examine potential relationships between seasonal physiological and behavioral responses of adult moose to air temperature and the condition and survival of the calves during their first year of life. An ongoing study investigating calf survival rates and specific causes of mortality is focused on linking our findings to the age of the mothers and their behavior (e.g., habitat use, movement and daily proximity to her calf), but what’s critically missing is our ability to relate the calves’ survival to their mothers’ physiological and behavioral responses to the environment (i.e., air temperature).

**3) Incorporate newly collared adults and calves into our on-going moose studies**

GPS-collared adults and calves will be incorporated into existing moose research projects by the MNDNR and partners. Both the adult and calf mortality studies are aimed at estimating survival rates and determining specific causes of death and contributing factors. Continuing these studies will assure long-term assessment of primary mortality factors, which will enhance data interpretation and our understanding by capturing the influence of as much environmental variation as possible. This will support long-term development of management strategies and activities.



II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Determine physiological and behavioral impacts temperatures have on adult moose and determine specific causes of mortality Budget: \$381,746

Internal temperature loggers and heart rate monitors will be coupled with GPS locations and used to link behavioral and physiological responses to the habitats used by moose. We will determine if moose alter their use of specific habitat types depending on air temperatures or their current physiological state.

Table with 2 columns: Outcome, Completion Date. Rows include: 1. Determine physiological impacts of air temperatures on moose (6/30/17), 2. Determine behavioral impacts of air temperature on moose (6/30/17), 3. Continue to determine specific causes of mortality (6/30/17)

Activity 2. Determine the potential effects of the condition of adult female moose on calf productivity and survival. Budget: \$361,902

Prolonged physiological stress (e.g., increased heart rates, body temperature) can have debilitating effects on the nutritional condition and overall health of adult moose, which can compromise their ability to become pregnant, fetal development, and calf survival throughout their first year. Further, behavioral responses to increased temperatures may compromise the nutritional condition of adult moose, contributing to reduced calf production, viability, and survival. We will assess the impact of air temperatures on viable calf production and annual survival relative to the mother's physiological status, condition, and behavioral responses (e.g., habitat use).

Table with 2 columns: Outcome, Completion Date. Rows include: 1. Determine the relationship between physiological responses of females and the production and survival of calves (6/30/17), 2. Determine the relationship between behavioral responses of females and the production and survival of calves (6/30/17), 3. Continue to determine specific causes of mortality of calves during their first year (6/30/17)

III. PROJECT STRATEGY

A. Project Team/Partners

Project manager: Dr. Michael A. Larson, MN DNR. Lead investigators1,2: Dr. Erika Butler (adult component) and Dr. Glenn D. DelGiudice (calf component), MN DNR. Co-investigators: MN DNR2; Natural Resources and Research Institute2; and University of Minnesota Department of Fisheries, Wildlife, & Conservation Biology1.

Collaborators: Fond du Lac Resource Management Division2; University of Minnesota Veterinary Diagnostic Laboratory1,2; 1854 Treaty Authority2; Minnesota Deer Hunters Association3; and Minnesota Zoo3.

1 Receiving money from this ENRTF request; 2 In-kind contributor; 3 Collaborator not receiving money or providing significant in-kind contributions.

B. Timeline Requirements

This project is designed as a 2-year study, although we anticipate that the adult portion will continue for the life of the collars and implants (likely up to 5 years). The calf component of the project is designed to be 2 years with the second year for data analyses and writing of the 3 years of data collection, including the on-going study.

C. Long-Term Strategy and Future Funding Needs

A greater understanding of the direct and indirect effects of air temperature will be important when developing and assessing the value of alternative management actions (e.g., habitat alterations). Continuing the adult moose and calf mortality studies will allow for long-term assessment of mortality factors to ensure we capture environmental and temporal variability of mortality factors.

## 2014 Detailed Project Budget

Project Title: Moose Decline and Air Temperature in Northeastern Minnesota

### IV. TOTAL ENRTF REQUEST BUDGET 3 years

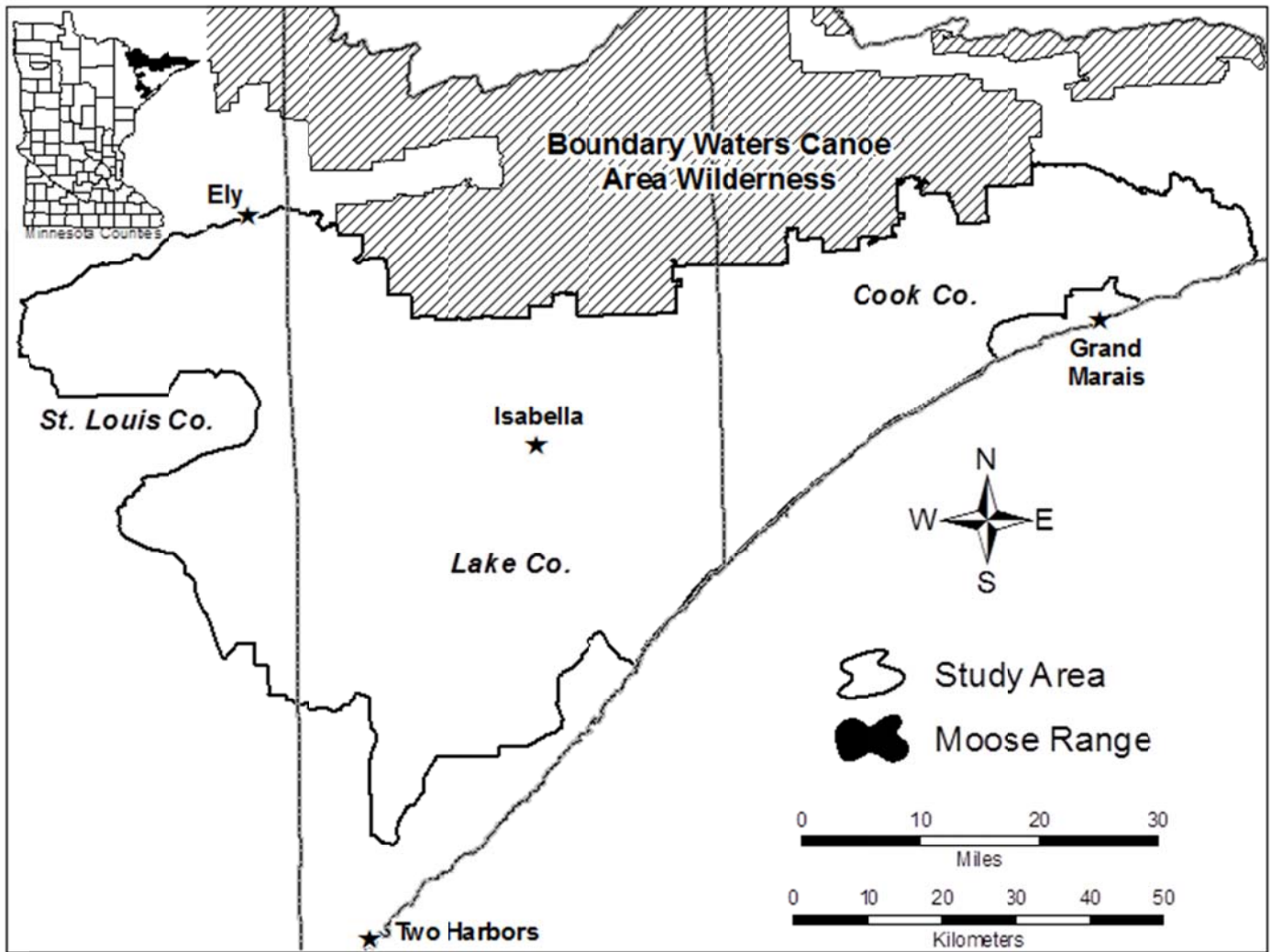
BUDGET ITEM	AMOUNT
<b>Personnel:</b>	
Wildlife Health Specialist, 1 FTE field data collection, analyze, field necropsies, outreach, 24 months, 50% effort (\$42,500/yr @75% salary, 25% fringe).	\$ 85,000
Spring field technicians (2): Full-time 120-day temporary hires to help with the calf capture operations, mortality investigations and necropsies, and habitat fieldwork	\$ 31,000
Student observer stipend: observe behavior of captive moose at MN Zoo to allow correlations with heart rate, internal temperature	\$ 10,000
Calf study fieldwork volunteer: room and board only	\$ 3,000
Fall Field technician (1): Full-time 120-day temporary hire to help with moose calf mortality investigations	\$ 8,200
<b>Contracts:</b>	
Wildlife helicopter capture company: Adult moose capture & handling (30 moose @ \$1,300 ea)	\$ 39,000
Wildlife helicopter capture company: Moose calf capture & handling (50 calves @ \$1,300 ea)	\$ 65,000
Univ. of Minnesota graduate student stipend (2 years) Leads fieldwork for capture operations, investigations of calf mortalities, and calving habitat analyses	\$ 80,000
University of Minnesota biometrician for statistical consulting (2.5 months @ 83% salary and 17% fringe)	\$ 26,795
University of California Davis, Veterinary Diagnostic Laboratory: metagenomics testing (screening of moose tissue for previously undiscovered disease) (est. 20 moose @ \$1,000 ea)	\$ 20,000
University of Minnesota, Veterinary Diagnostic Laboratory: diagnostic laboratory analyses associated with moose captures and necropsies	\$ 10,000
Iridium satellite adult moose data acquisition: transmission of location, temperature, heart rate data, and mortality messages	\$ 35,000
Globalstar satellite moose calf data acquisition: transmission of location and mortality messages	\$ 15,000
Direct and Necessary Services required to support this appropriation	\$ 49,903
<b>Equipment/Tools/Supplies:</b>	
GPS adult moose collars (30 @ \$3,000/each); collect location data, transmit temperature data and mortality notifications	\$ 90,000
GPS calf collars (50 @ \$2,000/each); collect location data, transmit mortality notifications	\$ 100,000
Subcutaneous heart rate monitors (5 @ \$1,000/each); collect internal heart rate	\$ 5,000
Ambient temperature loggers (30 @ \$150/each); logs ambient temperature of the specific moose	\$ 4,500
Capture drugs: \$250/moose for 30 moose; immobilization and reversal	\$ 7,500
Field supplies: Chainsaws, cell phones & boosters, necropsy supplies, canoes (2), life jackets	\$ 3,000
<b>Acquisition (Fee Title or Permanent Easements):</b>	N/A
<b>Travel:</b>	
Travel to study area by adult and calf moose project management staff (fleet @\$0.55/mi, estimated 20,000 miles)	\$ 11,000
Travel to study area by technicians and interns (fleet @\$0.55/mi, estimated 25,000 miles)	\$ 13,750
<b>Additional Budget Items:</b>	
Spotter plane to be used during adult and calf capture efforts (\$205/hour, 75 hours for each operation)	\$ 31,000
<b>TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =</b>	<b>\$ 743,648</b>

### V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
<b>In-kind Services During Project Period:</b>		
MNDNR Wildlife Health Program: Erika Butler, project management, field necropsies, analyze, write, outreach; 24 mos, 50% effort	\$ 79,670	Secured
MNDNR Forest Wildlife Populations & Research Group: Glenn D. DelGiudice, project management, fieldwork, data analysis, writing, outreach; 24 mos, 50% effort	\$ 95,250	Secured
MNDNR Wildlife Health Program: Michelle Carstensen, project management, field necropsies, analyze, write, outreach; 24 mos, 25% effort	\$ 39,475	Secured
MNDNR Wildlife Health Program: Erik Hildebrand, field data collection, field necropsies, outreach; 24 mos, 25% effort	\$ 25,990	Secured
University of Minnesota, Veterinary Diagnostic Laboratory; disease and health screening for dead moose (pathologists at 0.09 FTE for 2 years)	\$ 48,800	Secured
1854 Treaty Authority, capture & field necropsy support, supplies, equip., spotter plane costs	\$ 25,000	Secured
Fond du Lac Resource Management Division, capture support, field necropsy support	\$ 20,000	Secured
Natural Resources Research Institute: Ron Moen	\$ 10,000	Secured
<b>Funding History:</b> 2011 ENRTF funding for "Determining causes of death in declining moose population"	\$ 600,000	\$460k spent, \$140k obligated in FY14



MAP of the study area for the “Moose Decline and Air Temperatures” project in northeastern Minnesota





## Environment and Natural Resources Trust Fund (ENRTF)

### 2014 Manager Qualifications & Organization Description

**Project Title:** Moose decline and air temperatures in northeastern Minnesota

#### **PROJECT TITLE: Moose Decline and Air Temperatures in Northeastern Minnesota**

##### Michael A. Larson, Project Manager

Ph.D. 2001 University of Missouri, Fisheries & Wildlife Management

**Wildlife Research Group Leader** (2012–present) – Manage budgets and 8 permanent staff for MN DNR research and monitoring programs for moose, deer, bears, wolves, other furbearers, & grouse in Minnesota.

**Research Scientist** (2001–2012) – Developed and completed applied research projects on a variety of species (grouse, endangered shorebirds, marine mammals) for MN DNR, USGS, and USDA Forest Service.

##### Erika A. Butler, Primary Investigator – Adult component

D.V.M. 2006 University of Minnesota, College of Veterinary Medicine

**Wildlife Veterinarian** (2009–present), Wildlife Health Program – Dr. Butler is the Wildlife Veterinarian for the State of Minnesota where she investigates and manages diseases in the state’s wildlife populations. Dr. Butler is the project manager for the 2011 ENRTF-funded project “Determining causes of death in declining moose populations,” serves as a co-investigator for the “Moose calf survival and cause-specific mortality study,” and was the primary investigator on the “MN moose herd health assessment project.”

**Wildlife Veterinarian** (2007–2009) – Dr. Butler served as the North Dakota Game and Fish Wildlife Veterinarian prior to coming to MN. Primary job duties included monitoring the health and status of wild mammal, bird, and fish populations in ND by developing and implementing disease surveillance programs; responding to morbidity and mortality events; and conducting necropsies and examinations.

##### Glenn D. DelGiudice, Primary Investigator – Calf component

Ph.D. 1988 University of Minnesota, Wildlife Conservation

**Research Scientist (Moose Project Leader)**, Forest Wildlife Populations and Research Group (FWPRG, 2011–present) – Moose Project Leader orchestrates the MN DNR’s annual aerial moose survey in northeastern Minnesota, prepares the survey report, analyzes annual State moose harvest data and prepares the report, provides input on moose season-setting, and serves as a co-investigator on current moose research projects in northern Minnesota, including lead investigator on the recently-initiated “Moose Calf Survival and Cause-Specific Mortality Study” in collaboration with other scientists of the MN DNR, University of Minnesota–Duluth (NRRU), and the Fond du Lac Indian Band.

**Research Scientist (Deer Project Leader)**, FWPRG (1990–2011), led long-term research of the nutritional ecology of white-tailed deer in northern MN, examining relationships of winter severity, habitat, and food habits to deer nutritional status, movements, survival, cause-specific mortality, and reproductive success at the population level.

**Research Wildlife Biologist** (1980–present) – Also led research on the nutritional ecology of elk and mule deer in Arizona, elk and bison in Yellowstone National Park, caribou in Alaska, and moose on Isle Royale and in northern Minnesota.

**The mission of the MN DNR’s Section of Wildlife** is to work with the people of Minnesota to conserve and manage wildlife populations and habitats, to provide wildlife-related recreation, and to preserve Minnesota’s hunting and trapping heritage.