Environment and Natural Resources Trust Fund

2025 Request for Proposal

General Information

Proposal ID: 2025-309

Proposal Title: Recruitment and Fecundity of Minnesota Moose

Project Manager Information

Name: Michelle Carstensen

Organization: MN DNR - Fish and Wildlife Division

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Project Basic Information

Project Summary: Through a co-stewardship research project, state and tribal biologists will work collaboratively to estimate survival and fecundity of yearling and 2-year-old moose in northeast Minnesota to inform future management efforts.

ENRTF Funds Requested: $2,439,000

Proposed Project Completion: December 31, 2030

LCCMR Funding Category: Foundational Natural Resource Data and Information (A)

Project Location

What is the best scale for describing where your work will take place?

Region(s): NE

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Mooz, the Ojibwe term for moose or "twig eater", are vital to Indigenous rights-holders and stakeholders within the 1854 Ceded Territory in which three Ojibwe tribes have reserved rights to hunt, fish, and gather in what is now known as Minnesota. The population of moose in northeast Minnesota is half of what it was 20 years ago. Climate change may be the ultimate driver for the moose population decline; however, mechanisms driving the moose decline in Minnesota include winter ticks (Dermacentor albipictus), infection by brainworm (Parelaphostrongylus tenuis) with resultant paralysis and nutritional deficiency, and wolf (Canis lupus) predation. Recent studies to understand the factors affecting moose populations have collected data on adult and neonatal moose (see graphic). The proposed research project focuses on moose that would give birth at 2-years and 3-years old, when moose begin producing calves. Pilot research by the Grand Portage Band of Chippewa has indicated that moose can be captured and collared safely and successfully during their first winter (at 8-9 months old) and monitored for survival, habitat use, and causes of mortality. We propose to expand this work to the rest of core moose range in northeastern Minnesota (see map in graphic).

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

Using a co-stewardship framework with State and Tribal project leads, we will investigate recruitment of young moose (1 to 3-year-olds) into the breeding population by determining survival rates and age of first reproduction. Results will help identify habitat and wildlife management strategies that can be used to restore the moose population in Minnesota.
1: We will deploy GPS collars on 8- to 9-month-old moose across northeastern Minnesota moose range to measure survival rates, cause-specific mortality, and habitat use over a five-year period.
2: We will use non-invasive sampling techniques (fecal pellet collection) to determine age of first pregnancy for collared female moose.
3: We will use GPS collar data and aerial thermal surveys to determine parturition rates (percentage of moose giving birth), fecundity (number of calves born), and calf survival for 2 and 3-year-old female moose.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

To identify how yearling and 2-year-old moose contribute to restoring the moose population in Minnesota, we need survival rates, birth rates, and habitat use of these age classes. Results from this study will identify when female moose begin calving, indicate habitats that are related to survival and reproduction of yearling and 2-year-old moose (and their calves), identify cause-specific mortality, and identify how best to manage the species that affect moose (deer, wolves, and black bears). Further, if pregnancy rates vary across moose range, this may identify areas where forest management could potentially have the greatest positive impact on moose reproduction.

Activities and Milestones

Activity 1: Estimate survival and recruitment rates of moose from 8 months to 3.3 years old across northeast Minnesota.

Activity Budget: $1,783,780

Activity Description:
We will contract with a helicopter capture company to capture and collar 80 eight-month-old moose (20 males, 60 females) each January for three years. Capture effort will be dispersed throughout core moose range (see graphic). We will collect biological samples at capture to assess overall health, parasite exposure (especially P. tenuis and winter ticks), and morphological measurements to estimate body mass. GPS collars will be equipped with mortality sensors and will send mortality notifications via satellite. We will monitor all collared moose for survival from capture to 3.3 years old and investigate mortalities to determine cause of death. Survival and recruitment rates will be included in moose population models to increase accuracy of population trend estimates and identify how various management strategies may impact population performance.

Activity Milestones:

Description	Approximate Completion Date
Capture and collar 8-month-old female and male moose (January 2026, 2027, and 2028)	January 31, 2028
Evaluate health of moose at capture	January 31, 2028
Monitor moose movement and survival	September 30, 2030
Investigate mortalities through field necropsy or carcass extraction	September 30, 2030
Determine cause of death, parasite loads, and other health issues	September 30, 2030
Update vital rates in moose models, analyze all data	September 30, 2030
Interpret results and begin manuscripts	December 31, 2030

Activity 2: Determine pregnancy rates for 1.5 and 2.5-year old moose

Activity Budget: $226,412

Activity Description:
We will use a non-invasive field technique to determine pregnancy rate of females and determine age of first reproduction. Fecal pellets will be collected from collared females during winter. Fecal samples will be sent to the Smithsonian Conservation Biology Institute (Fort Royal, VA) for progesterone analyses to determine pregnancy status. To confirm fecal collections were obtained from the collared moose, a DNA match will be performed at the University of Minnesota-Duluth using a reference sample from each moose's original capture. Pregnancy is an important vital rate that serves as an indicator of adequate nutritional condition in moose; thus, improving our ability to determine if forage availability or quality may be limiting population growth in northeast Minnesota.

Activity Milestones:

Description	Approximate Completion Date
Collect feces from collared females during each winter to determine yearling pregnancy rate	March 31, 2030
Determine fecal progesterone levels to indicate pregnancy	March 31, 2030
Match DNA samples to verify individual moose	March 31, 2030
Update vital rates in moose models, analyze data	May 31, 2030

Activity 3: Determine fecundity of 2 and 3-year-old female moose and calf survival

Activity Budget: $428,808

Activity Description:

All collared female moose that were pregnant (determined in Activity 2) will be monitored for movements indicative of calving in May. This would be the first set of calves produced by these cows, at 2 or 3 years of age. Abrupt changes in movement/behavior patterns predict the occurrence of calving. However, these techniques alone cannot determine the number of calves produced by each pregnant female. We will use aerial thermal flights as a non-invasive method to confirm calving has occurred and determine the number of calves produced by each female moose. Given this technique is novel, we will plan to fly all female moose surviving to 2 years of age to reduce uncertainty in our fecundity estimates. All females that successfully produced at least one calf will have a secondary aerial thermal flight after leaf-off to estimate calf survival rates.

Activity Milestones:

Description	Approximate Completion Date
Intensely monitor females for calving movements	June 30, 2030
Conduct aerial thermal flights to determine fecundity	June 30, 2030
Analyze fecundity data	June 30, 2030
Conduct aerial thermal flights to determine calf survival	December 31, 2030
Analyze calf survival data	December 31, 2030
Interpret results and begin manuscripts	December 31, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Morgan Swingen	1854 Treaty Authority	Co-Project Manager; project leadership and fiscal management in a co-stewardship framework with DNR; lead moose capture and collaring operations, coordinate field work, respond to moose mortalities, and assist with manuscripts	Yes
Dr. Ron Moen	University of Minnesota - Duluth	Advise on project design, administer graduate student, model moose population, and assist with manuscripts	Yes
Dr. Seth Moore	Grand Portage Band of Lake Superior Chippewa	Advise on project design and data collection, assist with manuscripts, and provide in-kind research effort.	No
Dr. Janine Brown	Smithsonian Conservation Biology Institute	Analyze fecal samples for progesterone to determine pregnancy status of moose	Yes
Dr. Arno Wuenschmann	Minnesota Veterinary Diagnostic Laboratory	Train project team on field necropsy techniques, perform all diagnostics from biological samples of moose collected both at capture and death	Yes
Dr. Sergey Berg	University of St. Thomas	Provide consultation of moose model parameters and statistical methods	No
Dr. Michelle Verant	National Park Service	Provide wildlife veterinary consultation for moose capture operations	No

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

Data we collect on survival and reproduction of young moose will be directly applied to management questions, such as effective types and areas for habitat management and management of parasites and predators. In addition to informing management, we will pursue additional funding (Tribal Wildlife Grants, GLRI, internal DNR funding, America the Beautiful Challenge) to recollar moose at the end of this project. Known-age moose are valuable to inform ongoing population modeling work. Funding for this project could be used as match in other proposals, and recollaring known moose would greatly decrease time and cost required when additional funding is received.

Project Manager and Organization Qualifications

Project Manager Name: Michelle Carstensen

Job Title: Wildlife Health Program Supervisor; Co-Project Manager with 1854 Treaty Authority for this proposal

Provide description of the project manager's qualifications to manage the proposed project.

Dr. Michelle Carstensen has a B.S. in Animal Science from Cornell University, a M.S. and Ph.D in Wildlife Conservation from the University of Minnesota. She has been working for the Minnesota Department of Natural Resources for 20 years, leading efforts to monitor, manage, and research the health of the state's game species. Her work has included surveillance and management of bovine tuberculosis, chronic wasting disease, and epizootic hemorrhagic disease in deer, avian influenza and Newcastle disease virus in waterfowl, and survival and cause-specific mortality of moose. She is an adjunct professor with the College of Veterinary Medicine, University of Minnesota and works collaboratively with tribal, state, federal and academic institutions across the country on wildlife health projects. She serves as the DNR's Subject Matter Expert of moose health, is an Associate Editor of the Alces journal, and an active member of both the

Wildlife Disease Association and the Wildlife Society. Her current projects include assessing heat stress in moose, predicting climate change impacts to moose populations and how forest management may restore moose habitat, contaminate exposure (PFAS and neonicotinoids) in deer and waterfowl, elk genetics, and effectiveness of culling as a tool to manage chronic wasting disease.

Organization: MN DNR - Fish and Wildlife Division

Organization Description:
This is a co-stewardship project with Minnesota Department of Natural Resource (DNR) and 1854 Treaty Authority. The DNR is a state natural resource agency dedicated to protecting and managing land, water, fish and wildlife, and providing access to outdoor recreation opportunities. DNR's mission is to “work with citizens to conserve and manage the state's natural resources." The 1854 Treaty Authority is an inter-tribal natural resources agency governed by the Bois Forte Band of Chippewa and Grand Portage Band of Lake Superior Chippewa. The 1854 Treaty Authority protects and implements the off-reservation hunting, fishing and gathering rights of the Grand Portage and Bois Forte bands in the 1854 Ceded Territory, which is present-day northeastern Minnesota. The mission of the 1854 Treaty Authority is to “ensure that the rights secured to member Indian tribes by treaties of the United States to hunt, fish and gather within the 1854 Ceded Territory shall be protected, preserved, and enhanced for the benefit of present and future member Indian tribes in a manner consistent with the character of such rights, through provision of services.” Our collaborative research will provide information needed to help recover and maintain a sustainable moose population in Minnesota for all citizens.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
2 Natural Resource Technicians		collect fecal samples in winter, support capture operations and mortality responses			40%	1.5		$186,062
Moose Field Biologist		field support for capture operations, coordinate mortality investigations, assist technicians and grad student with field work, monitor moose movement data			40%	5		$466,775
On-call Pay for DNR staff		weekend and holiday support for a maximum of 2 staff to monitor moose for mortality events and conduct timely investigations			40%	0.9		$59,193
							Sub Total	**$712,030**
Contracts and Services								
Minnesota DNR Enforcement Division	Professional or Technical Service Contract	Aviation support for moose captures ($360/hr for locating moose, 40 hours each year, 3 years = $43,200) and thermal imaging flights ($425/hr for locating calves in May and Dec each year, 80 hours annually, 3 years = $102,000)				-		$145,200
TBD	Professional or Technical Service Contract	A helicopter capture company will capture and collar 80 moose per year for 3 years, at $1,300/moose				-		$312,000
Smithsonian Conservation Biology Institute	Professional or Technical Service Contract	Provide laboratory services for pregnancy testing via fecal progesterone ($25/sample, 300 samples over 4 years				-		$7,500
University of Minnesota-Duluth	Professional or Technical Service Contract	Conduct genetic testing of fecal samples ($42.50/each, 300 samples over 4 years) to ensure the correct collared moose was tested for pregnancy status				-		$12,750
University of Tennessee	Professional or Technical Service Contract	Conduct serologic testing for P. Tenuis exposure of moose at capture ($25/each, 80 moose/year, 3 years)				-		$6,000

University of Minnesota, Veterinary Diagnostic Lab	Professional or Technical Service Contract	Conduct necropsies of collared moose to determine cause of death and pathogen or parasite exposures ($250/each, 40 moose/year, 5 years)				-		$50,000
University of Minnesota, Clinical Pathology Laboratory	Professional or Technical Service Contract	Analyze serum chemistries and blood profiles of moose at capture to determine their health status ($200/each, 80 moose/year, 3 years)				-		$48,000
University of Minnesota-Duluth:	Professional or Technical Service Contract	Provides support for a Ph.D student ($191,206, 5 years); 5% faculty support ($29,602, 5 years); travel to field sites using fleet vehicle ($26,800, 3 years), and snowmobiles/ATVs ($36,000, 3 years)				-		$283,608
							Sub Total	**$865,058**
Equipment, Tools, and Supplies								
	Equipment	GPS collars for 80 moose/year at $1,880/each, for 3 years	Monitoring movements of moose for survival, calving, and investigating cause of death					$451,200
	Equipment	Data subscription and transmission fees for 240 collars	GPS collar fees: activation fee of $30/each = $7,200; data fees of $24/collar and transmission fees of $284.70/year for an estimate of 80, 140, 200, 160, 120 active collars over 5 years, respectively = $160,055					$167,255
	Tools and Supplies	Capture supplies, immobilization drugs, and biological sampling supplies	Chemically immobilize moose during capture operations, uniquely mark individuals, collect samples to assess health and genetics					$15,000
	Tools and Supplies	Necropsy supplies, fecal collection materials	Supplies to conduct field necropsies in remote locations and collect biological samples to determine cause of death and health status of individual moose, sampling materials for fecal collections to determine pregnancy and genetic matches					$22,745
							Sub Total	**$656,200**

Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Fleet costs for project team (1 vehicle at 20,000, 5 years and 1 at 10,000 miles for 4.5 years @ $0.67/mi)	Travel to conduct moose capture operations, respond to mortalities and collect biological samples or transport carcasses to the laboratory					$97,150
	Miles/ Meals/ Lodging	Fleet costs for technicians (1 vehicle for 10,000 miles @ $0.67/mi, 3 years)	Travel to support capture operations and collect fecal samples for pregnancy determination					$20,100
	Miles/ Meals/ Lodging	Lodging and meals for project team during field deployments	Project team will be deployed during moose capture operations and mortality responses that will require overnight lodging and meal reimburements					$24,000
							Sub Total	**$141,250**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		Direct and Necessary Costs (only applies to DNR portion of the funding)	HR Support ($14,207), Safety Support ($1,994), Financial Support ($7,230), Communication Support ($1,528), IT Support ($38,365), and Planning Support ($1,137).					$64,462

							Sub Total	**$64,462**
							Grand Total	**$2,439,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	Game and Fish Fund	Minnesota DNR Wildlife Health Program: Dr. Michelle Carstensen, project management, fieldwork, data analysis, writing, outreach, supervising graduate student; 60 mos, 50% effort	Secured	$262,500
In-Kind	Game and Fish Fund	Minnesota DNR staff support for capture operations and on-call mortalities responses, 8-12 staff, 60 mos, 5% effort	Secured	$150,000
			State Sub Total	**$412,500**
Non-State				
In-Kind	Tribal	1854 Treaty Authority: Morgan Swingen, project management, fieldwork, data analysis, writing, outreach, supervising technicians & graduate student; 60 mos, 20% effort	Secured	$93,750
In-Kind	Natural Resources Research Institute	University of Minnesota-Duluth, Natural Resources Research Institute: Unrecovered indirect costs (55% of total direct costs) for faculty and student support and administrative services	Secured	$140,724
In-Kind	Tribal	Grand Portage Band of Lake Superior Chippewa: Dr. Seth Moore, project management, field work; 60 mos, 5% effort ($35,000), matching moose capture and monitoring project on reservation lands and ceded territories of 10 juvenile/year ($102,000 in collar fees, $39,000 in capture costs, $15,000 for immobilization drugs, and $67,500 in tribal staff effort for monitoring and mortality investigations; 3 years).	Secured	$258,500
			Non State Sub Total	**$492,974**
			Funds Total	**$905,474**

Total Project Cost: $3,344,474

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 6c2d3ac9-559.pdf

Alternate Text for Visual Component

This visual highlights the knowledge gap of information related to survival, pregnancy, fecundity, and causes of mortality for moose between 8 months of age and 3 years old. A map displays northeast Minnesota and highlights core moose range where this study will take place....

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
1854 Treaty Authority Authorization Letter	c188d1c2-114.pdf
Grand Portage Commitment Letter	0c0f2731-5c3.pdf
NRRI Letter of Support	fa6cb516-fca.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

No

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing $10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Morgan Swingen (1854 Treaty Authority), Seth Moore (Grand Portage Band of Lake Superior Chippewa), Ron Moen (University of MN-Duluth)