Environment and Natural Resources Trust Fund
2015 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **013-A**

Genetic and Camera Techniques to Estimate Carnivore Populations

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 236,326

Proposed Project Time Period for the Funding Requested: 2 years, July 2015 - June 2017

Summary:

We will use genetic sampling and remote cameras to estimate population size of carnivore species. A new method to estimate wolf population size is an immediate practical application of products.

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Sponsoring Organization: U of MN - Duluth NRRI

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Location

Region: Central, NW, NE

County Name: Aitkin, Beltrami, Carlton, Cook, Itasca, Koochiching, Lake, St. Louis

City / Township:

Alternate Text for Visual:

Images of carnivores from remote cameras and sample genetic analysis

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

PROJECT TITLE: Genetic and Camera Techniques to Estimate Carnivore Populations

I. PROJECT STATEMENT

Minnesota has 18 carnivore species, ranging in size from the tiny least weasel to the black bear. The development of genetic DNA analysis and increasing use of trail cameras make it possible to improve existing methods of monitoring distribution and numbers of carnivores. Trail cameras would also provide a mechanism for significant public involvement with future development of a citizen science component.

The specific goals of this proposal for carnivore populations are:

1. **Develop a genetic sample collection and analysis protocol to estimate genetic effective population size and census population size for carnivore species from mark-recapture data when possible.**
2. **Develop a remote camera based protocol for independent estimates of census population size**
3. **Review historical trends in distribution and abundance from museum records and DNR data**

Developing expertise and knowledge about Minnesota carnivores is important because:

1. Wolves are now being managed by the DNR. The DNR needs an accurate estimate of wolf numbers for harvest management, and to consider interactions with other species (e.g., moose and deer).
2. Mountain lions are not classified as permanent residents, yet there are reports from road kills, trail cameras, or visual sightings each year. Verified reports and other sightings would help document status.
3. Raccoons and skunks appear to have increasing populations in urban areas. The potential for transmission of diseases to humans and pet animals exists (e.g., raccoon roundworm). Proactive knowledge of population sizes would help future disease management actions.

Wolves, mountain lions, raccoons, and skunks are 4 of the 18 different species of carnivores in Minnesota. Some species such as the coyote, mink, black bear, and raccoon are common throughout much or all of Minnesota. Other species (wolverine, mountain lion, spotted skunk) are either at the extreme edge of their distribution or are only known from historical accounts or recent occasional reports.

Step 1. Genetic Sampling Protocol. Recent developments in genetic analyses make it possible to estimate population sizes using field sampling techniques, high throughput genetic sequencing, and statistical techniques for analysis. Genetic analysis of DNA from tissue, hair, or scat can be used to estimate the genetic effective population size, which is an important measure of the amount of genetic variation in a species. Species with large census population sizes may still have low genetic variation, and so genetic and camera-based estimates of population size will provide complementary information about the status of each species in Minnesota. In addition, genetic data sampled throughout species' ranges in the state will allow us to infer patterns of migration and dispersal by tracking the spread of genetic variants. The use of high throughput genetic sequencing will provide us with large amounts of genetic data in a very cost effective manner, allowing us to make accurate estimates of genetic effective population size and recent population size changes. Field sampling will be for hairs, scat, or tissues depending on the species. Genetic analysis will be done by us in Minnesota (UMD) and statistical techniques will be developed from the literature and in collaboration with others.

Step 2. Developing Remote Camera Protocol. Remote cameras provide an efficient means of establishing the presence of rare and elusive species across a wide geographic area. Variables such as placement location, type of lure used, season of deployment, etc. must be accounted for when interpreting results from camera-based studies, but we will develop techniques to do this using our camera protocol, augmented by pictures submitted by the public. The genetic and census population size estimates will be compared, and this comparison will provide important information regarding recent population size changes and effects of harvests and other human activities.

Step 3. Review Historical and Current Status of Carnivores. Museum records, mammal distribution records, and DNR data will be reviewed for each carnivore species. Wolves and bears have relatively extensive records and history. Other species such as the least weasel and the spotted skunk have few available records or data.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Determine population sizes of carnivores **Budget: $236,326**

We will design a sampling protocol for field collection of samples for DNA extraction and analysis from several carnivore species, in addition to using samples already available for some species. Samples will be analyzed genetically and then statistical analyses will enable us to estimate genetic effective and census population sizes. We will deploy remote cameras at sites that are sampled genetically. Pictures of carnivores will enable us to estimate population size and do occupancy modeling. Museum records, harvest records, DNA data, and other reports will be used to estimate species distributions and abundances across time, providing a comprehensive picture of MN carnivore species population sizes and trends from a genetic and organismal perspective.

Outcome	Completion Date
1. Genetic estimate of wolf population size from mark-recapture in year 1	12/31/2016
2. Population size estimate from mark-recapture completed for selected carnivores	3/15/2017
3. Genetic effective population size and dispersal events identified for selected carnivores	3/15/2017
4. Report summarizing census and genetic effective population size estimates and trends	6/30/2017

III. PROJECT STRATEGY

A. Project Team/Partners

Dr. Ron Moen (NRRI-UMD) is overall project manager and will design camera deployment and field sample collection protocols.

Dr. Jared Strasburg (UMD) will manage the genetic analysis component of this project.

Other individuals will assist or provide advice on parts of this project, including:

Dr. John Erb (MN DNR) will provide input and some samples, with an intent to make long-term use of techniques developed in this proposal for DNR management purposes.

Dr. Steve Windels (Voyageurs National Park) will cooperate on the remote camera project and genetic sampling. He already has cameras deployed to test a mark-recapture method of estimating presence and abundance of carnivores in Voyageurs.

B. Timeline Requirements

This project would require 24 months of ENRTF funding from 7/1/2015 to 6/30/2017. We are ready to begin this project with existing equipment and facilities.

C. Long-Term Strategy and Future Funding Needs

Our long term strategy is to develop the ability to do genetic analysis of wildlife populations in Minnesota with in-house expertise. Specific applications will vary from estimates of wolf population size to pro-active preparation for future wildlife issues. For example, wildlife diseases and parasites may become important if they are transmitted to humans or companion animals like dogs and cats, like the raccoon roundworm example above.

We envision this as a project to develop techniques focussing on carnivore species in northeastern Minnesota. As techniques are successfully developed, we will expand to other parts of the state. Over the long-term, a genetic approach should decrease uncertainty in population estimates and even enable analysis of trends over time. The update on carnivore species status would need to be coordinated with the County Biological Survey data, and could be somewhat analogous to the ENRTF supported Breeding Bird Atlas Project in that it would result in a record of carnivore species distribution and abundance with the benefits of additional genetic data.

2015 Detailed Project Budget

Project Title: Genetic and Camera Techniques to Estimate Carnivore Populations

IV. TOTAL ENRTF REQUEST BUDGET *2* **years**

BUDGET ITEM	AMOUNT
Personnel	
Ron Moen, Principal Investigator (66.4% salary, 33.6% benefits); 6% FTE for 2 years	$ 12,933
Jared Strasburg, Co-Investigator (66.4% salary, 33.6% benefits); 1 month SUM-63.5% FTE for 2 years	$ 12,980
Field & Lab Technician (63.2% salary, 36.8% benefits); 25% FTE for 2 years	$ 23,567
Graduate Research Assistant (AY-84.3% salary, 15.7% benefits, and $17.32/hr tuition reimbursement cost; SUM-76.9% salary, 23.1% benefits, no tuition costs); AY-50% FTE, SUM-50% FTE for 2 years	$ 99,114
Undergraduate Research Assistant (100% salary, 0% benefits); AY-50% FTE, SUM-50% FTE for 2 years	$ 27,732
Contracts	n/a
Equipment/Tools/Supplies	
Trail cameras (20 estimated @ $400 each), purchased in year 1	$ 8,000
Genetic analysis supplies ($15,000 per year)	$ 30,000
Field supplies ($1,000 per year) (Batteries, mosquito repellent, flagging, etc.)	$ 2,000
Acquisition (Fee Title or Permanent Easements)	n/a
Travel	
In-state travel to/from field sites ($10,000 per year). Cameras will need to be deployed and maintained at sites in NE Minnesota and material will be collected for genetic analysis, requiring the use of University vehicles. Some trips will involve longer-distance travel and require overnight expenses (camping or motel) and food expenses.	$ 20,000
Additional Budget Items	n/a
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 236,326

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 Ron Moen salary/fringe (66.4% salary, 33.6% benefits); 3% FTE for 2 year(s)	$ 6,450	*Secured*
Other State $ To Be Applied To Project During Project Period Jared Strasburg salary/fringe (66.4% salary, 33.6% benefits); 3% FTE for 2 year(s)	$ 6,450	*Secured*
Foregone by UMN ICR funding (52% MTDC, excluding graduate fringe)	$ 105,084	*Secured*
In-kind Services To Be Applied To Project During Project Period	n/a	
Funding History. We have been developing the genetics and the field sampling components of this project over the past 2 years. Wolf scat and tissue samples from DNR wolf collar program are being analyzed genetically by a M.S. student we co-advise, and we have hundreds of thousands of trail camera pictures that could be used as a resource.	$ -	
Remaining $ From Current ENRTF Appropriation $157,000 remaining from ML-2013, Chapter 52, Sec 2, Subd. This project will be finished 6/30/2016	$ 157,000	*Unspent*

Figure 1. Some example trail camera pictures that could be used in a mark-recapture estimate of population size. These pictures were all taken in northeastern Minnesota.

Figure 2. Differences in base pairs among individuals (to right) lead to an estimate of effective migration or dispersal of individuals in a population. This example is for sunflowers from Strasburg (2006). We will use the same techniques on wolves and other carnivore species.

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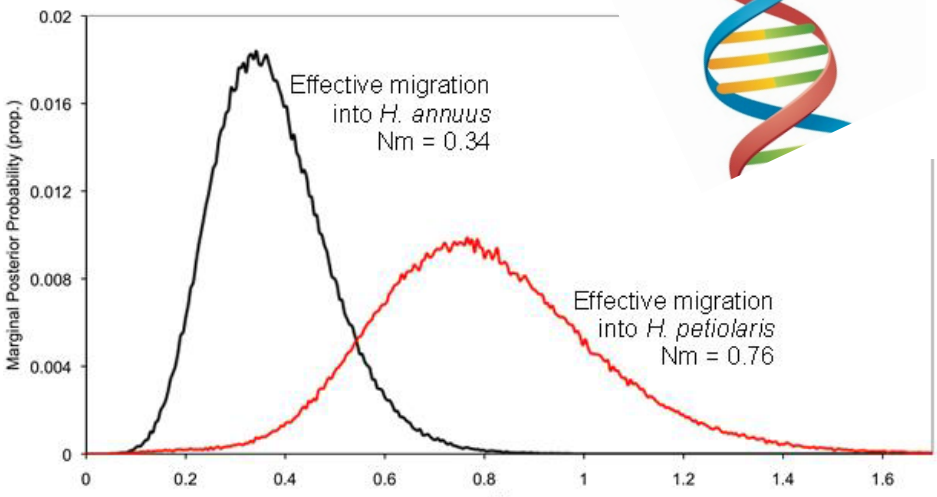

2015 LCCMR Project Manager Qualifications and Organization Description

Dr. Ronald Moen and Dr. Jared Strasburg, University of Minnesota Duluth.

Dr. Moen will lead field components and Dr. Strasburg will lead genetics components of this project.

Key Qualifications

Dr. Moen is a Senior Research Associate at the Natural Resources Research Institute, Adjunct Assistant Professor in the Department of Biology at the University of Minnesota Duluth, with appointments in Integrated BioSciences (Duluth) and Conservation Biology (Twin Cities) graduate programs.

Dr. Strasburg is an Assistant Professor in the Department of Biology at the University of Minnesota Duluth, with an appointment in the Integrated Biological Sciences graduate program (Duluth campus).

Education

Moen: University of Minnesota, Wildlife Conservation, Ph.D. 1995, University of Minnesota, Wildlife, M.S. 1988, Cornell University, Biological Sciences, B.S. 1984

Strasburg: Washington University in St. Louis, Evolution, Ecology, and Population Biology, Ph.D. 2004 University of Missouri Rolla, Biological Sciences, B.S. 1997

Selected Grants

2014. National Science Foundation. Comparative Landscape Genetics of the Lyme Disease System. **R. A. Moen, J. L. Strasburg**. In review.

2014. University of Minnesota Grant-in-Aid of Research, Artistry, and Scholarship. Non-Invasive Genetic Estimation of Population Size in Yellowstone Moose. **J. L. Strasburg**. In review.

2014. University of Wyoming-National Park Service. Estimating Population Demographics of Moose in Yellowstone National Park Using Non-Invasive Methods. **J. L. Strasburg**. In review.

2013. Preliminary data collection for Minnesota moose population genetic analysis. UMD Chancellor's Faculty Small Grant. **J. L. Strasburg**. $2,000.

2013. National Park Service / CESU. Climate Change Adaptation Planning for Northern Forest Ecosystems in the Great Lakes National Parks. **R. Moen**, L. Frelich., S. Windels. $400,000.

2013. Environment and Natural Resources Trust Fund. Moose habitat restoration in northeastern Minnesota. **R. Moen**. $200,000.

Selected Publications

McCann, N., R. Moen, and T. Harris. 2013. Moose respiration rates in relation to temperature and humidity. Canadian Journal of Zoology 91:893-898.

Strasburg J.L., N.C. Kane, A.R. Raduski, et al. 2011. Effective population size is positively correlated with levels of adaptive divergence among annual sunflowers. Molecular Biology and Evolution 28, 1569-1580.

McGraw, A.M., R.A. Moen, and L. Overland. 2012. Effective Temperature of Cover Types Found in Moose Home Ranges in Northeast Minnesota. Alces 48:45-52.

Strasburg J.L. 2006. Conservation biology – roads and genetic connectivity. Nature 440, 875-876.

Moen, R.A., S.K. Windels, and B. Hansen. 2012. Suitability of Voyageurs National Park as Canada lynx habitat. Natural Areas Journal 32:348-355.

Moen, R.A., M.E. Nelson, and A. Edwards. 2011. Radiotelemetry locations, home ranges, and aerial surveys in Minnesota. Alces 47:101-112.

The **Natural Resources Research Institute** is a part of the University of Minnesota Duluth. NRRI's mission is to promote private sector employment based on natural resources in an environmentally sensitive manner. Genetics facilities are installed at the **Department of Biology**, UMN-Duluth.