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

Project Title: **ENRTF ID:** **027-A**

LiDAR for Wildlife in Northeastern Minnesota

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 99,717

Proposed Project Time Period for the Funding Requested: 1 year, July 2015 - June 2016

Summary:

We will create a LiDAR-based coverage of vegetation structure from raw LiDAR data that was flown in 2011. Our work will improve research and management on most forest wildlife species.

Name: Ron Moen

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Location

Region: NE

County Name: Cook, Lake, St. Louis

City / Township:

Alternate Text for Visual:

Examples of LiDAR processing to create layers valuable for wildlife habitat analysis

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

PROJECT TITLE: LiDAR for Wildlife in Northeastern Minnesota

I. PROJECT STATEMENT

The Clean Water, Land, and Legacy Amendment approved by Minnesota voters in 2008 dedicates part of the state's sales tax to the Clean Water Fund. The Clean Water Fund provided base funding for a state-wide $10 million LiDAR acquisition project managed by MN DNR between 2010 and 2012. Useful calculated products from this project include digital elevation models, contour lines, building footprints, and raw data "clouds" that were part of the original RFP goals (http://geoint.lmic.state.mn.us/lidar.php).

Need:

At the same time, much more can be done with existing LiDAR data for wildlife and habitat management. There is a strong interest among biologists and managers for additional LiDAR products directly relevant to wildlife habitat requirements. Holding back this use is availability of useable LiDAR products on wildlife habitat. We want to use this type of data in our own research projects and we have been developing the organizational foundation to create this value-added product. We have also been developing the capability to enable other users (biologists, managers) to access the data we create.

For this project we will create a new interpreted LiDAR-based coverage of 3-D vegetation structure from raw LiDAR imaging data that has already been acquired. Our work will lead to improved research and management on most forest wildlife species. The new product will:

1. Answer wildlife habitat management and ecological questions for existing research projects, and
2. Deliver new LiDAR-based GIS products for Internet download.

Benefit:

We predict that our new LiDAR-based coverage of 3-D vegetation structure will improve research and management on most forest wildlife species. Vegetation structure is critical to wildlife use of habitats, and LiDAR makes it possible to carefully measure habitat quality across broad spatial scales. Wildlife management decisions will be more effective when landscape-scale vegetation data is available.

The benefit of creating this LiDAR-based GIS coverage is that resource managers and scientists will be able to access habitat data at the resolution with which animals perceive their habitat. This creates the potential for a fundamental change in how we manage natural resources. Some examples illustrate this point:

Example 1: American pine marten populations have been declining in Minnesota, with reduced season lengths and reduced harvest a consequence. The DNR responded with a project in which over 225 marten have been radiocollared to measure reproduction, survival, and habitat use. In a pilot project we are examining the utility of LiDAR to measure vegetative characteristics that correlate with habitat use.

Example 2: The Canada lynx is the only mammal species protected under the Endangered Species Act in Minnesota. The primary prey of Canada lynx is the snowshoe hare. I have a 10-year record of hare pellet counts in northeastern Minnesota. Hare pellet counts index the hare population size, and hare presence is correlated with understory structure that should be measurable with LiDAR.

Example 3: Many resources have been invested to prevent or slow the decline of moose populations in Minnesota. A LiDAR processing approach focused on forestry applications showed that daytime bedsite locations are correlated with canopy cover in warm weather. Additional LiDAR fields specific to wildlife will enable identification of locations with similar characteristics that moose will use across the landscape.

Each example has a common characteristic: hundreds to millions of GPS locations that identify a point from which data have been collected or animal locations have been obtained. LiDAR-based products allow us to use this data to its full potential. The end result of the project will be access to high resolution habitat data that managers and scientists can use to benefit Minnesota's wildlife and plant resources.

We will use the LiDAR output with collaborators to demonstrate the value of the proposed project. Other projects include bird distribution and abundance data has been collected for over 20 years at plots in Superior National Forest by Niemi and more recently as part of the ENRTF funded Breeding Bird Atlas Project, habitat use by the northern long-eared bat which has been proposed for listing by the U.S. FWS. Tree species compositions and thermal characteristics of the landscape are being measured using dataloggers at 102 sites in and near the BWCA from an ENRTF project to Frelich.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Improve Wildlife Habitat Management and Ecological Research in NE MN using LiDAR **Budget: $99,717**

We will develop methods for automating LiDAR processing beyond the pilot study scale. Covering 3 counties is a large scale project (e.g., 40 TB of disk space) that is computationally intensive. We will create a single coverage across NE MN that includes different ownerships. Conifer and deciduous shrubs and trees, tree density, and tree heights will be identified. We will make the LiDAR product available for internet download.

Outcome	Completion Date
1. Produce LiDAR GIS coverage for Cook and Lake Counties.	6/30/2016
2. Implement Internet download capability of LiDAR GIS coverage.	6/30/2016
3. Interpret and suggest improvements to habitat management recommendations for moose, American marten, bats, birds, and tree species with new LiDAR GIS coverage.	6/30/2016
4. Produce LiDAR GIS coverage for St. Louis County.	6/30/2016
5. Provide technical assistance for other agencies and scientists throughout this project.	6/30/2016

III. PROJECT STRATEGY

A. Project Team/Partners

Dr. Ron Moen (NRRI-UMD) is project manager and will supervise graduate students and post-docs using LiDAR for work on American marten, wolves, deer, snails, ticks, bats, and perhaps other species.
Dr. Kirk Stueve (NRRI-UMD) will implement LiDAR processing, supervise student employees, and do QA/QC.
Michael Joyce (NRRI-UMD) is a Ph.D. student who will do LiDAR processing and biological interpretation.
Dr. Lee Frelich (UM-TC) will use LiDAR on ENRTF project "Change and Resilience in Boreal Forests."
Dr. Gerald Niemi (NRRI-UMD) will use LiDAR output to analyze data collected over the past 20 years on breeding bird census plots and the ENRTF funded Breeding Bird Atlas Project.
Minnesota DNR. We are working on projects with the MN DNR (e.g., American marten with Dr. John Erb, Furbearer biologist, moose research, bat research). We believe that other MN DNR projects will also find the LiDAR output useful.

B. Timeline Requirements

This project would require 12 months of ENRTF funding from 7/1/2015 to 6/30/2016. We are ready to begin this project with LiDAR data at NRRI, a fiber optic internet connection, and preliminary work to determine feasibility of the processing protocol. We have already set up a pilot program with a data delivery mechanism. In addition, we will be building 2 or 3 computers in 2014 to do initial LiDAR processing.

C. Long-Term Strategy and Future Funding Needs

Scientists and resource managers want to apply LiDAR to improve analysis of habitat characteristics for different wildlife species. With future funding we could use the framework developed in this proposal to extend the LiDAR output to other forested regions of Minnesota. We expect this product to be useful for the next 7 to 10 years, after which it would be desireable to collect LiDAR again. When LiDAR is collected again it would be possible to repeat the processing protocol to detect change that has occurred.

2015 Detailed Project Budget

Project Title: LiDAR for Wildlife in Northeastern Minnesota

IV. TOTAL ENRTF REQUEST BUDGET: 1 year

BUDGET ITEM	AMOUNT
Personnel:	
Ron Moen, Principal Investigator (66.4% salary, 33.6% benefits); 4.71% FTE for 1 year	$ 5,000
Kirk Stueve, Data Analyst & Lab Tech (79.25% salary, 20.75% benefits); 25% FTE for 1 year	$ 18,734
Senior Lab Technician (63.2% salary, 36.8% benefits); 30% FTE for 1 year	$ 20,027
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 1 year	$ 40,113
Undergraduate Research Assistant (100% salary, 0% benefits); AY-45% FTE, Sum-60% FTE for 1 year	$ 14,343
Contracts:	n/a
Equipment/Tools/Supplies:	n/a
Acquisition (Fee Title or Permanent Easements):	n/a
Travel:	
In-state travel to-and from field work sites	$ 1,500
Additional Budget Items:	n/a
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 99,717

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: 4 computers built for processing LiDAR (i7, 32 GB Ram, 512GB SSD, 4 TB HD)	$ 5,000	*Secured*
Other State $ To Be Applied To Project During Project Period: Ron Moen salary/fringe (66.4% salary, 33.6% benefits); 4.71% FTE for 1 year	$ 5,000	*Secured*
Foregone by UMN ICR funding (52% MTDC, excluding graduate fringe):	$ 43,442	*Secured*
In-kind Services To Be Applied To Project During Project Period: Continued data collection on several research projects will be directly incorporated into the use of LiDAR output.	n/a	
Funding History: Ron Moen, Kirk Stueve, and Michael Joyce have been developing pieces of this proposed work since 2013 to establish feasibility and technical requirements. They will continue developing parts of the proposed work on a small scale throughout 2014.	n/a	
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. Comparison of LiDAR data "cloud" in thinned and mature forest stands on left. On right is visualization of LiDAR imagery from Lake county we did showing a cut area, stream, and forest using the Fusion software. We will use LiDAR data to obtain accurate measurements of shrub density, tree density, and tree heights. Birds and bats will clearly move through a mature forest stand differently from a thinned forest stand. These differences can be detected in existing LiDAR imagery with our analysis method.

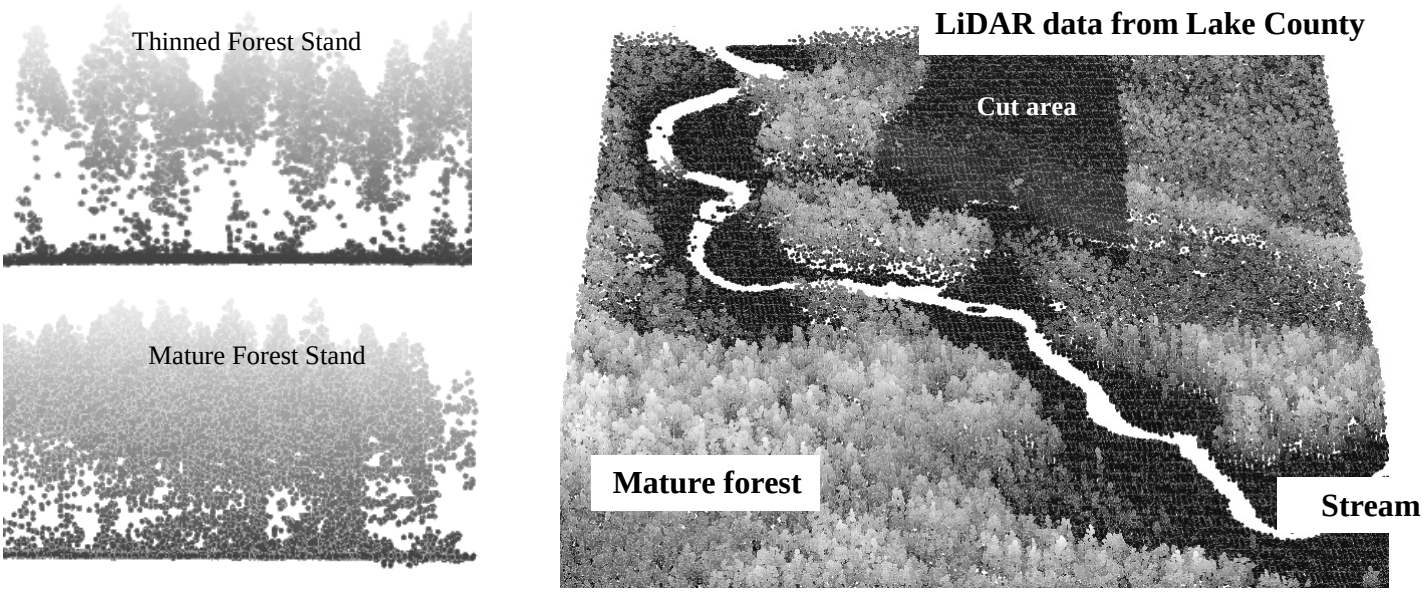

Figure 2. Aerial photograph and LiDAR analysis of moose locations. Moose are using cover in daytime and foraging at night in these locations. The strength of LiDAR will be that we can analyze locations automatically.

A. 2009 Aerial Photograph B. 2011 LiDAR raster

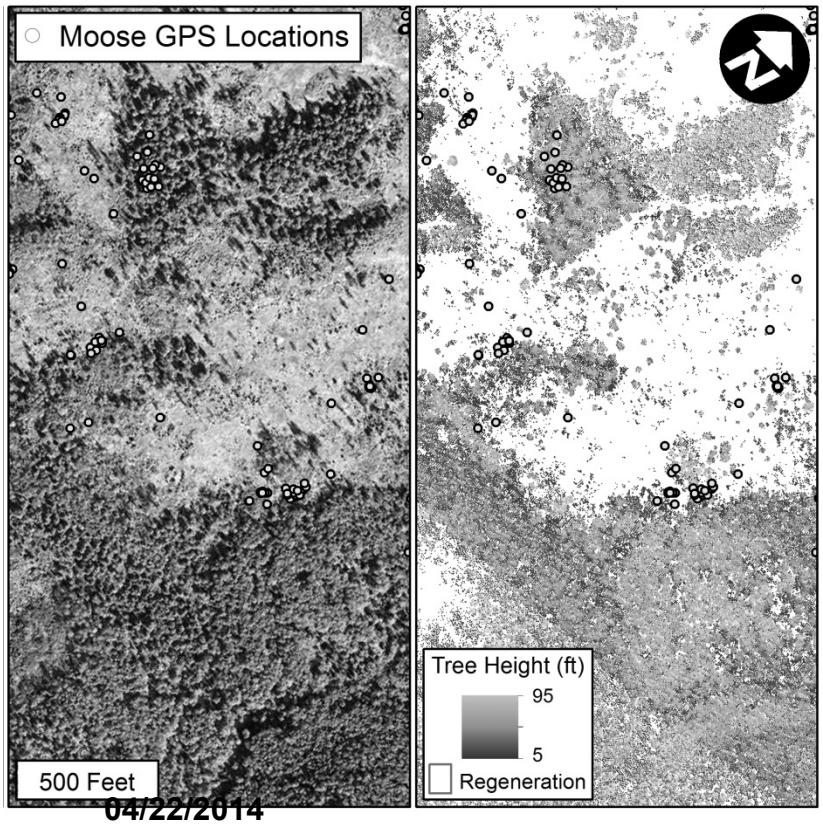

Table 1. We will create a LiDAR-based coverage of vegetation structure from raw LiDAR data collected in 2011. Our work will improve research and management on most forest wildlife species.

Species	Data Points
Moose 	2 million GPS locations 80 birth sites 200 foraging paths 155 bed sites
Wolves	>2,000 GPS locations
Deer	> 3,500 GPS locations
Canada lynx	~8,000 GPS locations 14 den sites
Snowshoe hare	> 900 pellet plots
Songbirds	~300 permanent plots
Wood turtles	~200 locations
Bats	~100 acoustic survey sites ~10 roost trees
Pine Marten 	>6,500 telemetry locations 250 dens and rest sites >200 vegetation plots

2015 LCCMR Project Manager Qualifications and Organization Description

Ronald A. Moen, Natural Resources Research Institute, University of Minnesota Duluth

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 the graduate programs of Integrated Biological Science (Duluth campus) and Conservation Biology (Twin Cities campus).

Education

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

Selected Grants

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.
2010. Environmental Protection Agency Great Lakes Restoration Initiative. Restoring moose foraging habitat in Lake Superior Uplands. R. Moen. $198,000.
2010. Environment and Natural Resources Trust Fund. Identifying critical habitats for moose in northeastern Minnesota. R. Moen, M. Lenarz, M. Schrage, A. Edwards, and M. Johnson. $510,000.
2009. U.S. Fish and Wildlife Service. Seth Moore, Andrew Edwards, and R.A. Moen. Mooz (Moose) habitat use in a changing climate. $199,999.
2009. U.S. Geological Survey. Steve Windels, Michael E. Nelson, and R.A. Moen. Investigate effects of climate change and other factors on population viability of moose in Voyageurs National Park. $307,700.

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.
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.
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.
McGraw, A.M., R.A. Moen, and M. Schrage. 2011. Characteristics of post-parturition areas of moose in northeast Minnesota. Alces 47:113-124.
McCann, N. and R.A. Moen. 2011. Mapping potential core areas for lynx (Lynx canadensis) using snowshoe hare (Lepus americanus) pellet counts and satellite imagery. Canadian Journal of Zoology 89:509-516.

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. NRRI scientists have extensive experience in applied ecological research on terrestrial and aquatic systems. Aquatic and Terrestrial LiDAR research is being conducted and complement each other at NRRI.