Environment and Natural Resources Trust Fund

2023 Request for Proposal

General Information

Proposal ID: 2023-222

Proposal Title: Integrating Remotely Sensed Data with Traditional Forest Inventory

Project Manager Information

Name: John Du Plissis

Organization: U of MN - Duluth - NRRI

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Project Basic Information

Project Summary: We will evaluate state-of-the-art lidar technology's ability to provide stand-level summary statistics of forest resource measurements and how these data can be used to estimate ecosystem services

Funds Requested: $191,000

Proposed Project Completion: June 30, 2025

LCCMR Funding Category: Small Projects (H)

Secondary 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?

Region(s): NE

When will the work impact occur?

During the Project

Narrative

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

The current area based inventory system is insufficient to reliably estimate the standing volume and above ground biomass at a stand level. This is primarily due to the sparse network of forest inventory plots for all land ownerships (e.g., USFS FIA Program has established one plot for every 3,000 acres of land). Lidar-derived data have been widely used to supplement forest inventories, as this active remote sensing system can accurately characterize 3-dimensional forest structure. Because lidar can provide spatially explicit coverage of metrics that are highly correlated with tree measurements on the ground, lidar data can be leveraged with limited forest sampling inventory data to formulate models for wall-to-wall mapping of stocking, biomass, merchantable volumes, and other important attributes for evaluating ecosystem service. There is a dearth of information on the current state of the forest at a small-scale such as stand or township. The expense and often inability to conduct highly local forest measurements results in inconsistent forest inventories which hampers the ability of managers and policy makers to accurately manage the resources. Likewise forest projections through time (growth and yield) are increasingly inaccurate when the vintage of the last measurement is more than 10 years old

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.

The Natural Resources Research Institute (NRRI) has developed stand distribution and stem volume models to improve prediction estimates of above ground biomass, sequestered carbon and merchantable timber volume in these economically and ecologically important forest-types. These models can be leveraged with the inventory data currently being collected by the MNDNR Forestry Resource Assessment Program and additional sampling data (planned in the project) for prediction of important forest resource measurements including but not limited to stocking, height and diameter of the target species at the sample plot locations. The high density LiDAR data being collected as part of the MN State Lidar Plan provides us with the unique opportunity to calibrate models relating the plot level estimates of forest metrics with co-located LIDAR-derived predictors. Such models can then be applied to accurately map standing volume in forest stands across the landscape. We are proposing to map aboveground biomass, trees per acre, stocking levels, carbon sequestration and forest-types across the entire LIDAR acquisition areas in Minnesota. This remote sensing based information will establish baseline inventories with much greater accuracy.

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?

Ensuring Minnesota maintains economic and ecological services from its forests requires timely and accurate information. This project will allow us to test models for field level accuracy and demonstrate the ability of remotely sensed data to improve forest stand volume estimates. It is this baseline inventory combined with stem volume equations developed by NRRI that will allow us to develop growth and yield models for management outcome assessment on a scale relevant to administrators and land owners across the state. This precision view of these forest resources will allow stakeholders to continue work towards the enhancement of Minnesota's forests.

Activities and Milestones

Activity 1: Field data collection to calibrate LiDAR metrics

Activity Budget: $132,000

Activity Description:
The purpose of field plots is to collect high-resolution forest inventory metrics at the tree level so that tree and plot level estimations can be accurately tied to remote sensing data (i.e. lidar). Lidar by itself does not allow for prediction of forest inventory making field plots a vital component of this analysis. Building upon work by the MN DNR Division of Forestry's Resource Assessment unit (MNDNR_DOF_RA) we will collect 1/10 acre field plots. Staff will install 140 field plots over two summers in aspen and red pine stands following the MNDNR-DOF-RA field plot protocol. Staff will then compile field plot data and produce plot summaries that will be used in Activities two and three.

Activity Milestones:

Description	Completion Date
Locate 300 1/10th acre plots	September 30, 2023
Collect forest resource metrics from the established plots	September 30, 2023
enter data into relational and spatial databases for summary and analysis	December 31, 2023
Measure remaining field plots	September 30, 2024
Enter data into relational and spatial databases for summary and analysis	December 31, 2024

Activity 2: Calibrate Lidar Data

Activity Budget: $32,000

Activity Description:
We will perform an assessment of the Division of Forestry's lidar data and the forest inventory plot data collected in Activity 1 and establish model relationships between on-the-ground field data collection and lidar estimates of stand level metrics and summary data.

Activity Milestones:

Description	Completion Date
Model relationships between field inventory plots and lidar metrics	March 31, 2024
Develop model correlations between field and remotely sensed data collections for each forest cover type	March 31, 2024
Finalize forest type models and spatial predictions	March 31, 2025

Activity 3: Develop stand level summary statistics for major forest cover types in Northeastern Minnesota

Activity Budget: $27,000

Activity Description:
Models and species maps developed from Activity one will be combined to create stand level summary maps for major forest cover types in northeastern Minnesota. The resulting inventory will be treated as a "starting inventory" and will be combined with NRRI's proprietary growth and yield models to estimate stand level summary data. Outcomes will be communicated through area meetings with stakeholders, as published papers, and spatial data will be made available on the Minnesota Natural Resource Atlas.

Activity Milestones:

Description	Completion Date
Create starting forest inventory and model utilization and ecological conservation scenarios	March 31, 2025
Conduct meetings with local stakeholders to communicate possibilities as well as feedback	May 31, 2025
Finalize publications and LCCMR reporting	June 30, 2025

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?
This project is being developed in concert with the MN DNR Division of Forestry Resource Assessment. The process developed will be utilized to improve estimates of or stand level metrics for all forest cover types on private, county, state (Forestry and School Trust Lands) and federal lands in northeastern Minnesota. These same data can be used by the industry, agencies, tribal governments, conservation and habitat organizations to improve shared stewardship at the local and landscape level. Expansion of this project to other species and to other regions of the state will depend on additional lidar data and financial support

Project Manager and Organization Qualifications

Project Manager Name: John Du Plissis

Job Title: Forest and Lands Research Group Manager

Provide description of the project manager's qualifications to manage the proposed project.
DuPlissis' provides direction and leadership for the NRRI's Forest and Lands research group focused on developing cutting-edge, applied forest management research leading to stabilization and expansion of forest-based industry in Minnesota. This includes development of a full range of silvicultural strategies from intensive forest management and multiple-use forestry to conservation forestry. Existing programs include research on intermediate stand treatments for aspen and red pine ecosystems, growth, yield and harvest volume modeling, regional resource analyses to assess timber quantity and availability and assessment of remote sensing data to accurately quantify stand forest volumes.

DuPlissis background includes serving as the Rural Forestry Program Leader for the University of Nebraska – Nebraska Forest Service where he oversaw program that deliver technical and financial assistance to help woodland owners improve the health, diversity and resiliency of their woodlands from 2015 through 2018 and as an Extension Forester and a Professor of Forestry in the College of Natural Resources at the University of Wisconsin - Stevens Point. John has an extensive background in applied research to characterize forest resources, forest resource management, public participation, and community development, both locally and overseas.

DuPlissis has extensive experience in the development, implementation and management of resource management and applied research projects funded by grants from private foundations and state and federal agencies. DuPlissis has served as the project manager on over a dozen grants, from nine different agencies or organizations, totaling nearly $5,500,000, to fund cost-share assistance to implement forest restoration project or applied research to guide land management decisions.

Organization: U of MN - Duluth - NRRI

Organization Description:
The Natural Resources Research Institute (NRRI) is a part of the University of Minnesota Duluth and employs over 130 scientists, engineers and technicians. Its mission is to deliver research solutions to balance our economy, resources and environment for resilient communities. NRRI collaborates broadly across the University system, the state and the region to address the challenges of a natural resource based economy.
By partnering with industry, business leaders, agency decision-makers and many others, NRRI researchers frame and deliver on real-world solutions. NRRI scientists have extensive experience in managing large, interdisciplinary projects. Major objectives include the development of tools for environmental assessment and resource management. NRRI's role is as an impartial, science-based resource that develops and translates knowledge by characterizing and defining

value-resource opportunities, minimizing waste and environmental impact, maximizing value from natural resource utilization and maintaining/restoring ecosystem function.
Major outcomes from NRRI projects include informing environmental management and policy and assisting industry and communities in defining and maintaining the social license to operate in natural systems. NRRI has an established mechanism for sharing outcomes through press releases, publication in peer-reviewed journals, annual reports (https://www.nrri.umn.edu/resources-publications/annual-reports), periodicals, and through social media channels.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
John DuPlissis, Project Manager		Project management			25.1%	0.16		$27,599
Kristi Nixon		Cover type mapping and producing/finalizing maps			22.3%	0.04		$3,301
Summer Intern		Field data collection			0%	0.5		$12,480
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Summer Intern		Field data colelction			0%	0.5		$12,480
TBD Researcher 6		Forest Cover Type Mapping and Site Quality Evaluations			25.1%	0.3		$31,049
TBD Researcher 4		Field Crew SUpervision and QA/QC			22.3%	0.5		$33,258
							Sub Total	**$145,127**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	Fieldwork Supplies	2 complete sets of equipment to support two teams (1) Suunto PM5/360PC Clinometer: hand-held tool used to measure tree height: $130.50 (2)Silva Ranger 2.0 Compass: Hand-held tool used with map to locate field plots to locate field plots: (x2 - $44.50 = $89) (3)Spencer Logger's Tape: hand-held tool used to measure tree diameter measure tree diameter for modeling:					$1,046

			(x2 - $51.25 = $102.50) (4) Haglöf Monopod: portable tool used in conjunction with the laser rangefinder mount for laser rangefinder: $124.95 (5) Aluminum 360° Adapter: mounts on monopod laser rangefinder receiving unit: $75.95 $522.90 total per team x two teams for a total of					
	Tools and Supplies	Additional Fieldwork Supplies	2 complete sets of equipment to support two teams (1) Haglöf Vertex Laser Geo 360° Package: laser range finder used to accurately measure heights and distances: $2,537.00 (2) mesa 3 rugged tablet: robust handheld device for data acquisition and processing in the field under all weather conditions: $3,125.00 (3) Trimble R2 GPS: global positioning unit to geolocate plots and trees with submeter accuracy: $4,700.00 $10,362 per team. Total of $20,724					$20,724
							Sub Total	**$21,770**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Forest Resource Field Data Collection. There will be two field crews plus a forest technician to check cruise the summer field team work.	(1) 2023 collect forest inventory data: two-person crew to collect stand level forest inventory data. 48 trips. Mileage+hotel+meals = $4140 * 2 crews = $8,280 (2) 2023 Training / Quality assurance. Provide training and support for remote located field staff and provide quality control checks on					$24,103

			data collected. 9 trips. Mileage+hotel+meals . $3,771 (3) 2024 collect forest inventory data: two-person crew to collect stand level forest inventory data. 48 trips. Mileage+hotel+meals = $4140 * 2crews - $8,280 (4) 2024 Training / Quality assurance. Provide training and support for remote located field staff and provide quality control checks on data collected. 9 trips. Mileage+hotel+meals . $3,772					
							Sub Total	**$24,103**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$191,000**

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				
			State Sub Total	**-**
Non-State				
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs.	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs)	Secured	$105,050
			Non State Sub Total	**$105,050**
			Funds Total	**$105,050**

Attachments

Required Attachments

Visual Component

File: 293c36c8-632.pdf

Alternate Text for Visual Component

Using lidar we can accurately measure tree height data and even digitally describe the crown of individual trees. Our goal is to collect comprehensive forest stand data and compare on-the-ground measurements to lidar estimates to build models that will allows us to use lidar to accurately estimate stand summary metrics...

Optional Attachments

Support Letter or Other

Title	File
UMD Sponsored Projects Transmittal Letter	52dc0a69-7c2.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

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

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?

Yes, Sponsored Projects Administration

Natural Resources Research Institute
University of Minnesota Duluth
Driven to Discover

PROJECT TITLE:
Integrating Remotely Sensed Data with Traditional Forest Inventory

Project Goal: We are proposing to map important stand level summary data that is used in growth and yield models to estimate aboveground biomass, trees per acre, stocking levels, carbon sequestration in the forests across northeastern Minnesota. We will do this by integrating on-the-ground field data collections with remotely sensed data, develop enhanced stand level metrics and estimate stand level summary statistics using NRRI proprietary growth and yield models.

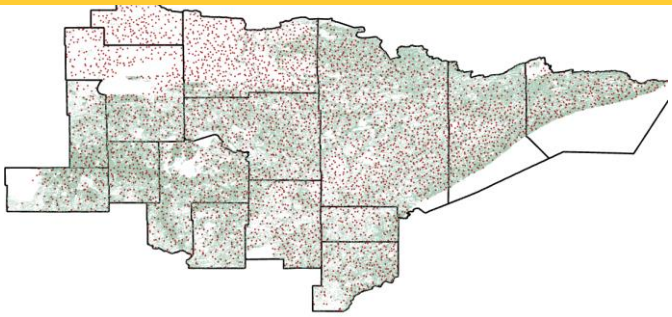
Challenge: Current methods of area-based inventory of Minnesota forests is insufficient to reliably estimate the standing volume and above-ground biomass ***at a stand level.***

Proposal: We will collect high-resolution forest inventory data ***at the tree level*** so that tree and plot level estimates can be accurately tied to forest metrics collected as part of the MN State Lidar Plan. By assessing relationships between on-the-ground field data collections and lidar data collections we will be able to calibrate lidar data to provide better estiamtes of stand level metrics than either system can by itself.

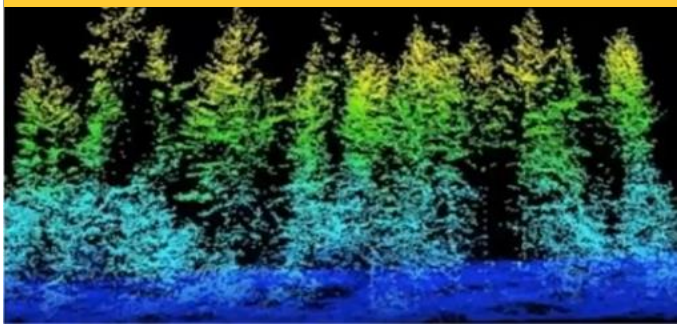
Outcomes:

1. The development of stand level-models that will allow us to accurately estimate above ground biomass, sequestered carbon and merchantable volumes for major forest cover types.
2. The development of growth, yield and harvest models for major forest cover types that can be used to accurately predict economic biologic rotation ages and expected harvest volumes,
3. The development of a geospatial map with stand level summary metrics of major forest cover types across the landscape of northeastern Minnesota.

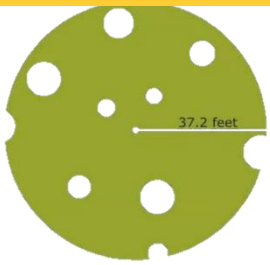
1) Current distribution of plots in Arrowhead is 1 to 1,700 acres



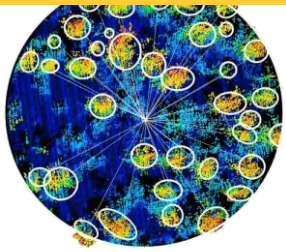
2) Utilize lidar scanning to characterize forest stands



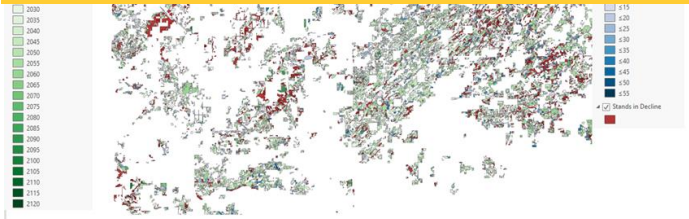
3) Inventory forest stands



4) Link inventory to lidar data



5) Model growth, volumes and schedule harvests



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