Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-048

Proposal Title: Precision Forest Inventory For Aspen And Red Pine

Project Manager Information

Name: John Duplissis

Organization: U of MN - Duluth - NRRI

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Project Basic Information

Project Summary: We will estimate sequestered carbon and standing volumes of red pine and aspen using state-of-the-art lidar technology to provide stand-level measures as an alternative to wide-spread data collection

Funds Requested: $199,000

Proposed Project Completion: 2023-06-30

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., US Forest Service 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 attributes.
In Minnesota, 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? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

The Natural Resources Research Institute (NRRI) has measured more than 9,000 cut and harvested red pine and aspen trees from over 450 locations across the Great Lakes region. This unique data set has allowed them to develop highly accurate 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 inventory 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 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 for a never before achieved stand level baseline of two ecologically and economically significant forest-types (red pine and aspen). 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: Calibrate Lidar data

Activity Budget: $95,000

Activity Description:
Data collected from the lidar state plan, and the forest inventory plots collected in Activity 1, will be used to establish the model relationships between plots and the lidar data. These models will include aboveground biomass (i.e. carbon stocking/CO2 equivalent), standing volume, quadratic mean diameter, max height, average height, trees per acre, site index, and age. At the same time, aspen and red pine stands will be mapped using remotely sensed data ((lidar, satellite, aerial photography).

Activity Milestones:

Description	Completion Date
Map aspen and red pine stands	2021-07-31
Compile and begin producing lidar metrics	2021-07-31
Compile Data from year two measurements	2022-12-31
Model relationships between field inventory plots and lidar metrics	2022-12-31
Finalize forest type models and spatial predictions	2023-02-28

Activity 2: Develop spatial analysis of aspen and red pine forest inventory in Northeastern Minnesota

Activity Budget: $38,800

Activity Description:
Models and species maps developed from Activity one will be combined to map aspen and red pine specific inventory metrics across the landscape and create a current inventory. The resulting inventory will be treated as a "starting inventory" and will be combined with NRRI's proprietary aspen and red pine models to model growth and create utilization scenarios that can inform decision making on how to balance production and carbon storage in the state of Minnesota. 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
Finalize publications and LCCMR reporting	2023-06-30
Conduct meetings with local stakeholders to communicate possibilities as well as feedback	2023-06-30
Create starting forest inventory and model utilization and ecological conservation scenarios	2023-06-30

Activity 3: Field data collection to calibrate LiDAR metrics

Activity Budget: $65,200

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 140 1/10th acre plots	2021-07-31
Collect forest resource metrics from the established plots	2021-09-30
enter data into relational and spatial databases for summary and analysis	2021-12-31
Measure remaining field plots	2022-09-30
Enter data into relational and spatial databases for summary and analysis	2022-12-31

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Division of Forestry - Resource Assessment	MN Department of Natural Resources	MN DNR, Division of Forestry - Resources Assessment staff will be coordinating plot locations with MN State lidar plan data collections, assisting with the analysis of field data, analyzing lidar data, building relationships between datasets, developing models, modeling aspen and red pine volumes and mapping across the arrowhead region	Yes

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 be funded?

This project is being developed in concert with the MN DNR Division of Forestry. The process developed will be utilized by the MN DNR to improve estimates of standing volumes of aspen and red pine on private, county, and state lands (Forestry and School Trust Lands) in northeastern Minnesota. These same data can be used by the forest products industry to better assess supply chains improve shared stewardship at the landscape level. Expansion of this project to other species and to other regions of the state will depend on state budget and grant funding to characterize additional species.

Project Manager and Organization Qualifications

Project Manager Name: John Duplissis

Job Title: Silviculture Research Program Manager

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

DuPlissis' provides direction and leadership for the NRRI's silviculture 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 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			26.7%	0.18		$24,905
Dan Buchman		Compiling and processing inventory data			24.1%	0.14		$12,970
Kristi Nixon		Cover type mapping and producing/finalizing maps			24.1%	0.08		$6,665
Temporary/Casual, Inventory Coordinator		Coordinating inventory			7.3%	0.14		$10,319
Summer Intern		Field data collection			0%	0.46		$16,762
Summer Intern		Field data collection			0%	0.46		$16,762
							Sub Total	**$88,383**
Contracts and Services								
Minnesota Department of Natural Resources	Sub award	MN DNR, Division of Forestry - Resources Assessment staff will be coordinating plot locations with MN State lidar plan data collections, assisting with the analysis of field data, analyzing lidar data, building relationships between datasets, developing models, modeling trembling aspen and red pine volumes and mapping across the arrowhead region				0.42		$84,297
							Sub Total	**$84,297**
Equipment, Tools, and Supplies								
	Tools and Supplies	Suunto PM5/360PC Clinometer: hand-held tool used to measure tree height (quantity 1)	To measure tree height					$131
	Tools and Supplies	Silva Ranger 2.0 Compass : hand-held tool used with map to locate field plots (quantity 2)	To locate field plots					$89
	Tools and Supplies	Spencer Logger's Tape: hand-held tool used to measure tree diameterr (quantity 2)	To measure tree diameter for modeling					$102
	Tools and Supplies	Haglöf Monopod: portable tool used in conjunction with the laser rangefinder (quantity 1)	To mount for laser rangefinder					$125
	Tools and Supplies	Aluminum 360° Adapter: mounts on monopod (quantity 1)	Laser rangefinder receiving unit					$76

	Tools and Supplies	Haglöf Vertex Laser Geo 360° Package: laser range finder (quantity 1)	Used to accurately measure heights and distances					$2,537
	Tools and Supplies	Mesa 3 rugged tablet: field data recorder (quantity 1)	robust handheld device for data acquisition and processing in the field under all weather conditions					$3,125
	Tools and Supplies	Trimble R2 GPS: global positioning unit (quantity 1)	To geolocate plots and trees with submeter accuracy					$4,700
							Sub Total	**$10,885**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Collection of forest inventory for Year 1 and 2: 48 day trips each year. 150 miles round trip. Costs include GSA approved rates for mileage	Two-person crew to collect stand level forest inventory data at the Rainy River site					$8,280
	Miles/ Meals/ Lodging	Training / Quality assurance for Year 1 and 2: 9 two-day trips each year. 400 miles round trip. Costs include GSA approved rates for per diem, lodging, and mileage	Provide training and support for remote located field staff and provide quality control checks on data collected					$7,155
							Sub Total	**$15,435**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$199,000**

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	$76,837
			Non State Sub Total	**$76,837**
			Funds Total	**$76,837**

Attachments

Required Attachments

Visual Component

File: b06706aa-795.pdf

Alternate Text for Visual Component

The visual should help the reviewers understand that the current area-based inventory estimates forest metrics using a system that measures approximately one, one-sixth acre inventory plot for every 1,700 acres of forest land in northeast MN. Light Detection and Ranging, also known as lidar, is an active remote sensing system that can be used to measure vegetation height across wide areas. 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 model aboveground biomass, sequestered carbon and merchantable timber with higher accuracy and lower cost than the current area-based inventory system

Optional Attachments

Support Letter or Other

Title	File
Sponsored Projects Authorization Letter	0524d318-f21.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

Does your project include 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:

Precision Forestry of Trembling Aspen and Red Pine

Project Goal: To reliably estimate above ground biomass, sequestered carbon and standing volumes of trembling aspen and red pine, model their growth and yield, and map these stands and volumes across the landscape.

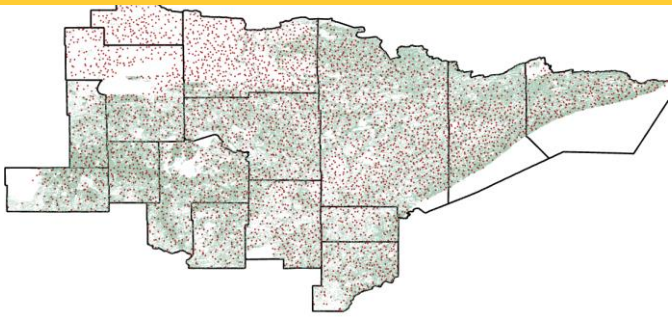
Challenge: Current methods of area-based inventory of MN forests is insufficient to reliably estimate the standing volume and above-ground biomass ***at a stand level.***

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 modeling relationships between plots and lidar data we will include stocking, above-ground biomass, carbon stocking/CO2 equivalent, merchantable volume, site index, and stand age.

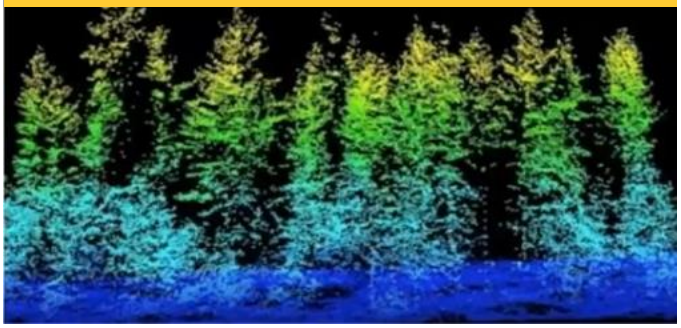
Outcomes:

1. The development of stand level-models that will allow us to accurately estimate above ground biomass, sequestered carbon and merchantable volumes for trembling aspen and red pine.
2. The development of growth, yield and harvest models for trembling aspen and red pine that can be use to accurately predict economic biologic rotation ages and expected harvest volumes,
3. Map trembling aspen and red pine across the landscape and create a current inventory of standing stock

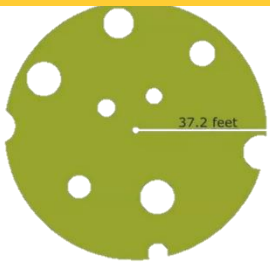
1) Current distribution of plots in Arrowhead is 1 to 1,700 acres



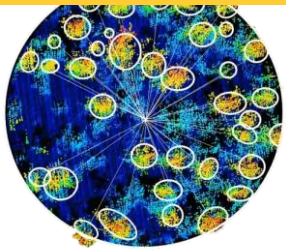
2) Utilize lidar scanning to characterize forest stands



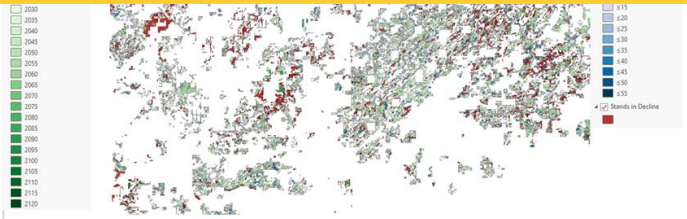
3) Inventory forest stands



4) Link inventory to lidar data



5) Model growth, volumes and schedule harvests



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