Environment and Natural Resources Trust Fund

2023 Request for Proposal

General Information

Proposal ID: 2023-066

Proposal Title: Removing Barriers to Carbon Market Entry

Project Manager Information

Name: John Zobel

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Basic Information

Project Summary: Carbon markets incentivize carbon sequestration, but significant cost-barriers exist for landowner participation. Leveraging remotely sensed data, cost-effective fieldwork, and robust modeling will enable climate-smart activities that benefit all Minnesotans.

Funds Requested: $590,000

Proposed Project Completion: June 30, 2026

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?
        Statewide

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

When will the work impact occur?
        During the Project and In the Future

Narrative

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

The buying and selling of carbon credits (carbon markets) represents a now viable and critical strategy to increase carbon sequestration. Forest landowners are incentivized to manage their properties in order to capture atmospheric carbon above and beyond the normal rate for their land, including delayed harvesting or replacing aging trees with faster growing younger forests. The excess carbon is then sold to companies to offset their carbon emissions. The federal government is currently considering significant investment in carbon market related programs through action by the USDA Climate-Smart Agriculture and Forestry Partnership Initiative. Emerging markets present attractive options for Minnesota landowners to enroll their property, leading to reductions in atmospheric carbon and a reliable income stream. However, traditional markets require landowners to conduct detailed carbon inventories to establish carbon stock baselines. Unfortunately, these exhaustive inventories are prohibitively expensive and time consuming for most landowners and present a barrier to market entry. Alternatively, other markets emerged that seek to soften entry requirements, but these markets lack the transparency of the established markets. Therefore, a crucial opportunity exists to remove the obstacles to entry while providing robust and credible estimates of carbon stocks.

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.

Carbon markets typically involve expensive ground-based inventories to estimate carbon stock baselines. However, Minnesota has invested heavily in acquiring remotely sensed data, including high resolution light detection and ranging (Lidar) data statewide. State, federal, university, county, and ENRTF partners have funded Lidar acquisitions and subsequent modeling of forest carbon and other attributes, making Minnesota a leader among peer states. Leveraging this wealth of publicly available remotely sensed data, we propose to compare remotely derived carbon inventories with the traditional, field-based inventories. Remote sensing will never replace the need for fieldwork and ground truthing, but may significantly reduce the number of data points or field plots necessary to achieve the required precision to enter carbon markets. Rigorous testing across the spectrum of fully remote and fully field-based carbon inventories will quantify the reduction in necessary fieldwork to still achieve the precision targets. Based on proof-of-concept studies in the western states and northern Minnesota, results will quantify the significant reduction in necessary fieldwork, opening the doors for landowners to enter carbon markets at a fraction of the cost. A workflow and decision support tool will provide landowners with clear and reproducible steps to quantify their carbon stocks for entry into the markets.

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?

Deliverables will result in increased participation in carbon markets and thus increased carbon sequestration throughout the state. Lowering atmospheric carbon remains a critical state strategy for addressing climate change. Positioning agency, tribal, and private landowners to capitalize on the rapidly increasing financial opportunities surrounding carbon markets will not only benefit forest landowners throughout the state, but directly all citizens through maintaining favorable climate conditions into the future. Also, significantly decreasing inventory costs will create more achievable management alternatives for Minnesota landowners and will allow better balancing of multiple use objectives that serve the diverse needs of the entire state population.

Activities and Milestones

Activity 1: Create baseline carbon stock information across all acres and all ownerships in Minnesota

Activity Budget: $153,000

Activity Description:

Previous and ongoing ENRTF funded projects provided high quality Lidar data throughout the state and subsequent forest attribute models. This project will extend this work by estimating and mapping carbon stocks for all acres and all ownerships across Minnesota. Many maps have been made that display carbon stocks across an area of interest, but few provide robust measures of uncertainty along with those estimates. California, Oregon, and Washington have recently funded similar wall-to-wall data layer creation using advanced statistical techniques to quantify error (Bayesian hierarchical modeling) that has proven revolutionary in advancing confidence around remotely sensed measurements. This work would be applied to Minnesota using the wealth of publicly available Lidar, satellite imagery, existing maps, forest inventory plots, and other information relevant to estimating carbon stocks. The result will be detailed spatial carbon estimates for every acre in Minnesota, coupled with measures of the reliability of those estimates using an innovative technique not yet explored in the region. Not only will the derived carbon layer remain publicly available on the Minnesota Natural Resource Atlas, but will form a critical component of the remaining activities of this proposal.

Activity Milestones:

Description	Completion Date
Compile all available statewide ground and aerial/Lidar data, as well as existing carbon information	April 30, 2024
Develop the Bayesian hierarchical model to estimate wall-to-wall carbon stocks across Minnesota	December 31, 2024
Validate the model through cross-validation and Activity 2 data	June 30, 2025

Activity 2: Conduct full-scale carbon market inventories on test locations and compare to the remote approach

Activity Budget: $375,000

Activity Description:

Leveraging remotely sensed data is critical to provide high resolution estimates of carbon across the state, but remote data alone does not generate the precision necessary to enter carbon markets. To determine the essential level of fieldwork, a complete carbon inventory will be conducted on four test locations in different regions of the state. These include UMN operated Cloquet Forestry Center and Hubachek Wilderness Research Center in northern Minnesota. We will also partner with the Leech Lake Band of the Ojibwe to inventory all their forestland in the central part of the state, as well as portions of the DNR managed Richard J. Dorer Memorial Hardwood State Forest in southeast Minnesota. Results from these traditional inventories will represent the current effort necessary to enter the carbon markets, while the carbon layer from Activity 1 represents a coarse alternative. Data simulations will then sequentially reduce the amount of available data from the fieldwork until the minimum combination of remote data and field data provides the necessary precision to meet carbon market standards. The sample size required will vary depending on forest conditions and regions of the state, so a range of inventory sizes will be identified for diverse applications.

Activity Milestones:

Description	Completion Date
Conduct carbon inventories on four test locations throughout Minnesota	September 30, 2024
Compile and edit the data for use with the carbon stock layer from Activity 1	June 30, 2025
Run simulations to determine necessary fieldwork to achieve carbon market precision requirements	December 31, 2025

Activity 3: Develop a reproducible and validated workflow for reasonable entry of Minnesota landowners into carbon markets

Activity Budget: $62,000

Activity Description:

The carbon layer from Activity 1 will remain publicly available for use by all forest landowners across Minnesota. We will develop a clear and straightforward workflow to allow landowners or consultants to determine the necessary fieldwork to couple with the remote estimates to produce a credible carbon inventory that meets market standards for accuracy and precision. Private landowners, agencies, and forestry professionals will have access to data, instructions, and a decision support tool to rapidly implement carbon inventories at significantly reduced costs. The carbon layer and workflow will be housed or linked through the ENRTF funded Minnesota Natural Resource Atlas and UMN resources. These hosts are curated and maintained by the Natural Resources Research Institute and UMN Department of Forest Resources through perpetuity, with the latter providing regular updates as needed. Use of the workflow and tool will be demonstrated to landowners through in-person activities or webinars facilitated by the Sustainable Forests Education Cooperative. By removing the financial barrier and limiting the effort required to enter carbon markets, this should position Minnesota to increase lands enrolled in carbon markets and continue to increase carbon sequestration and other climate-smart activities.

Activity Milestones:

Description	Completion Date
Upload the new carbon stock layer to the Minnesota Natural Resource Atlas for public use	July 31, 2025
Develop and publish the workflow and decision support tool on University of Minnesota servers	March 31, 2026
Conduct in-person seminars or webinars to demonstrate the importance and reproducibility for carbon market entry	June 30, 2026

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Chad Babcock	University of Minnesota	Co-Principle Investigator (Co-PI)	Yes
Joseph Knight	University of Minnesota	Co-PI	Yes
Jennifer Corcoran	Minnesota Department of Natural Resources	Co-PI	Yes
Scott Hillard	Minnesota Department of Natural Resources	Co-PI	Yes
David Wilson	Minnesota Department of Natural Resources	Co-PI	Yes
John Du Plissis	Natural Resources Research Institute	Co-PI	Yes
Christopher Wright	Natural Resources Research Institute	Co-PI	Yes
Eli Sagor	Sustainable Forests Education Cooperative	Educator	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?

Project results will form a comprehensive workflow and decision support tool that enables exact replication by landowners or forestry consultants. This will include a publicly available data layer providing detailed statewide estimates of baseline carbon stocks derived from robust modeling and uncertainty estimates. All data products and layers will be hosted on the Minnesota Natural Resource Atlas, an ENRTF funded clearinghouse for traditional and spatial natural resource data and products. All workflow and decision support tools provided to landowners will be housed on University of Minnesota (UMN) servers, with periodic updates funded through the UMN or external partners.

Project Manager and Organization Qualifications

Project Manager Name: John Zobel

Job Title: Assistant Professor

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

Dr. John Zobel works in the area of forest/natural resources biometrics, measurements, and modeling, including inventory and resource assessment. His research includes estimating carbon emissions due to forest disturbance, general growth and yield modeling, assessment of forest dependent wildlife habitat, and statistical support for projects

involving black bear behavior, bat population trends due to white-nose syndrome, recovery of forest after emerald ash borer, and bird habitat relationships. He has expertise in permanent and temporary sampling designs to acquire natural resource data. Dr. Zobel has lead or been part of teams that have proposals funded or under review for over $20,500,000 while advising five graduate students, supervising two post-doctoral associates, and authoring or co-authoring over 25 peer-reviewed publications.

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

Organization Description:
For over 100 years, the Department of Forest Resources, University of Minnesota has been a leader in fundamental and applied research in natural resources within Minnesota, the Lake States, nationally, and internationally.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
J. Zobel/Summer Salary		Project Lead			33.5%	0.18		$33,000
C. Babcock/Summer Salary		Co-PI			33.5%	0.15		$27,003
J. Knight/Summer Salary		Co-PI			33.5%	0.02		$4,014
J. Du Plissis/Summer Salary		Co-PI			33.5%	0.02		$4,661
C. Wright/Summer Salary		Co-PI			33.5%	0.02		$3,061
Researcher 5		Field data collection and analysis lead			33.5%	2		$152,250
Graduate Student		Lidar and modeling lead			23.6%	3		$92,985
Undergraduate Student Field Techs		Assisting in data collection for Activity 2			0%	3		$151,120
							Sub Total	**$468,094**
Contracts and Services								
Minnesota Department of Natural Resources	Sub award	Provide critical consultation on methods, deliverables, and dissemination of research to ensure maximum benefit to the pertinent stakeholders and general public.				0.06		$12,000
							Sub Total	**$12,000**
Equipment, Tools, and Supplies								
	Equipment	Sampling Equipment (7 logger's tapes, 7 clinometers, 7 compasses)	Sampling equipment necessary to collect data in support of Activities 2					$2,562

									Amount
			and 3. Tapes $76 ea., clinos $200 ea., and compass $90 ea.						
	Equipment	1 LaserTech 200x	Accurately and precisely collect tree heights and distances (a second one has already be acquired)						$2,000
	Equipment	2 tablets	Electronically collect data and include built-in error checking ($1,252 ea., including field protection)	X					$2,504
	Tools and Supplies	Safety equipment (7 sets)	Personal protective equipment (hard hats, vests, gloves, glasses, etc.)						$840
	Tools and Supplies	Comsumable Sampling Supplies	Write-in-the-rain paper and other consumable products to support data collection in Activies 2 and 3						$200
								Sub Total	**$8,106**
Capital Expenditures									
		2 survey-grade GPS units	Precisely establish plot centers for linking with Lidar and comparison to commonly used operational-grade GPS units already acquired ($10,000 ea.)						$20,000
								Sub Total	**$20,000**
Acquisitions and Stewardship									
								Sub Total	-
Travel In Minnesota									
	Miles/ Meals/ Lodging	We estimate a total of 168 travel days to complete the data collection associated with Activities 1 and 2. These days cover travel for six undergraduate field techs (130 days ea.), one researcher (28 days total), and investigators (10 days total). The cost is estimated at $100 per day.	The large in-state travel budget is necessary due to the required effort to conduct the detailed carbon inventories required for carbon market entry and the diverse locations across the state.						$81,800
								Sub Total	**$81,800**
Travel Outside Minnesota									

						Sub Total	-
Printing and Publication							
						Sub Total	-
Other Expenses							
						Sub Total	-
						Grand Total	**$590,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Equipment, Tools, and Supplies		2 tablets	Using electronic means to collect field data helps ensure accuracy through built-in error checking and avoidance of data transcription, reduces costs through fewer FTE required for data entry in the office, and substantially increases efficiency through time savings.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	Unrecovered Indirect Costs UMN (55% overhead)	Operating costs of the UMN	Secured	$324,500
			State Sub Total	**$324,500**
Non-State				
-			**Non State Sub Total**	-
			Funds Total	**$324,500**

Attachments

Required Attachments
Visual Component
File: 8b8e8e4e-90b.pdf

Alternate Text for Visual Component
In addition to the text, pictures of bur oak trees and foliage, small (sapling) red pine, close-up view of medium-sized aspen stems, and mature red pine canopy from below. Background watermark of mature red pine trees....

Optional Attachments
Support Letter or Other

Title	File
UMN submission approval form	1dc22481-dcf.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

Removing Barriers to Carbon Market Entry

Minnesota forests cover **17.7 million acres** and represent a critical resource to remove carbon from the atmosphere. Landowners now have the opportunity to generate income from capturing (sequestering) this carbon, but they face considerable financial **barriers**.

The solution…

CARBON MARKETS

- Provide payments to landowners for sequestering carbon above normal activities
- Reduce greenhouse gases in the atmosphere
- Incentivize natural, climate-smart practices

OPPORTUNITIES/CHALLENGES

- Capitalize on early stages of emerging markets
- Expensive carbon inventories create a barrier to entry
- Significantly reduce inventory cost through using ENTRF funded Lidar acquisitions and data products

DELIVERABLES

- High resolution estimates of carbon stocks across all acres in Minnesota
- Reproducible step-by-step workflow for landowners and consultants
- Establish Minnesota as a regional leader in enabling citizens to enter carbon markets
- Reduction in greenhouse gases that benefit all Minnesotans

PROJECT PARTNERS

University of Minnesota

Minnesota Department of Natural Resources

Natural Resources Research Institute

Leech Lake Band of the Ojibwe