Environment and Natural Resources Trust Fund

2023 Request for Proposal

General Information

Proposal ID: 2023-092

Proposal Title: Statewide Forest Carbon Inventory and Change Mapping

Project Manager Information

Name: David Wilson

Organization: MN DNR - Forestry Division

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Project Basic Information

Project Summary: Accurate inventories are needed to facilitate carbon market entry for forestland owners. An estimated 1,000 plot-based inventories will be collected from private forestland to expand all-lands lidar forest inventory statewide.

Funds Requested: $1,538,000

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.

Minnesota's forests play a key role in providing natural climate solutions by absorbing carbon dioxide from the atmosphere and storing it in vegetation, soil, and harvested wood. Accurate estimation and mapping of attributes like standing volume, biomass, and carbon are needed to support operational and strategic forest management planning, and emerging opportunities for climate mitigation. Current forest inventories do not provide sufficient spatial and temporal resolutions to accurately assess carbon stocks over time. Recent high-density lidar data, acquired as part of the Minnesota Lidar Plan, have potential to provide foundational forest inventory information when paired with a network of on-the-ground forest sampling data through plot-based inventory (PBI). However, the availability of PBI data is currently limited to public forest lands and needs expansion over private lands to capture their forests' unique characteristics. Programmatic design, in coordination with partners, is needed to build on initial ENRTF investment for trial private, county, and Tribal PBI data collection. This project will provide critical information about forestlands statewide by combining privately held forestland PBI information with existing public forestland PBI and remotely sensed data (i.e., lidar and imagery). The results will help expand forest structure, carbon stock, and change mapping across all ownerships.

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.

This project creates connections, incentives, and assistance to private landowners to opt-in to the MNDNR Division of Forestry's PBI program, resulting in an all-lands forest inventory. By expanding on work beginning fiscal year (FY) 2023, our goal is to collect 1,000 additional plots on private lands. Collaboration with the DNR's Private Forest Management Program, Board of Soil and Water Resources, Soil and Watershed Conservation Districts, University of Minnesota Extension Services, Minnesota Forestry Association, and the Minnesota Forest Resources Council Landscape Committees will expand the PBI network. Collaborators will help to design sound programmatic approaches that incentivize participation, add value through measurable outcomes, and meet stakeholder needs. The proposed 1,000 private plots, when paired with existing public PBI, will improve accuracy of lidar-based forest inventory across all ownerships and enable error estimation for private forestlands. This expansion of PBI to private lands is needed for the creation of more precise information used by the broader forestry community in site-to-landscape level planning, analysis, and monitoring at the statewide scale. The ground plot network collected through PBI will be used in combination with existing lidar, satellite, and aerial imagery to enhance Minnesota's forest inventory and enable estimates and projections of change.

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?

The Resource Assessment Program (RAP) will oversee the collection of approximately 1,000 PBI plots on private lands critical to accurately mapping and monitoring changing forest conditions across ownerships. These private field plots will be used in combination with existing public PBI, and remotely sensed data to produce statewide models of forest inventory metrics. This project contributes to understanding the role our forests play in carbon storage and sequestration and provides key benchmark information for management planning and policy evaluation. The inclusion of private lands enables enhanced landscape and regional planning for many shared ownership natural resource priorities and values.

Activities and Milestones

Activity 1: Strategic Planning and Network Design for Programmatic Approach to Plot Based Inventory and Model Development Incorporating Private Lands.

Activity Budget: $200,000

Activity Description:
Strategic design and collaboration will begin with new investment from ENRTF in FY23 starting in a priority pilot region. This design work will continue throughout the first year of the proposed project, with heavy emphasis in the first six months to meet PBI data collection time constraints. Though coordinated by RAP, other state and non-state partners will be involved in development of this program, including: DNR's Private Forest Management Program, University of Minnesota Extension Service, Minnesota Forestry Association, and the Minnesota Forest Resources Council Landscape Committees. Strategic elements to be addressed include: identification and collaboration with organizations focused on private lands forestry, design of the needed PBI network for inventory metric estimation at desired levels of precision, development of private lands data management model and procedures, and project management planning for contracting with private forestry consultants for PBI data collection. Additional effort will be needed to identify all feasible logistical solutions for collecting PBI on private lands. Partner input will be essential in solidifying the organizational structure needed to accomplish project objectives. Final design of the private lands PBI network will depend on partner capacity and organizational priorities as well as desired levels of model precision and data privacy considerations.

Activity Milestones:

Description	Completion Date
Agreement on overall strategic organizational roles and responsibilities; project organizational chart.	August 31, 2023
Finalize private lands data management model and procedures; identify responsible organization.	August 31, 2023
Identification of landscape priorities for PBI collection; forest conditions and areas to be sampled.	September 30, 2023
Identify desired maps and levels of model precision for landscape and ownership strata	September 30, 2023
Develop plan for engaging private vendors able to complete private lands PBI field work.	September 30, 2023
Design alternatives for private lands PBI network establishment (# plots in priority landscapes).	October 31, 2023

Activity 2: Strategize and begin private landowner outreach, PBI network development, and use of alternatives expanding the forest inventory to all lands.

Activity Budget: $670,000

Activity Description:
RAP will work with internal and external stakeholders identified in Activity 1 to coordinate private landowner outreach associated with strategic priorities and needs defined by Activity 1. RAP's proposed Program Coordinator will work with private forestry consultants to conduct PBI field work on lands where permission to collect data is granted. Private PBI data will be managed by a non-state entity identified during Activity 1 to ensure privacy considerations. Procedures and standards used for PBI data collection will follow the public lands PBI effort currently nearing completion. Approximately 1,000 PBI plots will be collected on private forestland ownerships to enable extension of public lidar derived forest inventory models to all-lands, providing information needed for carbon market engagement. We'll investigate incorporating other field inventory efforts from public lands PBI and United States Department of Agriculture's Forest Inventory and Analyses Program (FIA) to improve precision of final products. Other stakeholders are also working on complementary pieces of this process via separate project proposals (Zobel - Removing Barriers to Carbon Market Entry, Duplissis – Integrating Remotely Sensed Data with Traditional Forest Inventory). We will work with these project partners to merge our methods and work products, producing the best available models and maps.

Activity Milestones:

Description	Completion Date
Development of request for proposals and contract for use with private forestry consultants doing PBI.	September 30, 2023
Incorporate any changes to public lands PBI process needed for development of private PBI network.	October 31, 2023
Priority landowner identification, landowner contact and permissions for private lands PBI collection.	November 30, 2023
Coordination with partners producing inventory models based on FIA and other forest inventory data.	June 30, 2024
Design workflow for merging PBI and other data to produce best possible models.	June 30, 2024

Activity 3: PBI data collection, carbon model development, multi-temporal map production, and stakeholder training workshops

Activity Budget: $668,000

Activity Description:

PBI data will be collected on private lands using a combination of private forestry consultants and DNR Private Forest Management Program foresters. Private lands PBI data will be maintained by a third party and a depersonalized version of the data will be provided to RAP for use in lidar inventory metric and model development. RAP Research Scientists will work in consultation with external partners to produce up to date carbon models and maps, also leveraging research from ENRTF investment beginning in FY23. RAP will also produce multi-temporal maps showing forest carbon change over time (ex. 2003, 2008, 2013, 2018, 2023), by leveraging 2010 statewide lidar, a time-series of Landsat imagery and other data. Multi-temporal maps will be designed to correspond with the 5-year cycle used by FIA to facilitate validation of statewide carbon estimates. Final carbon maps will be published to an online service and individual property reports will be developed for landowners participating in the private lands PBI network. Final maps and models will also be shared with stakeholders via one or more workshops focused on utilization of the project deliverables for resource evaluation and management planning. Project collaborators will participate in the design and execution of workshops.

Activity Milestones:

Description	Completion Date
Plot based inventory data collection via forestry consultants	November 30, 2024
Lidar derived forest inventory model development	June 30, 2025
Final point in time carbon models using all available data	October 31, 2025
Multi-temporal map development showing carbon change over time	February 28, 2026
Publish final carbon maps to online GIS service, provide property reports to private landowners	June 30, 2026
Stakeholder workshops to showcase project results and demonstrate product application to natural resource management planning.	June 30, 2026

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Resource Assessment Program	Minnesota DNR - Forestry	Project Management, Remote Sensing Model Development, Partner Coordination, PBI Network Design, PBI Collection Procedure Oversight, Time Series Map Production	Yes
Minnesota Forest Resources Council	Minnesota DNR - Forestry	Partner Coordination, Landscape Prioritization for PBI Collection, Strategic Direction and Oversight of Project Objectives and Deliverables, Oversight of student workers involved with private landowner interactions.	No
Department of Forest Resources	University of Minnesota	Carbon Program Integration, Consultation on USDA-Forest Inventory and Analysis data Integration, Map Product Validation, Private Lands Data Management	Yes
Private Forest Management Program	Minnesota DNR - Forestry	Private Landowner Contact and PBI Permissions for Private Lands	Yes
Extension Services	University of Minnesota	Private Landowner Contact and Permissions	Yes
Minnesota Forestry Association	Minnesota Forestry Association	Private Landowner Contact and Participation	Yes
Natural Resources Research Institute	University of Minnesota - Duluth	Online GIS Map Hosting and Tools	Yes
Forest Stewardship Planning Coordination	Minnesota Board of Soil and Water Resources	Coordination with local Soil and Water Conservation Districts, Partner Coordination, Strategic Direction and Contribution to Project Objectives and Deliverables, Private Landowner Contact and Participation	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?

Through this project, time-sensitive private lands PBI will be collected and merged with public data to produce statewide estimates of forest resources focused on carbon storage and sequestration over time. Project results will be shared with all project participants in the form of statewide and / or landscape / property specific maps and reports. Private landowners participating in the PBI initiative will be provided with reports for their properties based on the project results and PBI data specific to their property. Carbon maps will be made available through one or more online GIS platforms managed by project participants.

Project Manager and Organization Qualifications

Project Manager Name: David Wilson

Job Title: NR Program Consultant - Guideline Monitoring

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

David Wilson holds a M.S. in Geographic Information Systems Science and a PhD in Natural Resource Science and Management (forest biology, ecology, and management). David has 16 years of experience applying spatial and relational data techniques to analyze, quantify, and plan for the management of natural resources. David also has 11 years of experience working with forest biometrics data, statistical analysis of natural resources data (esp. forest

inventory) and developing spatial and statistical models from field-based and remotely sensed data. Examples include: 1) development of forest connectivity models quantifying the potential for management of forest habitat for area sensitive and forest interior migratory bird species, 2) examination of USDA-Forest Service Forest Inventory and Analysis (FIA) data with respect to trends in Minnesota's moose herd to identify generally aging forests as a possible contributor to the decline of the population, 3) quantification of the potential to sustainably utilize forest biomass to offset fossil fuels used to generate electricity in Minnesota and the Upper Lake States Region, 4) examination of forest disturbance trends in Minnesota via FIA plot observations (1999-2018), 5) development of a machine learning algorithm and associated methods to infer native plant community classifications for forest inventory plots and stands in Minnesota, 6) examination and development of forest regeneration models and biomass accumulation rates on stands harvested since 2000 using lidar and Landsat remotely sensed data (Arrowhead Region).

David has extensive project management experience, ranging from coordination of the Upper Mississippi Basin Stakeholders Network and the Driftless Area Initiative to managing the 2014 re-inventory of forest resources at the University of Minnesota's Cloquet Forestry Center. David's current post is with the Minnesota Department of Natural Resources as a Natural Resource Program Consultant managing all aspects of the Forest Management Guideline Monitoring Program for the Division of Forestry.

Organization: MN DNR - Forestry Division

Organization Description:
The Minnesota Department of Natural Resources' mission is to work with citizens to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life.

The Division of Forestry's mission is to provide a shared expertise to understand, sustain, and manage Minnesota's trees, woodlands, and forests; provide a sustainable supply of multiple forest resources and opportunities; Protect lives and property from wildfires; and fulfill responsibilities to the permanent school trust.

The RAP supports Division of Forestry and DNR goals to maintain and improve the health of Minnesota's forests and natural resources. RAP provides natural resource managers with critical support for decision-making by providing; expertise in natural resource field inventory, aerial photography, spatial analysis, remote sensing analysis, including lidar and satellite image processing. These products and services are critical in supporting management of forest health, timber yields and wildlife, among other uses. These rich data and analysis are important to help deal with the effects of widely variable forest change patterns, invasive species and disease, disruptive forest events, and many other impacts of climate change.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Project Coordinator		Project Management and Coordination			25%	3		$375,000
Natural Resource Program Consultant		Project Oversight and Technical Consulting			25%	0.6	X	-
							Sub Total	**$375,000**
Contracts and Services								
Resource Assessment Program	Professional or Technical Service Contract	RAP will provide overall project coordination, hiring, data analysis, model development, and contractor management services. All project deliverables will be produced directly by RAP (lidar inventory models, maps, property reports).				0		$360,000
Private Forestry Consultants	Professional or Technical Service Contract	Private Forestry Consultants will do most of the actual plot based inventory data collection. Private contractors will report to Resource Assessment. Private data will be managed by a third party.				0		$400,000
University of Minnesota	Professional or Technical Service Contract	University of Minnesota - Department of Forest Resources researchers will work to independently validate final maps and products of the project. U of M researchers will be consulted throughout the project for input on best model development, FIA data integration and carbon market requirements. Private data management for project.				0		$200,000
Private Forest Management Program - MNDNR Forestry	Professional or Technical Service Contract	PFM foresters working on private stewardship plans will provide a point of contact with landowners likely to agree to participate in the private lands PBI network. PFM foresters may collect PBI plots on lands where they have developed stewardship plans.				0		$50,000
Minnesota Forestry Association	Professional or Technical Service Contract	MFA will provide a point of contact with private forest stewards possibly interested in participation in the private lands PBI network. Landowner information and communications related to this				-		$50,000

		effort will be maintained by MFA. Participating landowners will be provided with a private forestry consultant to collect PBI data.						
Natural Resources Research Institute	Professional or Technical Service Contract	Online GIS Map Hosting and Tools				0		$35,000
							Sub Total	**$1,095,000**
Equipment, Tools, and Supplies								
	Equipment	Laptop computer (1), field tablets (1), high precision GPS (1), cell phone(1)	Needed equipment for project coordinator					$10,000
							Sub Total	**$10,000**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
							Sub Total	**-**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Printing	Mailings associated with landowner contact and permissions.	A large number of landowners will need to be contacted to request permissions for inclusion of their property in the PBI network.					$30,000
							Sub Total	**$30,000**

Other Expenses								
		Direct and Necessary Costs	People Support, Safety Support, Financial Support, Communication Support, IT Support, Planning Support					$28,000
							Sub Total	**$28,000**
							Grand Total	**$1,538,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Personnel - Natural Resource Program Consultant		Project Oversight and Technical Consulting	**Classified :** N/A

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	General Fund (DNR, MNIT, DOT), DNR-FOR (FMIA, PFM, Fire)	High density lidar collection and processing (In progress: Statewide 2021 - 2024)	Secured	$2,145,000
In-Kind	DNR - DOF	Public lands PBI collection (Statewide)	Secured	$1,690,525
In-Kind	General Fund (DNR-DOF)	0.2 FTE x 3 years for Project Oversight and Consulting	Secured	$56,000
Cash	ENRTF FY2023 - HF 3765 (d) Forest Data Inventory	$500,000 the second year is from the trust fund to the commissioner of natural resources for an enhanced forest inventory on county and private lands.	Secured	$500,000
			State Sub Total	**$4,391,525**
Non-State				
In-Kind	County, Federal, Tribal and local government	High-density lidar collection statewide (In progress: 2021-2024)	Secured	$16,544,874
In-Kind	County, Federal	Public lands plot based inventory (2021-2024)	Secured	$658,360
In-Kind	Federal, County, Tribal and local government	High Density lidar data collection statewide (Planned: 2022-2024)	Potential	$5,000,000
			Non State Sub Total	**$22,203,234**
			Funds Total	**$26,594,759**

Attachments

Required Attachments

Visual Component

File: 5ce4ff4d-80b.pdf

Alternate Text for Visual Component

Timeline of overall lidar forest inventory process and and funding status with maps of total and private plot based inventory needs for each Minnesota county....

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?

No

Statewide forest carbon inventory and change mapping: Plot Based Inventory (PBI) Timeline and Private PBI Maps

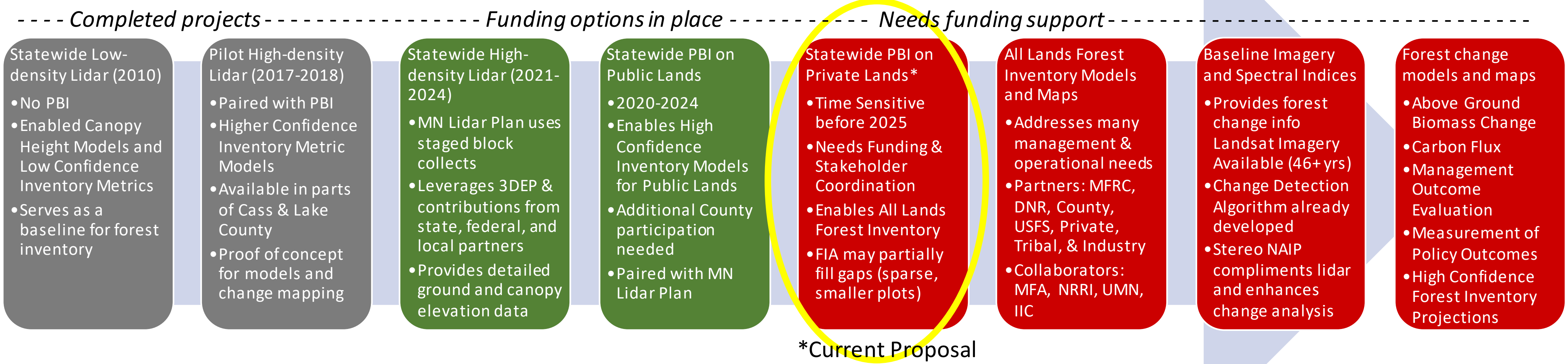

Figure 1. Starting with a pilot project on the far left, the arrow in the background walks through a timeline showing completed projects, funded projects, and future projects that need funding, as you read from left to right. The current proposal is circled in yellow with an asterisk next to the title: Statewide PBI on Private Lands.

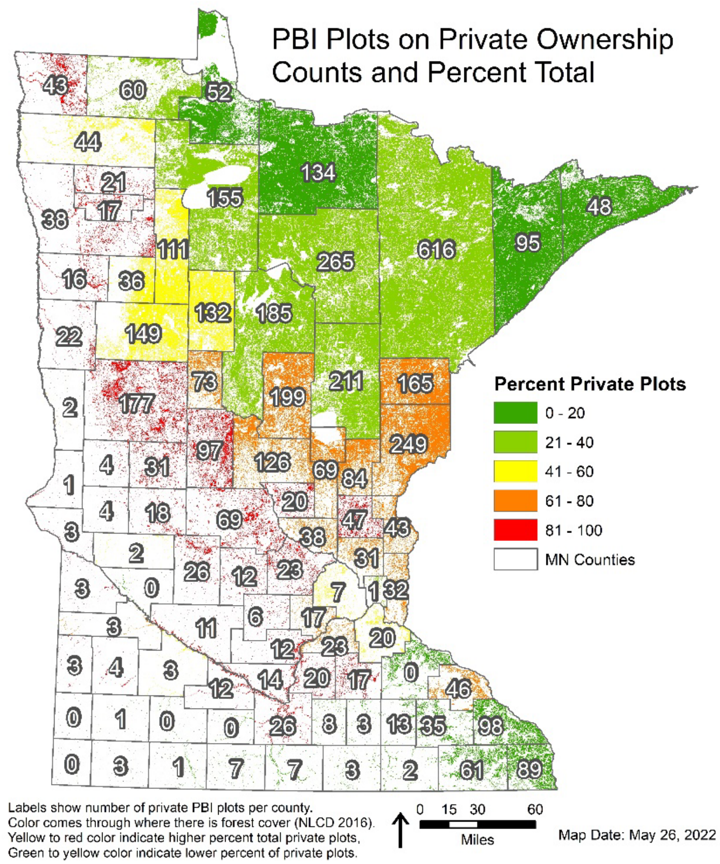

Figure 2. Labels show number of private PBI plots per county. Color comes through where there is forest cover (NLCD 2016). Yellow to red color indicate higher percent total private plots, green to yellow color indicate lower percent of private plots. This project will focus on counties with highest private percentage.

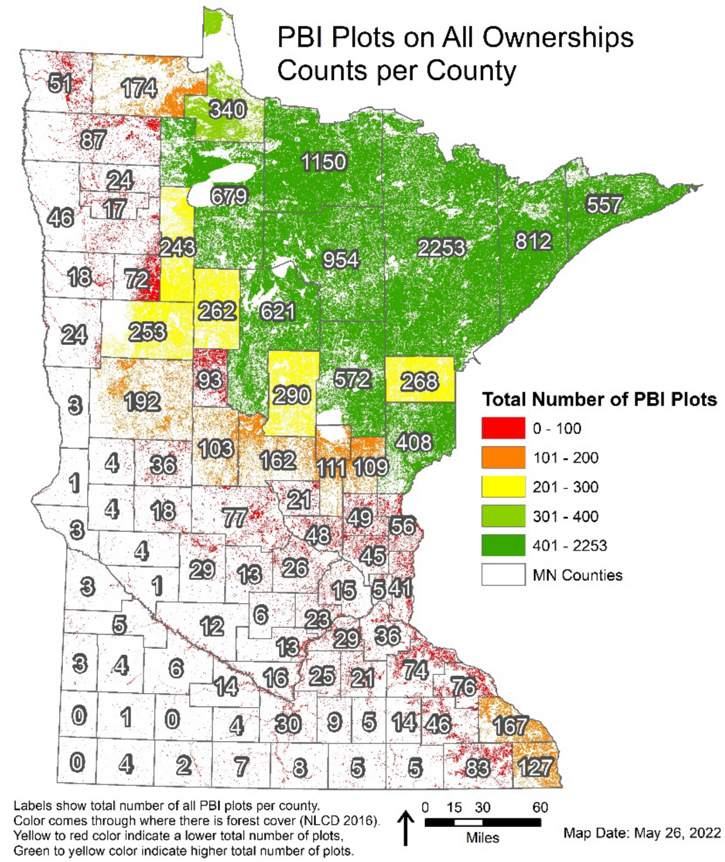

Figure 3. Labels show total number of all PBI plots per county. Color comes through where there is forest cover (NLCD 2016). Yellow to red color indicate a lower total number of plots, green to yellow color indicate higher total number of plots. This project will focus on counties with a lower total number of plots.