Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-534

Proposal Title: Remotely-Sensed Tree Inventories for Urban and Community Forests

Project Manager Information

Name: Adriana Uscanga Castillo

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

Office Telephone: (541) 606-9249

Email: auscanga@umn.edu

Project Basic Information

Project Summary: Resilient urban forest management relies on up-to-date tree inventories. We will map trees on public and private lands for Minnesota cities vulnerable to pest outbreaks using remote sensing and AI.

ENRTF Funds Requested: $300,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Small Projects (G)
Secondary Category: Resiliency (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.

Effective urban forest management relies on inventories accurately representing the location, taxonomy, size, and other characteristics of trees. Municipalities across Minnesota allocate considerable amounts of funds to tree inventories and monitoring programs. For example, Hennepin County recently awarded the City of Plymouth $43,704 to update their municipal public tree inventory.

Municipal inventories, however, do not survey private lands. This represents a critical knowledge gap since 73% of Minnesota's urban trees are privately owned (USFS Urban Forest Inventory Analysis, 2025). Ignoring the taxonomic composition of trees in private lands is problematic because threats like pests do not respect municipal and property boundaries. Susceptible species like Green Ash and Maple (affected by Emerald Ash Borer and the Asian longhorned beetle, respectively) are commonly planted in public and private lands alike.

Furthermore, community forest composition is rapidly changing due to pest outbreaks, global warming, and new residential developments, and current tree inventory methods are too labor-intensive and expensive for frequent updates, especially in small and mid-sized communities with limited budgets for proactive community forest management. This data lag hinders cost-effective preventative practices like early pest treatment. Timely response to these threats demands updated inventories and constant monitoring across public and private lands.

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.

Municipal natural resource managers across urban and suburban communities need simple tools, data synthesis, and actionable science to assess threats, opportunities, risks, and costs from challenges like pest outbreaks affecting statewide forests in public and private lands.

Our proposal will leverage AI and advanced remote sensing (LiDAR, multi- and hyperspectral data) to produce comprehensive (wall-to-wall), up-to-date maps of individual trees for small urban areas and suburban communities of greater Minnesota. We will focus on communities with recent Emerald Ash Borer infestations (EAB), such as Brainerd and Fergus Falls, or with imminent threat, like Alexandria and Bemidji.

By training AI-models with remote sensing, ground-based inventories and field data, we will identify, classify, and map individual tree genus across entire community forest canopies, including areas traditionally excluded from street tree inventories and most vulnerable to costly devastations such as trees in private lands and remnant forest patches.

To ensure long-term and widespread impact, the resulting maps will be publicly accessible and our methodology will follow open science guidelines to build a reproducible workflow. This will allow seamless updates as new data becomes available, facilitating continuous monitoring and scaling this methodology to other cities in Minnesota and the United States.

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?

This project enhances Minnesota's urban and community forests by providing the first comprehensive, up-to-date, and interactive tree inventory maps for urban areas at the greatest risk of pest invasion. By including all components of the urban tree canopy we will facilitate precise management for urban and community forest protection, conservation, and preservation. These publicly accessible maps will be available on user-friendly platforms like ArcGIS Online and stored in stable, long-term repositories. Additional deliverables include a tutorial on using the interactive maps for natural resource management, and a report detailing the reproducible workflow, main results, and scripts.

Activities and Milestones

Activity 1: Recruit interested stakeholders, gather remote sensing imagery and collect field data

Activity Budget: $52,000

Activity Description:
We will recruit municipal natural resource managers from two small to medium sized urban and suburban communities that have recently experienced EAB infestations and two communities that do not yet have EAB. From these communities, we will gather the most recent municipal tree inventories and compile them into a single database that includes tree identification and geographic coordinates. We will identify the most abundant tree genera (expected to include Ash, Maple, and Aspen), which comprise most of the canopy cover and will serve as primary targets for model training.

We will collect remote sensing data from the state-wide airborne lidar acquired from 2021-2024 by MnGEO, the high-spatial resolution National Agricultural Imagery Program (NAIP) multispectral imagery acquired in 2023, and Sentinel-2 multispectral images from different seasons acquired in 2023. We will supplement these public datasets by purchasing high-resolution Wyvern hyperspectral images for our study areas. Finally, we will conduct fieldwork to collect leaves from the top of the canopy of the most abundant trees. Using a portable SVC spectroradiometer from the Remote Sensing and Geospatial Analysis Lab at the University of Minnesota, we will record the spectral reflectance of these leaves for ground-truthing AI models in Activity 2.

Activity Milestones:

Description	Approximate Completion Date
Collect hyperspectral remote sensing data from the most abundant urban canopy trees using portable spectroradiometer	November 30, 2027
Compile all most recent inventories into one single database with geographic references	December 31, 2027
Collect and process airborne and satellite remote sensing data for the areas of interest	December 31, 2027

Activity 2: Develop AI-model for tree identification and model validation

Activity Budget: $157,000

Activity Description:
Using lidar and NAIP data, we will employ advanced segmentation algorithms, like the AI model Segment Anything (SAM), to delineate tree crowns across the four communities. By overlaying these individual crowns with multispectral and hyperspectral satellite images, we will extract metrics useful for tree identification, including visible and near-infrared light reflectance, vegetation and chlorophyll indices, and seasonal phenological traits.

We will train an AI-model to classify individual trees to the genus-level based on 70% of inventory records, and the metrics extracted from lidar, hyper- and multispectral data. To reduce model noise and ensure temporal consistency across datasets acquired in different years, we will use Sentinel-2 time series analysis to detect and mask significant canopy changes. We will use the leaf spectral library collected in the field (Activity 1) to calibrate these models.

This wall-to-wall classification will encompass trees on both public and private lands. To enhance model accuracy, we will bolster the training set by including samples from our targeted tree genera planted locally to Minneapolis-Saint Paul and will request permission for these samples through existing research collaborations. Model accuracy will be rigorously validated by comparing the remaining 30% of ground-truth inventory records against our automated model classifications.

Activity Milestones:

Description	Approximate Completion Date
Delineate tree crowns using lidar and NAIP data.	March 31, 2028
Extract tree identification metrics using hyper- and multispectral satellite data.	June 30, 2028
Classify individual trees based on remotely sensed metrics and inventory data.	August 31, 2028
Validate models based on inventory and field data	November 30, 2028

Activity 3: Create an interactive tree map and disseminate broadly

Activity Budget: $91,000

Activity Description:
Using the high-performing model from Activity 2, we will make an interactive, user-friendly map of urban trees for the partner communities. Using the University of Minnesota's existing subscription, the map will be openly available through the accessible platform ArcGIS Online and will include scientific and common names as well as an associated classification accuracy level.

End users, including municipal natural resource staff, tree advisory committee volunteers, or private landowners, will then be able to click on a tree on a map and find out the tree genus (e.g., Acer for maples) and view its common name alongside a classification probability percentage. Additionally, the map will include filtering tools to help end users visualize trees by genus and assess the vulnerability and risk of trees across their entire community forest population. To ensure adoption, we will provide a self-paced tutorial detailing potential uses and broader impacts.

We will publish a comprehensive report describing our methods and results and deliver public-facing presentations. All project scripts will be made permanently available through the Data Repository for the University of Minnesota (DRUM), ensuring the workflow is reproducible and ready to be applied and scaled to other urban and suburban communities across the state.

Activity Milestones:

Description	Approximate Completion Date
Make interactive and friendly online maps with individual tree scientific and common names	March 31, 2029
Make tutorial for non-specialists on using the map for enhancing urban forest resilience.	May 31, 2029
Write a report to disseminate methods, results, and map applications.	June 30, 2029
Offer public-facing presentations for statewide natural resource professionals	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Alicia Coleman	University of Minnesota	Co-Principal Investigator	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
Dissemination will occur through several outlets: (1) Multiple public-facing presentations at the Minnesota Shade Tree Short Course annual meeting and UMN Extension's Fridays with a Forester webinar series for statewide tree care professionals; (2) One or more professional society presentations to the Society of American Foresters Annual Convention, Association of Natural Resource Professionals, Association of American Geographers Annual Meeting, and/or the Ecological Society of America; (2) Multiple peer-review manuscripts to inform the scientific community of our approach and findings; (3) Public-facing webpage via UMN Remote Sensing and Geospatial Analysis Lab. All dissemination materials will acknowledge Environment and Natural Resources Trust Fund through use of the trust fund logo and/or attribution language on project print and electronic media, publications, and other communications per the ENTRF Acknowledgement Guideline.

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?
Findings will be disseminated via the Minnesota Geospatial Commons and Big Ten Academic Alliance Geoportal, with all code and maps permanently archived in the Data Repository for the University of Minnesota (DRUM). This ensures long-term, open-access availability for state and local agencies. We will share results to urban forest managers who are the people that will immediately benefit from this product. In the future, we will improve the accuracy and usability of the maps through direct input from end-users. Future work will be sustained through local, state, and federal grants interested in funding geospatial products for natural resource enhancement.

Project Manager and Organization Qualifications

Project Manager Name: Adriana Uscanga Castillo

Job Title: Assistant Professor

Provide description of the project manager's qualifications to manage the proposed project.
Dr. Adriana Uscanga is an expert in the spatial analysis of social-ecological systems, with over eight years of experience integrating remote sensing data and vegetation surveys to study forest ecology and human-modified ecosystems. She utilizes satellite and airborne remote sensing data to develop AI models for mapping forest ecological features essential for sustainable natural resource management.

As a faculty member at the University of Minnesota in the Department of Forest Resources, Dr. Uscanga teaches Geographic Information Systems for Natural Resource Management and leads a research group dedicated to the spatial analysis of social-ecological systems. This group operates within the Remote Sensing and Geospatial Analysis Lab (RSGAL) at the University of Minnesota.

She has a proven track record of academic leadership, currently supervising three graduate and two undergraduate students, and managing multiple concurrent research projects. Dr. Uscanga has 11 peer-reviewed publications and is leading three active research projects, two of them as principal investigator. Related ongoing projects led by Dr. Uscanga include initiatives focused on mapping urban greening and biodiversity, and analyzing urban forest disturbance and stability in Minnesota. She has received several honors and awards including the North American Cartographic Information Society (NACIS) Best Cartographic Research.

For this LCCMR project, Dr. Uscanga will serve as Principal Investigator, overseeing the project's progress, direction, budget, and timeline. She will supervise the researcher dedicated to this project and co-advise a graduate research assistant alongside Co-PI Dr. Coleman, an expert in urban and community forests. RSGAL provides Dr. Uscanga and her team with advanced high-performance computing hardware and software required for the proposed analysis. Dr. Uscanga's experience in technical spatial analysis and project leadership will ensure the successful delivery of the proposed outcomes.

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

Organization Description:
The College of Food, Agricultural and Natural Resources Sciences (CFANS) within the University of Minnesota seeks to inspire minds, nourish people, and enhance the natural environment. CFANS vision is to advance Minnesota as a global leader in food, agriculture, and natural resources through extraordinary education, science-based solutions, and dynamic public engagement that nourishes people and enhances the environment in which we live. CFANS hosts twelve academic departments and ten research and outreach centers, the Minnesota Landscape Arboretum, the Bell Museum, and several interdisciplinary centers. Within CFANS, the Department of Forest Resources advances the science and management of forests and related natural resources by developing solutions to important problems affecting these resources; training the next generation of scholars and practitioners; and informing the broad public on the importance of forests and natural resources and how they enrich our quality of life. This project will be developed in the Remote Sensing and Geospatial Analysis Lab (RSGAL) at the Department of Forest Resources, which is part of CFANS. RSGAL mission is to advance the development and application of remote sensing and geospatial analysis to inventory and monitor natural resources and environment through research, education, and outreach.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
PI		Oversee the project's progress, direction, budget, and timeline. Oversee remote sensing data collection, model development, and mapping efforts. Supervise the researcher dedicated to this project and co-advise a graduate research assistant.			26%	0.2		$28,891
Co-PI		Oversee project progress, relationship with stakeholders and partner communities, and dissemination of results to urban and suburban natural resource managers. Co-advise graduate research assistant.			26%	0.2		$29,494
Civil Service		Researcher will lead data integration, AI-model development, tree classification, model validation, workflow reproducibility, and map development. The researcher will be in communication to stakeholders of partner communities along with PI and Co-PI and will contribute to drafting results.			24%	1		$97,902
Graduate Research Assistant		The graduate research assistant will be in charge of conducting fieldwork to collect spectral data of leaves from the top of the canopy to calibrate AI-model. The graduate student will carry out remote sensing data collection and processing, tree inventory compilation, and contribute to model training. The graduate research assistant will be highly invested in creating the final maps and disseminating results through reports and public-facing presentations.			45%	1		$120,665
							Sub Total	**$276,952**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	High-resolution hyperspectral imagery (~20 images)	High-resolution hyperspectral imagery from Wyvern or Planet will be used for					$15,000

			training the AI-model, supplementing public imagery of lower spectral and spatial resolution.					
							Sub Total	**$15,000**
Capital Equipment								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Field trips	Field trips to collect leaves from the top of the canopy to calibrate AI-models and to connect with stakeholders of partner communities					$8,048
							Sub Total	**$8,048**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$300,000**

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				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $300,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: ca5c3085-e29.pdf

Alternate Text for Visual Component

Three panels describing our activities: (1) Recruit stakeholders and collect data shows an aerial view of trees on public and private lands; (2) Develop AI-model for individual tree classification depicts tree classification on aerial view; (3) Map of individual trees shows an example of interactive platform with a Maple tree...

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
University SPA letter of approval	93f82d24-4f3.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

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

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?

No

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing $10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Andrea Little, University of Minnesota

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A