Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-292

Proposal Title: Automated Invasive Detection Using Multispectral and LiDAR UAVs

Project Manager Information

Name: Tyler Nelson

Organization: Real Vision Drones

Office Telephone: (651) 408-2550

Email: tyler@realvisiondrones.com

Project Basic Information

Project Summary: We will develop an automated detection algorithm to identify target invasive species using UAV(drone)-based Multispectral and LIDAR sensors, streamlining statewide monitoring and management for natural resource managers.

ENRTF Funds Requested: $347,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Land (F)

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.

Local Government Unit (LGU) land managers are responsible for overseeing vast jurisdictions, often covering thousands of acres of public land. However, current staffing levels and budgets frequently limit their capacity to do much more than reactive maintenance. In discussions with partners like Chisago County, a primary challenge is the sheer labor required for manual scouting.

Currently, identifying new stands of invasive species requires extensive "boots on the ground" time—a luxury most managers don't have while balancing daily operations. Because they are understandably occupied with managing known high-priority areas on top of other county and state goals, many parts of their jurisdiction may go unmonitored simply due to a lack of hours in the day. This creates a significant gap in their ability to efficiently manage the total acreage under their care. The problem isn't a lack of intent, but a lack of tools that can scale their reach across the landscape.

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.

Current invasive species monitoring relies on labor-intensive ground surveys or low-resolution satellite imagery, which often miss emerging infestations in difficult terrain. Our solution leverages the synergy of Multispectral imaging (vegetation health/pigment signatures) and LiDAR (structural density/height) collected via Unmanned Aerial Vehicles (UAVs).

We are seeking funding to develop and validate a specialized machine learning algorithm capable of processing these fused datasets to automate species identification. By training the model on the unique "bio-signatures" of our 3 target invasives, we can survey vast or inaccessible acreage with higher precision than traditional methods in a fraction of the time.

The work involves three phases:
1) Controlled UAV data collection over known infestations to establish a training library.
2) Algorithm development and "ground-truth" validation.
3) Creation of a standardized data pipeline.

This technical framework allows land managers to move from reactive treatment to proactive, precision management. Instead of manual detection, our workflow produces validated coordinates and density maps, transforming raw sensor data into a scalable, statewide early-detection and monitoring tool without the need to physically walk acreage. This project provides the technological "eyes" needed to find and manage stands while they are operationally feasible to treat.

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 primary outcome is a validated, open-source detection tool that enhances the protection and preservation of Minnesota's land by enabling more thorough oversight at a significantly larger scale. By providing high-resolution data, this project allows for targeted management that can reduce the overall volume of herbicides and human intervention required for control. This contributes to the enhancement of natural resources by replacing labor-intensive manual scouting with precise, systematic data. Ultimately, this tool saves substantial time for staff, allowing them to manage vast jurisdictions more effectively and ensuring that state-funded conservation efforts are directed exactly where they are needed most.

Activities and Milestones

Activity 1: Site selection based on known invasives and operational data collection.

Activity Budget: $150,000

Activity Description:
The objective is to capture as much high quality data as possible based on factors that will help identify the 3 invasives being targeted within this project.

Phenological Windows: Target "Early Leaf-Out" (spring), "peak-growth' (summer) and "Green-Stay" (late autumn) for each invasive based on information found in MN databases and information passed on through parternships with LGU's on the project.

Native Validation: Utilize the UMN Phragmites Map and Chisago county information on Buckthorn, Phragmites and Wild Parsnip to identify 15 control sites that contain known monocultures of the 3 target invasives. (Offering the ability to detect across 3 main ecosystems: Forest, Wetland and Prairie.) Utilize RTK GNSS receivers to precisely and accurately mark the monoculture stand locations.

Drone flights / data collection / storage: Fly drones, ground truth using RTK GPS recievers for pin-point accuracy/precision and process data to build library of information for teaching machine learning model. 1 flight / data collection per site per week.

Success in this activity will be derived from robust truthing and validation of exact invasive species and multiple copies of data collected. Validation will be done with the help of partners such as Chisago County and external folks like the UMN phragmites team.

Activity Milestones:

Description	Approximate Completion Date
Control Site Selection: Identify 10-15 sites containing Invasive Phragmites, Buckthorn, Honeysuckle, and their native look-alikes.	August 31, 2027
Autumn: Capture "Green-Stay" spectral signatures and structural data (LiDAR) for our 3 test invasives.	November 30, 2027
Spring: Capture "Early Leaf-Out" spectral signatures and structural data (LiDAR) for our 3 test invasives.	June 30, 2028
Summer: Capture "peak-growth" spectral signatures and structural data (LiDAR) for our 3 test invasives.	November 30, 2028
Ground truthing and exact RTK GPS location of invasive species. *Confirm in each season.*	November 30, 2028

Activity 2: Development, Training, and Ground-Truth Validation of the Detection Algorithm.

Activity Budget: $150,000

Activity Description:
The objective is to ingest the high-resolution data library from Activity 1 into a robust machine learning workflow to automate invasive species detection.

Data Processing & PDAL: Utilize Python and the Point Data Abstraction Library (PDAL) to process raw LiDAR point clouds into Canopy Height Models (CHM). Utilize GDAL to "stack" Multispectral and LIDAR bands into a "Data Fusion". This allows the model to "see" the unique vertical structure, density and Multispectral signature on a pixel by pixel basis.

Model Training: Use the ML4QGIS plugin and Python-based Scikit-learn to train a Voting-Based Ensemble Classifier. By

inputting the RTK-accurate GPS "patches" and Data Fusion's, the model will learn to distinguish invasives from native look-alikes and other plant species in the area.

Algorithm Refinement: Integrate the Data Fusion's and RTK accurate GPS "patches" across the three seasonal phenological windows to identify when highest accuracy can be achieved and create a more robust machine learning environment.

Success in this activity will be defined by achieving a model with a Kappa Coefficient >0.85. This ensures the software can reliably identify pioneer invasive patches for LGUs, even in complex, high-density native environments. The final output will be a refined detection algorithm ready for statewide use.

Activity Milestones:

Description	Approximate Completion Date
Integration of multispectral/LiDAR data into "Data Fusion's" to build the library of processable maps.	October 31, 2028
Build the Ensemble Classifier using ML4QGIS and Python-based machine learning libraries.	March 31, 2029
Input RTK-validated patches to "teach" the model specific invasive spectral signatures.	June 30, 2029
Run validation tests against native look-alikes to reach 90% detection accuracy.	August 31, 2029
Finalize the model for transition into a user-friendly LGU software toolkit.	November 30, 2029

Activity 3: Statewide Implementation, LGU Training, and Software Toolkit Deployment.

Activity Budget: $47,000

Activity Description:
The objective is to institutionalize the model into a user-friendly "Prescription Mapping" toolkit for Local Government Units (LGUs) and their ground crews.
Toolkit Development: Package the Python-based scripts and ML4QGIS workflows into a standardized "Technical SOP." This allows LGUs to process their own drone data or utilize our services to generate GPS-accurate "target maps" for the precise management of these invasives.

LGU Outreach & Training: Conduct an initial series of workshops with Chisago County as they were the initial pilot county. These sessions will train field technicians on how to interpret the model's "probability maps" to prioritize manual treatment of high-density pioneer patches.

Intern-Led Validation: Our environmental data intern will lead the "Real-World Accuracy" phase. This involves visiting 10 new, non-trained sites to verify if the model correctly identified invasives in the wild, ensuring the software remains robust across different Minnesota biomes.

Success in this activity is defined by the successful adoption of the workflow by Chisago County. By transitioning the "Intelligence Layer" from a lab setting to the field, we empower local managers to move from reactive broad-spraying to precision-targeted neutralizing of invasive Phragmites, Buckthorn, and Honeysuckle.

Activity Milestones:

Description	Approximate Completion Date
Finalize technical data-sharing agreements with Chisago County LID partners.	January 31, 2030
Deliver "Drone-Based intelligence-Layer" training sessions for Chisago County field technicians.	April 30, 2030
Perform ground-truth audits at 10 pilot sites to verify detection accuracy.	June 30, 2030
Submit the "Pilot-to-Scale" toolkit and open-source models to the LCCMR.	June 30, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
MN counties	Chisago County Parks Department	Chisago County Parks will serve as the primary field site for data collection and algorithm validation. As our lead partner, they will receive first-access to the completed detection workflow, high-resolution invasive maps, and the open-source algorithm to directly enhance their local resource management and restoration efforts.	No

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.
Project findings will be disseminated through the 'Minnesota Precision-Conservation & Drone IPM Technical Manual'—a standardized SOP for LGUs and SWCDs. We will host two statewide training webinars to demonstrate the 'Intelligence Layer' workflow and distribute our multispectral signature library for public use. All technical templates and data will be made free and accessible on the Real Vision Drones, LLC website. Additionally, results will be presented at the MN GIS/LIS Consortium and shared directly with the MN DNR to ensure integration into statewide invasive species management strategies.

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?
Results will be implemented by providing the algorithm and data capture/processing protocols to state agencies and local units of government. Following project completion, the core algorithm will be maintained as an open-source resource, allowing LGUs to develop their own 'intelligence layers' for localized target species. Additionally, future work—such as the development of specialized detection libraries for emerging invasive threats—will be sustained by Real Vision Drones LLC through fee-for-service partnerships with LGUs and state agencies on an 'as-needed' basis.

Project Manager and Organization Qualifications

Project Manager Name: Tyler Nelson

Job Title: Owner / operator / Drone Pilot / Data analyst

Provide description of the project manager's qualifications to manage the proposed project.
Tyler Nelson is a FAA Part 107 certified remote pilot with 4 years of experience in specialized aerial data acquisition, focusing on LiDAR and multispectral imaging for environmental applications. As the founder of Real Vision Drones, LLC, he has successfully managed complex technical projects involving high-precision mapping, data analysis and videography for counties like St. Louis County and private business's like Cedar Creek Energy and LHB corp.

Technical expertise includes -

Precision Mapping: Advanced proficiency in deploying LiDAR and multispectral sensors to identify fine-scale ecological changes and unique vegetation spectral signatures.
Technical Data Workflow: Proficiency in developing custom detection pipelines using Python and R for multispectral analysis and point-cloud processing. I specialize in integrating these automated outputs into QGIS to create high-resolution, actionable map layers.

Operational Safety: A proven track record of safe flight operations in diverse terrains, ensuring compliance with all federal and state aviation regulations.

Responsibilities -

Technical Execution: Overseeing all flight operations, sensor calibration, and data processing to ensure centimeter-level accuracy in invasive species detection.
Project Governance: Managing the project budget, ensuring funds are used strictly for approved work plan activities, and maintaining detailed records for state audits.
Reporting & Milestones: Submitting biannual status updates and a final report to the LCCMR, ensuring all project milestones—including the development of the "LGU Training Package"—are met on schedule.
Collaboration: Coordinating with any partner agencies or local government units to ensure successful information dissemination and project scalability.
Operational Coordination: The Project Manager will be responsible for translating raw multispectral / LiDAR datasets into validated detection coordinates, ensuring the seamless integration of automated algorithm outputs into actionable maps for precise management practices.

Tyler Nelson will be the main point of contact for the LCCMR.

Organization: Real Vision Drones

Organization Description:
Real Vision Drones is a single owner LLC here in Minnesota based in North Branch. As the single owner / operator of the business, Tyler Nelson is fully vested in this business. The work that is performed supplies the sole income for his wife and small family of 1 new born child, 2 German short haired pointers, 2 cats, and several chickens and pigeons. The business has a large focus and passion for the betterment of the environment through the use of technology in unmanned aerial systems. As Tyler was a solar electrician for his working career before starting this business, he had a realization that the natural environment was his true passion and really where his heart belongs. Doing this work is the most rewarding, intriguing and motivating thing he has ever ventured to do. The timeliness, honesty and overall commitment of the company Real Vision Drones is a direct reflection of the passion Tyler has burning in his heart for this beautiful world of ours.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Lead Remote Pilot, GIS Specialist and Senior Software Engineer		Responsible for all FAA-compliant flight operations, LiDAR/multispectral data acquisition, Data-Fusion, and the architectural development of the Machine Learning detection model. This includes managing the Python-based PDAL workflows, training the ensemble classifiers, and overseeing the Environmental Data Intern's field-truthing efforts. With expertise in RTK-precision mapping and multispectral/LIDAR analysis, I will lead the transition of raw geospatial data into actionable "Prescription Maps" for Chisago County and statewide LGU partners.			15%	2.1		$240,000
Environmental Data Intern		Ground-Truthing & RTK GPS Mapping: Utilizing handheld RTK GPS receivers to precisely mark "Invasive" vs. "Native" patches (e.g., Phragmites australis vs. americanus) to create the "Gold Standard" training data for the ML model. Spectral Data Tagging: Assisting in the ML4QGIS workflow by manually "tagging" and classifying multispectral imagery to teach the Ensemble Classifier how to identify specific plant signatures. Phenological Monitoring: Conducting field visits during "Green-Stay" and "Early Leaf-Out" windows to document plant health and growth stages for seasonal model calibration. LGU Outreach Support: Assisting in the development of "Technical SOPs" and training materials for Chisago County field technicians to ensure the toolkit is user-friendly for non-GIS experts.			12%	0.9		$75,000
							Sub Total	**$315,000**
Contracts and Services								
							Sub Total	**-**

Equipment, Tools, and Supplies								
	Equipment	Consumables: Batteries, propellers and field maintenance kits.	This will cover costs of wear items that will be used for the project.					$3,000
	Equipment	(2) 12TB External Hard Drive	These will be used to store all the pre-processed and post-processed data. Each unit containing one copy of each for redundency and security.					$1,000
							Sub Total	**$4,000**
Capital Equipment								
		(2) Emlid Reach RS3 GNSS RTK Receivers with Tilt Compensation.	Essential for sub-centimeter ground-truthing of invasive species "patches" to train the Machine Learning model. Tilt compensation allows the intern to capture accurate data in dense vegetation where traditional vertical leveling is impossible.	X				$7,000
		This budget item covers a High-Performance Geospatial Processing Workstation specifically spec'd for multi-modal data fusion. Technical components include an NVIDIA RTX 4090 GPU (24GB VRAM) for hardware-accelerated machine learning, 128GB of DDR5 RAM for large-scale point cloud manipulation, and a multi-terabyte NVMe SSD array for high-speed data I/O. The build includes a dedicated 20TB redundant storage system to ensure the security and integrity of the raw LiDAR and multispectral datasets collected across the 15 control sites. This hardware is the central engine for all Activity 2 and Activity 3 operations.	The purpose of this workstation is to serve as the Centralized Processing Hub for the project's machine learning "Intelligence Layer." Computational Necessity: Standard office computers lack the CUDA cores and memory capacity required to run Python/PDAL and ML4QGIS ensemble classifiers on fused LiDAR and 4-band multispectral data. Scalability: This PC is designed to ingest and process raw data transmitted from Chisago County and other LGU partners via a cloud-based workflow. Efficiency: By centralizing the processing, we eliminate the need for individual counties to purchase expensive hardware, providing a cost-effective, shared-resource model.	X				$6,000
							Sub Total	**$13,000**

Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Mileage, lodging, and per diem for field operations across diverse Minnesota study sites (wetlands, forests, and drainage corridors).	Necessary travel to and from sites, lodging and per diem.					$12,000
							Sub Total	**$12,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Printing	This budget covers the design and production of 500 high-quality "Program Blueprint" Booklets. These are 6-10 page, full-color professional pamphlets featuring: Visual Case Studies: Before-and-after maps of the Chisago County pilot sites. Technical Infographics: Simple "How-To" diagrams explaining the Python/ML4QGIS workflow. Equipment Specs: A "Shopping List" for LGUs (e.g., Emlid RS3, Multispectral sensors) to start their own programs. QR Code Integration: Direct links to your open-source code and the UMN Phragmites Map.	Institutionalization: It acts as a professional "Sales Pitch" for the program, helping LGU directors justify the purchase of their own drone hardware to their boards. Clarity: It translates complex machine learning data into a "Cool Visual" format that is easy for non-technical stakeholders to understand. Statewide Visibility: It ensures that the ENRTF-funded research doesn't just sit on a hard drive but is actively distributed at the Association of Minnesota Counties and SWCD annual meetings.					$2,000
							Sub Total	**$2,000**
Other Expenses								
		FAA Part 107 Remote Pilot Certification Package: (1) FAA Knowledge Exam Fee, (1) Commercial Drone Ground School/Study Course, and associated study materials. (For Real Vision Drones LLC hired Intern.)	To ensure operational safety and FAA compliance, budget is allocated for the field intern to obtain their Part 107 Remote Pilot Certificate. This allows for					$1,000

			more efficient, multi-team data collection while the PI focuses on specialized modeling and algorithm development.					
							Sub Total	**$1,000**
							Grand Total	**$347,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Capital Equipment		(2) Emlid Reach RS3 GNSS RTK Receivers with Tilt Compensation.	The dual Emlid RS3 GNSS receivers are essential for the ground-truthing and machine learning (ML) phases of this project. While the MNCORS network is available in some areas, when high-priority invasive "patches" are located in remote wetlands with unreliable cellular connectivity, a base and RTK rover are needed. These receivers provide the independent Base/Rover RTK link required for sub-centimeter accuracy. Without this precise GPS data, the ML model cannot be trained to differentiate invasive species signatures from native look-alikes. This equipment is a direct, necessary cost for the successful creation of the "Intelligence Layer" and cannot be replaced by existing state infrastructure alone in "remote" (No cell network coverage) field conditions. **Additional Explanation :** Statewide Scaling: After the Chisago County pilot, the equipment will be utilized to collect "training data" for new priority invasives identified by the DNR or Department of Agriculture, such as Wild Parsnip or Palmer Amaranth. LGU Technical Support: The units will remain available for specialized field-truthing missions where partner counties lack high-precision RTK or LiDAR capabilities.
Capital Equipment		This budget item covers a High-Performance Geospatial Processing Workstation specifically spec'd for multi-modal data fusion. Technical components include an NVIDIA RTX 4090 GPU (24GB VRAM) for hardware-accelerated machine learning, 128GB of DDR5 RAM for large-scale point cloud manipulation, and a multi-terabyte NVMe SSD array for high-speed data I/O. The build includes a dedicated 20TB redundant storage system to ensure the security and integrity of the raw LiDAR and multispectral datasets collected across the 15 control sites. This hardware is the central engine for all Activity 2 and Activity 3 operations.	While computers are generally ineligible, this workstation is a direct and necessary technical requirement for the success of Activity 2 (Machine Learning). The project involves fusing high-density LiDAR point clouds with multispectral imagery to create 3D structural models of invasive species. This process is computationally "heavy" and requires specialized GPU acceleration and high-capacity RAM that is not available on standard agency hardware. Furthermore, this PC acts as a shared infrastructure asset; it is configured to process data for the Chisago County pilot and future LGU partners who lack the technical hardware to run these complex algorithms themselves. This exception is sought to provide a centralized, high-efficiency data hub that ensures the project's technical outputs are achievable and scalable for the State of Minnesota. **Additional Explanation :** Post-grant, this hub will continue to generate "Prescription Maps" for Minnesota land managers, ensuring the model's sustainability and statewide adoption.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $347,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 59ae0605-b44.pdf

Alternate Text for Visual Component

This infographic outlines a three-phase UAV monitoring workflow. Phase 1 shows aerial scouting using multispectral and LiDAR sensors. Phase 2 illustrates data fusion and machine learning for automated species identification. Phase 3 depicts a manager using validated GPS coordinates to perform targeted, large-scale field management more efficiently....

Financial Capacity

Title	File
Financial Capacity Note	4972fedc-3b5.pdf

Supplemental Attachments

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

Title	File
Support Letter from Chisago County Parks Director, Joseph Tart	dc4e36d9-570.pdf
Support Letter from Chisago County CLLID Administrator, Benjamin J. Elfelt	771b769f-fd1.pdf
Real Vision Drones, LLC Official Authorization Letter	950fa89f-f13.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 Commissioner's Plan 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?

No

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:

Tyler Nelson - Real Vision Drones LLC

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