



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-491

Proposal Title: Validating AI Trail Analytics for Minnesota Public Lands

Project Manager Information

Name: Zachary Pope

Organization: Verticl Ventures LLC

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Project Basic Information

Project Summary: AI-based trail monitoring using new vision-based technology will be validated at Minnesota public lands to improve understanding of recreational use, enabling agencies to make better stewardship decisions with better data.

ENRTF Funds Requested: \$235,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Small Projects (G)

Secondary Category: Education and Outdoor Recreation (C)

Project Location

What is the best scale for describing where your work will take place?

Region(s): Metro, NE, NW,

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 parks, trails, and natural areas are experiencing increasing recreational use, yet land managers often lack reliable, detailed data describing how these spaces are actually used. Traditional trail counters can provide basic counts but typically offer limited insight into visitor patterns, user types, congestion timing, or repeated movements that influence infrastructure planning and stewardship decisions.

For many years, researchers and land managers have discussed the potential for image-based monitoring to provide richer information about trail use. However, practical implementation has historically been limited by cost, computing requirements, and the difficulty of accurately interpreting imagery.

Recent advances in camera technology, cloud computing, and artificial intelligence now create a realistic opportunity to evaluate this long-discussed approach. Vision-based monitoring could provide a more complete understanding of recreational use patterns, helping managers better assess visitor pressure, plan maintenance and infrastructure, and reduce unintended impacts on natural resources.

Despite growing interest in this technology, it has not yet been rigorously validated for trail and public land management applications in Minnesota. Land managers need independent, field-tested evidence demonstrating whether vision-based monitoring can reliably measure trail use and how it compares to existing counting methods.

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 will validate and demonstrate a vision-based AI monitoring system designed to improve understanding of recreational use on Minnesota public lands. Waypoint Telemetry will deploy image-based monitoring systems at selected pilot trail locations and analyze imagery using artificial intelligence models that detect and classify recreational activity while applying filtering methods to reduce duplicate counts.

The project will work with land managers and external research advisors to design a validation protocol and compare results against traditional counting methods and field observations. This comparison will evaluate the accuracy, reliability, and operational feasibility of vision-based monitoring across different trail types, seasons, and usage conditions.

In addition to testing performance, the project will examine practical considerations for responsible implementation, including privacy-conscious data handling, equipment placement, and operational workflows for agencies managing public lands.

Findings will be synthesized into guidance for Minnesota land managers describing when vision-based monitoring is effective, how it compares to existing approaches, and how agencies could incorporate these tools into recreation management and planning.

By validating this emerging technology in real-world conditions, the project will provide evidence on whether vision-based trail analytics can help improve stewardship and decision-making for Minnesota's public lands.

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 will produce validated evidence on the effectiveness of vision-based AI monitoring for Minnesota trails and public lands. Outcomes include a tested monitoring methodology, accuracy comparisons with existing counting approaches, and guidance for land managers on deployment and privacy practices. Improved recreation analytics can help agencies better understand visitor patterns, manage congestion, prioritize maintenance, and plan infrastructure while reducing unintended impacts on natural resources. By providing reliable data on recreational use, the project supports better stewardship of Minnesota's parks, trails, and natural areas and helps balance recreational access with protection of natural resources.

Activities and Milestones

Activity 1: Develop AI Vision Algorithms for Trail Monitoring

Activity Budget: \$90,000

Activity Description:

This activity will develop and refine AI algorithms capable of detecting and classifying recreational activity captured by trail monitoring cameras. The objective is to create a robust analytics system that can accurately identify diverse trail users and conditions encountered on Minnesota public lands.

Tasks include assembling labeled training datasets from pilot imagery and developing computer vision models to detect recreation activity types such as hikers, bicyclists, cross-country skiers, snowmobiles, and vehicles. Filtering approaches will be implemented to reduce duplicate counts caused by repeat movements or group travel. Directionality estimation will also be incorporated to distinguish inbound and outbound travel and address edge cases such as dogs accompanying users, groups, and partially obscured subjects.

Algorithms will be designed to operate under varied environmental conditions including daylight, nighttime infrared imagery, precipitation, snow cover, and partial visibility. System architecture will also account for field deployment constraints such as solar power availability, canopy cover, and intermittent cellular connectivity.

Outputs include trained detection models, documented processing workflows, and measured algorithm performance. These outputs form the technical foundation for field validation and recreation monitoring applications.

Activity Milestones:

Description	Approximate Completion Date
Training dataset assembled and labeled	March 31, 2028
Initial detection and classification models developed	July 31, 2028
Algorithm refinement addressing duplicate filtering and directionality	November 30, 2028

Activity 2: Field Validation Across Trail Types and Environmental Conditions

Activity Budget: \$110,000

Activity Description:

This activity will evaluate the performance of the AI monitoring system through field deployments at selected Minnesota trail locations. The objective is to test system accuracy and operational reliability across diverse recreation environments and conditions.

Monitoring systems will be deployed at pilot sites representing multiple trail uses and landscapes. Data collection will occur across seasons to capture varied conditions including daylight and nighttime imagery, precipitation, snow cover, fog, and seasonal canopy changes.

The system will be tested against different activity types such as hiking, biking, cross-country skiing, snowmobiling, and vehicles. Validation will also examine challenging scenarios including fast-moving users, group travel, repeated trail passes, and dogs accompanying users.

Validation protocols will compare AI-generated counts with existing monitoring methods, field observations, or manual image review where appropriate. Additional evaluation will assess operational considerations such as solar power

reliability, camera placement, and performance in areas with limited cellular connectivity.

Outputs include validated datasets, accuracy metrics, and operational insights describing strengths and limitations of vision-based monitoring for recreation management.

Activity Milestones:

Description	Approximate Completion Date
Pilot monitoring systems deployed at trail sites	May 31, 2028
Multi-season monitoring data collected and processed	February 28, 2029
Accuracy validation and method comparison completed	April 30, 2029

Activity 3: Develop Implementation Guidance for Minnesota Land Managers

Activity Budget: \$35,000

Activity Description:

This activity will translate project findings into practical guidance for Minnesota land managers interested in improving recreation monitoring and stewardship of public lands. The objective is to provide recommendations on when and how vision-based monitoring systems can support trail and recreation management.

Results from field validation will be analyzed to identify strengths, limitations, and appropriate use cases for image-based monitoring. Guidance will address considerations such as site selection, camera placement, privacy-conscious deployment practices, data processing workflows, and operational requirements including power and communications.

The project will also evaluate how vision-based analytics can complement existing trail counting approaches by providing additional insights into visitor patterns, activity types, and congestion periods. Recommendations will highlight situations where vision-based monitoring provides meaningful advantages and where traditional methods remain appropriate.

Outputs will include a final report, implementation guidance for Minnesota agencies, and summary materials describing key findings and lessons learned to support informed recreation management decisions.

Activity Milestones:

Description	Approximate Completion Date
Draft implementation guidance prepared	May 31, 2029
Final report and monitoring guidance completed	June 30, 2029
Project results presented to Minnesota recreation managers	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Tyler Thompson	Three Rivers Parks District	Pilot site collaborator / field deployment partner	No
Dr. Greg Lindsay	University of Minnesota	Recreation monitoring research advisor	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.

Results from this project will be shared with Minnesota land managers, recreation planners, and natural resource professionals through several channels. A final project report and technical summary describing the validation methods, results, and lessons learned will be made publicly available and distributed to agencies responsible for managing trails and public lands in Minnesota.

Findings will be presented to relevant professional groups such as park districts, state agencies, and recreation management organizations to support awareness of emerging monitoring approaches. Presentations will focus on practical guidance for evaluating vision-based monitoring technologies and understanding their strengths and limitations relative to traditional trail counting methods.

Project documentation, including validation results and recommended monitoring practices, will be made accessible online to support long-term use by agencies and researchers. These materials will help inform future recreation monitoring efforts and improve data-driven management of Minnesota's public lands and trail systems.

All publications and communications will acknowledge support from the Environment and Natural Resources Trust Fund as required by ENRTF guidelines.

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 be shared with Minnesota land managers through a final report, implementation guidance, and presentations to parks and recreation agencies. The project will identify when vision-based monitoring is effective, how it compares to existing methods, and practical considerations for deployment and privacy. Agencies interested in using these tools can implement monitoring through their own operational budgets, grants, or partnerships. Waypoint Telemetry will continue improving the technology using private investment and commercial revenue. This approach ensures the ENRTF-funded project produces publicly useful knowledge while enabling long-term adoption and continued development without additional ENRTF funding.

Project Manager and Organization Qualifications

Project Manager Name: Zachary Pope

Job Title: Founder

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

Zach Pope, Founder and Project Manager of Waypoint Telemetry, has a strong background in engineering, technology

commercialization, and entrepreneurship. He holds a B.S. in Electrical Engineering and an M.S. in Management of Technology, both from the University of Minnesota. Earlier in his career, he served as Director of Engineering for a medical device company, where he led engineering and commercialization efforts for new technology products in the hearing-aid industry. That experience included managing technical development, coordinating cross-functional teams, and advancing innovative products toward real-world deployment.

Zach later founded TroutRoutes, a mapping and analytics software company serving anglers and outdoor recreation users. As founder and CEO, he led product strategy, software development, operations, partnerships, and growth, ultimately building the company into a successful business that was acquired by onX. This experience is directly relevant to the proposed project because it demonstrates his ability to build and execute applied outdoor technology products, manage technical teams and contractors, and deliver solutions used by large numbers of end users.

At Waypoint Telemetry, Zach now leads development of AI-based trail and public-land analytics tools to help land managers better understand recreational use and stewardship needs. He is actively managing pilot deployments and validation work in Minnesota, including work with Three Rivers Park District. The project is further strengthened by outside expert input, including guidance from trail-monitoring researcher Dr. Jeff Marion of Virginia Tech on validation approach and field-study design.

Together, Zach's engineering training, prior leadership in technology commercialization, successful startup track record, and current progress with Waypoint position him well to manage the proposed project, coordinate collaborators, oversee technical execution, and deliver useful results for Minnesota land managers.

Organization: Verticl Ventures LLC

Organization Description:

Verticl Ventures LLC (dba Waypoint Telemetry) is a Minnesota-based technology company developing sensing systems and analytical tools to improve outdoor recreation monitoring and environmental stewardship. The organization focuses on applying artificial intelligence and sensor technologies to help land managers better understand recreational usage patterns, infrastructure needs, and environmental impacts on public lands. Waypoint Telemetry develops and evaluates emerging monitoring approaches that can support data-driven decision making for parks, trails, and natural resource management agencies.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Principal Investigator / Project Manager		Provide overall project management and technical oversight. Responsibilities include coordinating pilot deployments, supervising algorithm development, managing partnerships and validation protocols, overseeing data analysis, and leading preparation of project reports and implementation guidance for land managers.			0%	0.5		\$70,000
AI / Computer Vision Engineer		Develop and refine AI algorithms for detecting and classifying recreation activity from trail imagery. Responsibilities include training datasets, model development, duplicate filtering methods, directionality detection, and evaluation of algorithm performance across environmental conditions.			0%	0.4		\$60,000
Field Technician / Data Analyst		Support field deployments, maintain monitoring systems, collect validation data, prepare image datasets, and assist with performance analysis. Responsibilities include site visits, equipment installation, manual data validation, and assisting with preparation of project deliverables.			0%	0.4		\$35,000
							Sub Total	\$165,000
Contracts and Services								
University of Minnesota – Dr. Greg Lindsay (Trail Monitoring Research Advisor)	Service Contract	Provide technical advisory support on trail monitoring research and validation methodology. Work includes guidance on study design, development of validation comparisons between AI-based monitoring and traditional counting methods, and review of project results to ensure alignment with established recreation monitoring practices.				0.04		\$15,000
Image Validation and Dataset Labeling Services	Service Contract	Provide manual image review and dataset labeling services to support AI model training and validation. Tasks include identifying recreation activity types in imagery, validating automated detections, and				0.2		\$15,000

		creating labeled datasets used to measure algorithm accuracy.						
Cloud Computing and Image Processing Services	Service Contract	Provide cloud-based computing services used to process trail imagery and run AI detection models during algorithm development and validation. These services support scalable processing of datasets generated during pilot monitoring deployments.				0		\$10,000
							Sub Total	\$40,000
Equipment, Tools, and Supplies								
	Equipment	AI trail monitoring systems (20 units) including camera, solar power, and cellular connectivity components.	Deploy monitoring systems at pilot trail locations to capture imagery used for AI-based detection and classification of recreational activity during field validation across multiple environments and seasons.					\$10,000
	Tools and Supplies	Field deployment supplies including mounting hardware, weatherproof enclosures, cables, and installation materials.	Support installation, positioning, and maintenance of monitoring systems at pilot trail locations during field validation.					\$5,000
							Sub Total	\$15,000
Capital Equipment								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Field site visits for monitoring deployment and validation (approximately 30 trips, ~150 miles average round trip, mileage reimbursement at state rate).	Travel to Minnesota pilot trail locations to install monitoring systems, perform maintenance, conduct validation observations, and collect field data during the project.					\$6,000
	Conference Registration	Travel for presentation of project findings to Minnesota parks and recreation professionals (2 trips	Present project findings and implementation guidance to Minnesota					\$2,000

	Miles/ Meals/ Lodging	including mileage, lodging, and per diem for project staff).	land managers and recreation professionals to support adoption of improved monitoring practices.					
							Sub Total	\$8,000
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
	Printing	Production of final project report, implementation guidance document, and printed presentation materials (approximately 100 copies total).	Support preparation and distribution of project findings and implementation guidance for Minnesota land managers, agencies, and practitioners.					\$2,000
							Sub Total	\$2,000
Other Expenses								
		Data Storage and Processing	Cloud storage and data management for image datasets generated during monitoring deployments and validation analysis.					\$5,000
							Sub Total	\$5,000
							Grand Total	\$235,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	-
Non-State				
In-Kind	Verticl Ventures LLC (dba Waypoint Telemetry)	Private funds invested by Verticl Ventures support development of the underlying vision-based monitoring technology, including prior engineering work, AI model development, additional cloud infrastructure, and advisory support. These resources complement the ENRTF-funded work by enabling continued system development and expanded pilot testing beyond the scope of the proposed validation activities.	Secured	\$100,000
			Non State Sub Total	\$100,000
			Funds Total	\$100,000

Total Project Cost: \$335,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [d340ddd4-f70.pdf](#)

Alternate Text for Visual Component

The illustration shows the AI-based trail monitoring system evaluated in this project. Solar-powered cameras capture recreation activity on Minnesota trails. Artificial intelligence analyzes images to detect and classify users and produce trail-use analytics. The project validates this approach across environments, seasons, recreation types, and monitoring technologies....

Financial Capacity

Title	File
Financial Capacity Note	83b465ca-46f.pdf

Supplemental Attachments

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

Title	File
SOS Good Standing	ceedd9bb-761.pdf
No Liens Statement	aefa668f-cd1.pdf
Vertic_Ventures_Board_Authorization.pdf	c1c6cf5d-9f2.pdf
Three Rivers Park District Pilot Study Summary	6daab473-aec.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?

Yes

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

Yes

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

No

Does your project include original, hypothesis-driven research?

Yes

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:

Zachary Pope, Verticl Ventures LLC, Project Manager / Proposal Author

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

Yes, I understand