Environment and Natural Resources Trust Fund
2026 Request for Proposal

General Information

Proposal ID: 2026-553

Proposal Title: Enhancing Visits and Environmental Management; Effective, Adaptive AI

Project Manager Information

Name: Nikolaos Papanikolopoulos

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: This project will leverage state-of-the-art Artificial Intelligence methods to improve visitor experiences and protect the environment. Real-time data will inform park management actions that enhance visitor experience and environmental conditions.

ENRTF Funds Requested: $456,000

Proposed Project Completion: November 30, 2028

LCCMR Funding Category: Education and Outdoor Recreation (C)

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.

Management of our outdoor economy and resources is challenged by a lack of comprehensive, timely, and accurate data. Optimal park and protected area management are already thwarted by insufficient staffing levels, ongoing fiscal resource challenges, and unpredictable events. Timely and geographically specific data is paramount to protect recreation resources, promote their use, and sustain satisfying experiences in light of ongoing management challenges. To address these challenges, this proposal leverages social media and park data to provide real-time insights into key indicators—crowding, trail conditions, and usage patterns—without costly in-situ infrastructure. Geographically specific user feedback and visit details can be extracted efficiently from the social media data by integrating state-of-the-art AI algorithms (Multi-Modal Large Language Models (MMLLMs)). Deploying AI algorithms with publicly available data informs and enhances decision-making. Although research highlights social media's proven correlation with visitation trends, its real-time potential remains under-explored, making this a timely opportunity for innovation in park and outdoor management. This work will be conducted under the supervision of an Advisory Board including members from the Minnesota Recreation and Park Association, the Greater Minnesota Regional Parks and Trails Commission, the Minneapolis Parks and Recreation Association, and the MN Trail Users Association.

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.

To augment park management efforts, and optimize visitor experiences and recreation-based economies, we will develop, test, and validate autonomous online AI methods that harness real-time social media data and visitor-centered insights across a sample of Minnesota state parks. These methods will leverage social media to track key metrics— crowding, trail and facility conditions, and usage patterns—offering a high-frequency, scalable alternative to infrequent, onsite surveys. State-of-the-art multi-model large language models (MMLLMs) and data harvesting methods will extract geographically-specific feedback from posted text and photos, identifying visitor sentiments and facility conditions. The result will be a flexible, adaptable online AI tool that can reveal and express quantitative trends (through generated visual and textual outputs) by leveraging the reasoning capabilities of MMLLMs. Integrated with publicly available visitation data, our system will augment and automate monitoring. Onsite validation will assess visitation and facility conditions. Managers and facility personnel will be able to make immediate data-informed resource allocation decisions leading to enhanced visitor experiences. We will validate the approach with on-the-ground visitations and activity counting and surveys for a subset of the 64 Minnesota state parks which reflect categorical themes, diverse geographical features, and visitor attributes.

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?

Real-time data insights will enable management to simultaneously optimize resource protection, restoration and visitor experiences. By providing managers with accurate, up-to-date usage patterns and park-specific characteristics, the project supports proactive management actions and prioritizes experiences. This efficiently and effectively strengthens resource conservation across diverse areas, safeguarding natural assets for public enjoyment while minimizing environmental and facility impact. The project data can be combined with historical visitation data, weather patterns, and ecological indicators. These systems can potentially recommend optimal visitation times and routes that minimize disruption to wildlife and help in vegetation recovery.

Activities and Milestones

Activity 1: Site Selection and Data Contextualization

Activity Budget: $173,000

Activity Description:

The first objective is to identify representative park sites and build a contextual data corpus (written textual representation structured for Natural Language Processing) for analysis. This activity provides a foundation for monitoring, improving resource allocation, and preservation tailored to park types. Managers will use this to pinpoint needs. This step will rely on communication with DNR Parks and Trails staff to select candidate parks across Minnesota's districts of different types, and to obtain the DNR's publicly available data on facility management, attributes, visitation (including available counts), and visitor sentiment, via required formal request procedures. Using data structuring tools, the UMN team will then compile the data into a new contextual database. It should be noted that a portion of these selected parks will be used for in-situ observation to evaluate the proposed method's capability to predict visitor flow and behavior patterns (See Activity 3). The outcome of this task will be a curated dataset of park-specific metrics and visitor feedback, enabling precise analysis.

The evaluation will focus on assessing dataset completeness via data coverage metrics (e.g., % of parks/districts included) and validate representativeness through panel review. Outcomes will inform subsequent agent development, ensuring applicability across Minnesota's park system.

Activity Milestones:

Description	Approximate Completion Date
Selection of representative state park sites for building attribute corpus	August 31, 2026
Build full attribute knowledge data from compiled data	December 31, 2026
Evaluation of data completeness and level of representation	January 31, 2027

Activity 2: Development of autonomous data harvesting and sentiment extraction tools

Activity Budget: $131,000

Activity Description:

The objective is to build an AI online tool to monitor real-time social media and DNR data. We will design algorithms using state-of-the-art multi-modal LLMs to scrape social media for crowding, trail conditions, and usage patterns. Popular social media platforms and social network forums will be identified and targeted for designing the agent and data harvesting architecture. The data harvesting tools and LLM frameworks will then be deployed to parse geographic-specific posts and photos. Signs will be designed and deployed at the test park locations to inform visitors of the study and how to participate through social media sharing. The advisory panel will provide feedback on the content and design, and guide the approval process and viable locations to place the signs at the study locations. Data will get formal approval from the University of MN Internal Review Board Human Subjects Review (IRB) and follow the highest ethical standards of data privacy. The testing of the online tool is an iterative process using collected data from the test sites and the relevant social media content, to tune and validate the predictive capability of the approach. The evaluation will assess the ability to filter social media posts and their completeness.

Activity Milestones:

Description	Approximate Completion Date
Implement harvesting strategy to enhance relevant real-time social media content	March 31, 2027
Create Sentiment extraction and aggregation architecture for texts and photos	April 30, 2027
Initiate data collection for testing and model fine-tuning	May 31, 2027

Activity 3: Data validation

Activity Budget: $152,000

Activity Description:
The objective is to understand and provide necessary corrections to the social media data collected on visitation, activities, and conditions. The effort will include temporary deployments of compact wireless visitor counting sensors to capture the visitation across varied conditions over extended periods. The accuracy of these sensors will be verified by comparing manual in-situ observation sessions. The UMN team will maintain the sensors. Data comparisons will enable model enhancement and contribute to the validity and utility of social media data for integration into planning and communications. A refined prototype tool will be evaluated during the 2028 spring and summer periods. A workshop will be conducted to demonstrate the tools to the project advisory panel and other interested regional park management groups. The evaluation will conduct (when applicable) a statistical comparison between in-situ fixed location sensor-based counts with in-situ observations, trend analysis between the visitation counting, and harvested social-media data, at different time scales (i.e., per-day, etc.). The AI modeling approach will be evaluated for sentiment level and reasoning correctness, as well as for its ability to identify park-specific sentiment-based trends and any correlations with in-situ data. The Advisory Board will be a key guiding force for this evaluation.

Activity Milestones:

Description	Approximate Completion Date
Field data for comparison with social media data observation	November 30, 2027
Evaluation of refined models for decision making	September 30, 2028
Workshop presentations and reports	October 31, 2028

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Nikolaos Papanikolopoulos	University of Minnesota	PI	Yes
Saad Bedros	University of Minnesota	Co-PI	Yes
Theodore Morris	University of Minnesota	Co-PI	Yes
Vassilios Morellas	University of Minnesota	Co-PI	Yes
Ingrid Schneider	Department of Forest Resources, College of Food Agriculture, Natural Resource Sciences (CFANS), University of MinnesotaUniversity of Minnesota	Co-PI	Yes
Christopher J. DesRoches	Minneapolis Parks and Recreation Board	Advisory panel member	No
Michelle Snider	Minnesota Park and Recreation Association	Advisory panel member	No
Renee Mattson	Greater Minnesota Regional Parks and Trails Commission	Advisory panel member	No
David Sperstad	Mn Trail Users Association	Advisory panel member	No

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

Project results will be implemented by sharing the opportunity to integrate autonomous online tools into park management systems, providing park managers with real-time dashboards for decision-making. The system, built using scalable, open-source frameworks, will be maintained by the University of Minnesota throughout the funded study period. Part of the scope of this study includes workshops to introduce the framework to organizational IT, data science, and management staff, who will also be serving as advisors for the project. The workshops will also be advertised to other stakeholder groups and local park management organizations.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Water Quality and Robots: Experientially Educating Minnesotan Youth	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 05s	$353,000

Project Manager and Organization Qualifications

Project Manager Name: Nikolaos Papanikolopoulos

Job Title: Minnesota Robotics Institute Director, McKnight Presidential Endowed Prof. of CS

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

Nikolaos P. Papanikolopoulos, an IEEE Fellow, received a Diploma degree in electrical and computer engineering from the National Technical University of Athens, in Greece, in 1987, an M.S.E.E. in electrical engineering from Carnegie Mellon University, in 1988, and a Ph.D. in electrical and computer engineering from Carnegie Mellon University, in 1992. Currently, Papanikolopoulos is the McKnight Presidential Endowed Professor in Computer Science, a Distinguished McKnight University Professor in the Department of Computer Science at the University of Minnesota, and Director of the Minnesota Robotics Institute (MnRI). His research interests include robotics, computer vision, sensors for transportation applications, and control. He has authored or co-authored more than 350 journal and conference papers in the above areas, including more than 80 refereed journal papers. His work has been funded by NSF, NIH, DHS, DARPA, MnDOT, Wisc DOT, Kansas DOT, FHWA, Honeywell, Minnesota Corn Growers, 3M, Johnson Controls, and Sentera. He has advised more than 30 Ph.D. students and holds eight patents. He has been General and Program Chair for the two largest international robotics conferences (IEEE International Conference on Robotics and Automation and IEEE/RSJ International Conference on Intelligent Robots and Systems). He has received the IEEE Robotics and Automation Distinguished Service and George Saridis awards. He founded along with his students ReconRobotics Inc. which has deployed more than 6,000 robots worldwide. His service to the University of Minnesota ranges from working with a donor to secure a $10M donation for the robotics effort to chairing the MnDRIVE Robotics, Sensors, and Advanced Manufacturing planning committee for organizing MnRI and the MS in Robotics program. He has also organized and supported robotics summer camps for middle schoolers from various groups for the last 16 years. More than 1,000 students have participated in these events.

Organization: U of MN - College of Science and Engineering

Organization Description:

The project will be managed by the Minnesota Robotics Institute (a unit of the College of CSE, UMN). The Minnesota Robotics Institute (MnRI) is an outcome of the University of Minnesota's Discovery, Research, and InnoVation Economy initiative that brings together interdisciplinary researchers to solve grand challenges and increase Minnesota's position as a worldwide leader in robotics research and education. MnRI is housed in the world-class Gemini-Huntley Research Laboratory, made possible by a generous gift from Jim & Sharon Weinel and Fred & Siri Oss. The laboratory has a 20,000-square-foot, state-of-the-art robotics research space and includes nine flexible robotics labs and various workspaces for faculty and graduate students—including a two-story drone lab and labs that provide research space for research on underwater robots. MnRI is offering several outreach programs that range from robotics summer camps to support of high school robotics teams throughout the state. MnRI has also started an MS program in Robotics. The project will be done in collaboration with CFANS. An Advisory Panel consisting among others of Michelle J. Snider (Executive Director, Minnesota Recreation and Park Association), Renee Mattson (Executive Director, Greater Minnesota Regional Parks and Trails Commission), and a DNR representative will help us execute the plan.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Nikolaos Papanikolopoulos - PI		Management of the Project and related activities			27%	0.04		$20,948
Saad Bedros-Co-I		Assist sensor, database & software development, workshop activities			27%	0.32		$35,819
Theodore Morris - Coordinator		Project coordinator, Assist sensor, database & software development and deployment, workshop activities			27%	0.32		$67,270
Vassilios Morellas -Co I		Coordinate AI software development activities			27%	0.16		$49,344
Ingrid Schneider- Co-PI		Co-PI, Coordinate in-situ visitor behavior data collection, model validation activities			27%	0.18		$46,500
Graduate Research Assistant		Assist AI model and agent development, data preparation, and validation experiments			46%	0.9		$186,254
Undergraduate Research Assistant		Assist in-situ data collection and site management.			0%	0.9		$27,126
							Sub Total	**$433,261**
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Tools and Supplies	Sensors, Information signs, consumables supplies for the projects	Protection, notice, and maintenance of the project signage.					$3,746
							Sub Total	**$3,746**
Capital Expenditures								
							Sub Total	-

Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Other	Conferences and site data collections	Conferences for research collaborations, data site for collection of the data					$18,993
							Sub Total	**$18,993**
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
							Sub Total	-
							Grand Total	**$456,000**

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: $456,000

This amount accurately reflects total project cost?

     Yes

Attachments

Required Attachments

Visual Component

File: a73b05f6-ecd.pdf

Alternate Text for Visual Component

The visual summarizes the project objectives and the main problem considered and their relationship to the efforts and theme of the proposal to accomplish the development and evaluation of the AI park management visitor experience and environment monitoring tools....

Supplemental Attachments

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

Title	File
SPA Letter	ded2e881-d24.pdf
Budget & Justification	5651bc5e-c89.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?

Yes

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:

Nikos Papanikolopoulos, Professor, CSE, UMN

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