



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-266

Proposal Title: Tick-Borne Disease Risk in Earthworm-Invaded Minnesota Forests

Project Manager Information

Name: Benjamin Cull

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

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Project Basic Information

Project Summary: This project aims to determine if the activity of blacklegged ticks and risk of tick-borne disease will increase with the advent of jumping worm invasion of Minnesota woodland ecosystems.

ENRTF Funds Requested: \$350,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Resiliency (A)

Project Location

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

Region(s): Metro

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.

Earthworms are invasive species in Minnesota, and their activity causes dramatic changes to soil structure, with knock-on effects for woodland vegetation and wildlife. While European earthworms (nightcrawlers) are now established throughout Minnesota, jumping worms are a more recent invader and their effects on the state's ecosystems are less understood. Nightcrawlers greatly reduce leaf litter causing changes to understory vegetation. Meanwhile, jumping worm-infested forests have substantially more leaf litter, due to these worms' shorter activity period.

Leaf litter is an important component of a healthy woodland ecosystem, and provides a humid microenvironment which is essential to the life cycle of the blacklegged tick (deer tick), responsible for most tick-borne diseases in Minnesota. Immature ticks are sensitive to desiccation and use the leaf litter as a safe habitat from which to ascend vegetation to seek host animals to feed on. Leaf litter also provides an insulating layer that allows ticks to overwinter. Removal of leaf litter has been shown to be an effective method of tick control, and nightcrawler-mediated leaf litter reduction is known to reduce tick numbers.

As jumping worms spread and displace or co-exist with nightcrawlers, alterations in woodland ecosystems may have consequences on tick survival and tick-borne disease risk.

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.

Whilst modification of the leaf litter and vegetation by nightcrawlers is linked to reduced tick numbers, further changes to forests caused by the arrival of jumping worms may improve tick survival, with implications for tick-borne disease risk for people recreating and working in Minnesota's woodlands. This project aims to quantify tick numbers and tick infection prevalence in earthworm-invaded habitats and relate these to changes in humidity, leaf litter density and composition of understory vegetation caused by earthworms. We will compare the habitat characteristics and tick abundance/infection rates at several field sites where nightcrawlers are established with sites where jumping worms have also invaded. Changes to woodland vegetation may also alter the composition of important animal hosts for ticks, so wildlife in each habitat will be monitored. Additionally, we will recreate the soil and leaf litter composition of uninvaded, nightcrawler-invaded, and jumping worm/nightcrawler-invaded woodlands in laboratory enclosures and measure the survival and behavior of blacklegged ticks in each environment as well as recording humidity, a key factor in tick survival. These experiments will identify characteristics of earthworm-invaded habitats that affect tick survival and infection prevalence, providing an estimation of how ongoing jumping worm invasion may change tick-borne disease risk.

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 identify effects of earthworm-mediated woodland ecosystem modification that may have knock-on effects on tick survival, and quantify how these may alter tick-borne disease risk in earthworm-invaded habitats. It will also show how tick-borne disease risk may be further changed by the ongoing spread of invasive jumping worms. An improved understanding of changing tick-borne disease risk as an additional unexplored consequence of the expanding jumping worm invasion of Minnesota forests will enable land managers to prepare for and communicate this risk to workers and recreational land users, improving safety and enhancing enjoyment of the outdoors.

Activities and Milestones

Activity 1: Assess habitat characteristics, tick abundance and tick infection prevalence at earthworm-invaded field sites

Activity Budget: \$181,978

Activity Description:

Objective: Identify whether jumping worm-associated changes in habitat have effects on tick abundance and infection prevalence in Minnesota.

Task 1: Compare tick abundance at nightcrawler-dominated versus jumping worm-dominated sites. We will include 3 nightcrawler-invaded sites and 3 sites dominated by jumping worms. Ticks will be collected using a standard flagging technique from five 10m transects at each field site, and abundance quantified. Surveys at each site will be conducted fortnightly from April to October.

Task 2: Identify earthworm invasion-associated changes to habitat, relevant to tick survival. Along each transect, worms will be identified and quantified. Additionally, we will record thickness and coverage of the leaf litter layer, survey understory vegetation, and measure ground level humidity and temperature using an environmental data logger. Comparisons will be made between nightcrawler-dominated and jumping worm-dominated sites.

Task 3: Compare tick infection with *Borrelia* spp, *Anaplasma phagocytophilum* and *Babesia microti* (the most prevalent tick-borne pathogens) at nightcrawler-dominated field sites versus at jumping worm invaded sites. Ticks will be processed in the lab and infection rate measured using pathogen-specific qPCR assays. At least 100 ticks from each site will be tested.

Activity Milestones:

Description	Approximate Completion Date
Identify transects at field sites	September 30, 2027
Complete soil sample carbon/nitrogen analysis	September 30, 2028
Fortnightly surveys of ticks, worms, and habitat characteristics (April to October)	October 31, 2028
Tick identification and DNA extraction	December 31, 2028
Testing for tick-borne pathogens	March 31, 2029

Activity 2: Determine how earthworm-mediated changes to woodlands affect presence of tick host animals

Activity Budget: \$84,410

Activity Description:

Objective: Identify the main animal hosts present in earthworm-invaded field sites, which may affect composition of reservoir hosts for tick-borne pathogens.

Task 1: Identify animal hosts present at each field site and compare dominant animal species between nightcrawler-dominated and jumping worm invaded field sites. Motion-activated trail cameras will be installed on one transect per field site to record presence of animal hosts. At each visit image data will be downloaded and the captured animals identified using Wildlife Insights, an open access website for identification and sharing of camera trap data. Population density of each identified species will be estimated using no. animals captured per hour. The most abundant animals will be compared between field sites to determine whether key hosts relevant to tick feeding and tick-borne disease transmission differ.

Activity Milestones:

Description	Approximate Completion Date
Installation of trail cameras at field sites	April 30, 2028
Fortnightly download and examination of camera images	October 31, 2028
Camera image identification and dominant host comparison between sites	December 31, 2028

Activity 3: Assess how earthworm-modified soil structure affects tick survival and questing behavior

Activity Budget: \$83,612

Activity Description:

Objective: Determine how soil ecosystem conditions caused by earthworm activity alter humidity conditions and affect tick survival and questing activity.

Task 1: Construct terrariums in the laboratory to compare tick activity in environments mimicking nightcrawler-invaded, jumping worm-invaded, and un-invaded soil habitats. Using soil and leaf litter collected from field sites, three 5 gallon terrariums will be prepared with locally sampled soil and leaf litter, recreating soil conditions under these three different invasion scenarios. Dowel rods will be inserted vertically into soil to act as substrate on which ticks can quest (the behavior by which ticks climb vegetation to search for hosts). Each terrarium will contain environmental sensors to record humidity and temperature in both air and soil. 50 blacklegged tick nymphs (from our lab colony) will be added to each terrarium and their survival recorded after one month. Frequency and height of tick questing will be monitored at set intervals throughout the observation period. The month-long experiment will be repeated on three separate occasions.

Activity Milestones:

Description	Approximate Completion Date
Collection of soil samples from Minnesota field sites	August 31, 2027
Construction of terrarium soil ecosystems	August 31, 2027
Run monthly terrarium experiments (September to November)	December 31, 2027
Data analysis	February 28, 2028
Publish results in scientific journal	June 30, 2028

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Kyungsoo Yoo	University of Minnesota CFANS	co-investigator; will provide expertise on soil ecosystems and earthworm-related aspects of the project.	Yes
Meg Duhr	Three Rivers Park District	Provide access to field sites; facilitate dissemination of project results through local outreach events.	No
Landscape Arboretum	University of Minnesota CFANS	Provide access to field sites; facilitate dissemination of project results through invasive earthworm outreach events.	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.

Ongoing results from the project will be shared with the Three Rivers park district and UMN Landscape Arboretum and their staff/volunteers through existing events focused on raising awareness of invasive jumping worms (at which Kyungsoo Yoo is already a regular speaker). Results will also be shared through regular updates through the LCCMR newsletter, UMN outreach webpages, and other channels for communication with organizations involved in work related to ticks or earthworm invasion. Any guidelines resulting from project results will be publicly accessible to benefit worm- and tick-related control and management. Final results from the project will be published in an open-access scientific journal article with raw data from the project made freely available online through the Digital Repository of the University of Minnesota (DRUM; <https://hdl.handle.net/11299/166578>). Any genetic data resulting from tick pathogen testing will be uploaded to the NIH-managed National Center for Biotechnology Information, where it will be publicly accessible. Camera trap footage of wildlife will be shared on Wildlife Insights, an open online repository for sharing camera trap data, enabling land managers, researchers and wildlife biologists to access video of the wildlife captured during the project. All results will be shared with acknowledgement of support from the ENRTF.

We also plan to disseminate results from the project at 2 local/regional conferences encompassing audiences from both the invasive species and medical entomology communities; the Upper Midwest Invasive Species conference and the Entomological Society of America North Central Branch meeting. Both meetings are usually held in Minnesota or neighboring states.

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 communicated with land owners to improve awareness of the effects of earthworm invasion on tick-borne disease risk, so that this can be taken into account in safety materials for staff and visitors. Results will be shared through existing networks focussed on jumping worm awareness and management. Findings will be interpreted into guidelines for tick-borne disease risk management in different earthworm invasion scenarios. Additionally, it is expected that at least one scientific publication will result from this project. Further external funding will be sought to carry out additional in-depth investigations, if warranted by the findings of this work.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
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Updating and Sharing Information on Minnesota's Tick Biodiversity	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 03k	\$186,000
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Project Manager and Organization Qualifications

Project Manager Name: Benjamin Cull

Job Title: Research Assistant Professor

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

Benjamin Cull is a Research Assistant Professor whose research interests cover a broad range of complementary aspects of vector-borne disease, including vector biology, vector ecology, vector surveillance, enzootic cycles of vector-borne disease, and host-pathogen-vector interactions, with main expertise in ticks and tick-borne bacteria. His lab has a strong background in molecular and cell biology, as well as vector biology and ecology, and their research aims to combine these to relate findings at a molecular level to broader trends in vector-borne disease eco-epidemiology. Dr. Cull has worked in the UMN Department of Entomology since 2019, first as a postdoctoral researcher and since 2024 as a Research Assistant Professor. Prior to moving to the University of Minnesota, he worked in the Medical Entomology and Zoonoses Ecology team at Public Health England (now the UK Health Security Agency) where he was involved in running national surveillance projects for ticks and mosquitoes, as well as research projects on the ecology of ticks and Lyme disease.

He currently leads an ENRTF-funded project aiming to improve knowledge of tick biodiversity in Minnesota through a collaborative community science-driven tick collection effort, as well as a National Institutes of Health-funded project investigating blacklegged tick symbionts. He is also involved in NIH-funded projects investigating tick-borne pathogen-host interactions and developing novel tick-borne pathogen surveillance methods.

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

Organization Description:

The UMN's College of Food, Agricultural and Natural Resources Sciences (CFANS) is comprised of 12 academic departments and 10 research and outreach centers, along with the Minnesota Landscape Arboretum, the Bell Museum, and dozens of interdisciplinary centers. As part of a major urban university located in the heart of the Twin Cities, we also provide immersive study opportunities across the state. Our living laboratories allow students, faculty, and staff to study throughout Minnesota's diverse ecosystems.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Faculty (tick specialist)		PI. Overseeing project, mentoring and training of staff, identification of tick samples, contribute expertise on tick ecology. Data analysis and report writing.			36.6%	0.4		\$51,507
Faculty (soil specialist)		Co-investigator. Overseeing project, mentoring and training of staff, contribute expertise on soil ecosystems and earthworms. Data analysis and report writing.			36.6%	0.1		\$19,547
Research scientist		Conduct laboratory assays to screen tick samples for tick-borne pathogens.			32.3%	0.4		\$30,130
Postdoctoral researcher		Undertake tick/animal field surveys and laboratory experiments. Collect and analyze project data; write reports and communicate results.			26.1%	2		\$165,680
Graduate research assistant		Assist postdoc in field surveys, taking environmental and earthworm measurements. Collect and analyze project data; aid in writing reports.			24.2%	0.5		\$59,573
							Sub Total	\$326,437
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Tools and Supplies	Tick collection equipment (drags, forceps, tubes, tube storage boxes, DNA/RNA Shield)	Tools & supplies for field collection and storage of ticks					\$500
	Tools and Supplies	Environmental monitoring (environmental data loggers (30 iButtons & accessories, 10 trail cameras, 1 soil probe), and worm collecting tools (trowels, ethanol, sampling bags, forceps). Soil sample carbon/nitrogen testing.	Tools & supplies for collecting worms and monitoring environmental parameters at field sites and in terrarium experiments					\$8,000
	Tools and Supplies	Terrariums, dowel rods, and humidity sensors	Tools and supplies required for terrarium based experiments					\$500
	Tools and Supplies	DNA extraction kits x 3, primers, qPCR reagents, pipette tips, plates, and other lab consumables	Lab supplies and kits for tick pathogen testing					\$4,160

							Sub Total	\$13,160
Capital Equipment								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Fortnightly travel to field sites during April to October 2028. Includes vehicle rental (4 days / month), 264 miles/month and per diem expenses for two people per trip.	Fortnightly travel to field sites within the Three Rivers Park District and UMN Landscape Arboretum during April to October 2028, including local travel to communicate results with park staff and gardener groups focused on issues related to invasive jumping worms.					\$3,003
	Miles/ Meals/ Lodging	Car rental, 600 miles roundtrip, and per diem and overnight accommodation costs (2 nights/2 people).	Budget for collecting soil samples for terrarium (worm-free site) in 2027. Since there are no nearby worm-free sites, a long distance trip is required to an uninvaded site in Boundary waters to collect soil.					\$1,000
	Conference Registration Miles/ Meals/ Lodging	Travel to two regional conferences for one person per conference, including travel (expected to be within Minnesota or a neighboring state), lodging, conference registration, and per diem expenses.	Travel to present results at two regional conferences (Upper Midwest Invasive species conference and Entomological Society of America North Central Branch meeting) to communicate project results to the wider scientific community.					\$3,400
							Sub Total	\$7,403
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								

	Publication	Costs for publication of an article in a scientific journal	Dissemination of project results to scientific community					\$3,000
							Sub Total	\$3,000
Other Expenses								
							Sub Total	-
							Grand Total	\$350,000

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				
			Non State Sub Total	-
			Funds Total	-

Total Project Cost: \$350,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [c3c2767f-3c9.pdf](#)

Alternate Text for Visual Component

Graphics showing the environmental factors that may be affected by jumping worm invasion of Minnesota woodlands and their potential effects on ticks and tick-borne bacteria. Aim: Determine how jumping worm invasion changes woodland characteristics relevant to ticks and tick-borne disease. Outcomes: improve awareness of this issue and improve outdoor safety....

Supplemental Attachments

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

Title	File
UMN SPA confirmation letter	703a29ec-c1c.pdf
Letter of support (Three Rivers Parks)	2b0f266b-a94.pdf
Letter of support (UMN Arboretum)	685580f1-f14.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:

Kyungsoo Yoo, University of Minnesota CFANS

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