



Environment and Natural Resources Trust Fund

2024 Request for Proposal

General Information

Proposal ID: 2024-097

Proposal Title: Mitigating the Spread of Invasive Jumping Worms

Project Manager Information

Name: Vera Krischik

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

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Project Basic Information

Project Summary: Jumping worms are an invasive, exotic that poses a threat to forests by removing soil organic matter and seedlings. It is necessary to develop IPM tactics for mitigating jumping worms.

Funds Requested: \$516,000

Proposed Project Completion: June 30, 2027

LCCMR Funding Category: Aquatic and Terrestrial Invasive Species (D)

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.

Jumping worms (JW) pose a serious and growing threat to forest ecosystems and methods to prevent their spread through infested compost, mulch, soil, and nursery stock, are needed to protect MN natural resources. JW refer to a species complex including *Amyntas agrestis* and *A. tokioensis*, and *Metaphire hilgendorfi* (Chang et al. 2021). JW were first observed in Minnesota in Minneapolis (Loring Park) in 2006, and in St. Paul (UM campus) in 2007 (MN DNR 2022), JW live in the litter layer and top few inches of the soil and feed on leaf litter with negative impacts on soil chemistry and structure, soil water dynamics, seedling establishment and forest regeneration (Chang et al. 2021, Hale et al. 2008, Laushman et al. 2017). JW produce eggs in protective cocoons in summer/fall. Adults and juveniles die in the fall and overwintering eggs hatch in spring to start a new generation (MN DNR 2022). Importantly, unlike European species, JW can reproduce without mating and proliferate quickly to produce large populations (Ridge 2022, MN DNR 2022). No viable control methods currently exist, a serious concern that must be addressed if the spread of JW is to be prevented.

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.

The proposed research will focus on IPM strategies for managing JW, including environmentally safe, biorational chemicals (tea seed meal, *Beauveria* fungus, sulfur, iron phosphate), cultural practices (irritant mustard drenches that force JW to the surface and solarization in combination with chemical treatments in mulch piles), and conventional pesticides (carbaryl). Tea seed meal (active ingredient are saponins) is used as a soil amendment to manage earthworms on golf courses, but it is not labeled for JW and merits research (Potter et al. 2010). Also, non-target effects will be studied on beneficial, soil-dwelling insects and on phytotoxicity of common native plants when treated with JW chemical treatments. Chemicals that prove effective will be tested further using mulch piles. The goal of this research is to develop effective IPM strategies for managing JW in mulch, compost, and nursery stock and to reduce their spread into natural areas. Achieving this goal will require completing three objectives, which focus on assessing the efficacy of currently available environmentally safe chemicals and pesticides; developing a new mustard drench and tea seed meal soil amendment; and studying non-target effects on beneficial insect (decomposers and bumble bee colonies in the soil) and native plants (phytotoxicity).

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 proposed research will focus on developing IPM strategies, including cultural tactics such as solarization and biorational chemicals (tea seed meal, beneficial fungi, and mustard drenches) to reduce the spread of invasive JW, which are detrimental to plant health in MN forests and parklands. Research will demonstrate that these IPM tactics are safe to beneficial insects, such as soil-dwelling bees and decomposers. Outreach educational programs with mulch producers, park managers, landscapers, and nursery managers will spread the awareness of the threat of JW and how to manage them with IPM. An Advisory Committee will help disseminate reaching findings.

Activities and Milestones

Activity 1: Objective/Research Activity 1: Bioassays

Activity Budget: \$250,000

Activity Description:

Standard acute toxicology protocols for creating dose-response curves to calculate the median lethal concentration (LC50) will be performed for soil amendments, such as sulfur (Duiker and Stehouwer 2008) and tea seed meal (Potter et al. 2010), microbial pesticides, such as *Beauveria bassiana* (Nouri-Aiin and Görres 2021) and *Metarhizium anisopliae* (Copping 2004), slug pesticides, such as iron phosphate (Edwards et al., 2008, Dörler et al. 2019), and the conventional insecticide carbaryl, as a positive control (Gupta and Saxena 2003, Gupta et al. 2011). As we learn about the life history and production of cocoons, we will add cocoons to the bioassays either with adults or on their own. Cocoons are produced in summer and fall.

The optimal soil for JW survival and growth will be used in bioassays. Bioassay length will be the standard 4 days (96hr). However, containers with low mortality, will be monitored daily for an additional 4 weeks to ascertain additional mortality over time. Tea seed meal is used in Europe and the US on golf courses to kill worms, but it is not registered as a pesticide. We cannot promote tea seed meal as a pesticide without USDA and EPA approval.

Activity Milestones:

Description	Approximate Completion Date
Determine the best methods and chemicals for reducing JW numbers in lab studies.	June 30, 2027
Determine the best methods and chemicals for reducing JW in mulch piles in field studies.	June 30, 2027
Determine the best methods and chemicals to use in nursery containers moving plants and soil.	June 30, 2027
Outreach to disseminate research results.	June 30, 2027

Activity 2: Objective/Research Activity 2: Non-Target Effects

Activity Budget: \$250,000

Activity Description:

Understanding the toxicity of the treatments to non-target insects that live in soil are necessary. We will use single species experiments on adult carabid beetles, larval stratiomyid flies, psocids, and sowbugs, as well as soil nesting bumblebees. The same protocols and treatments will be used as in Activity 1.

Understanding the toxicity of these treatments on plant roots in soil are necessary. Once we determine the best chemical and dose, we will perform a 4 -week bioassays as described above, with native plants (gayfeather, anise hyssop, and milkweed), geranium, and hosta in containers and in the field to determine if the mustard drench and chemicals affect plant roots, growth, or mortality.

Once we have determined an effective chemical dose and the benefits of a mustard drench, we will test the chemicals on mulch piles at the UM Experiment Station (AES), St Paul, parks (3 collaborative parks), MN Arboretum, and MNLA nursery collaborators that have JW present.

Determining non-target effects of the treatments is important so that natural ecosystems, native species, and processes like decomposition are not affected or altered.

Activity Milestones:

Description	Approximate Completion Date
Determine the effects of chemical and methods on non-target bees and insects in lab studies.	June 30, 2027
Determine the effects of chemical and methods on non-target bees and insects in field studies.	June 30, 2027
Outreach to disseminate research results.	June 30, 2027

Activity 3: Determine tea seed meal active ingredients and concentrations that are effective in killing JW

Activity Budget: \$16,000

Activity Description:

Currently, tea seed meal, a soil amendment, is used like compost tea and is applied to the litter and watered in to kill JW. Unfortunately, tea seed meal is not registered as a JW pesticide, and we cannot advertise its use as such. We must use these chemical data to discuss EPA registration through the USDA IR4 program.

In collaboration with Prof. Dr. Fathi Halaweisch at South Dakota State University, we will use High-Performance Liquid Chromatography (HPLC)-Mass Spectroscopy (MS) techniques to identify the chemical profile and create various polar fractions and to test them for activity against JW, such as the saponin named lancemaside A (Ahmed and Wang 2015).

Tea seed meal will be extracted into fractions and then evaporated. Active fraction will be analyzed by HPLC-MS to identify the chemical profile and concentration. HPLC spectroscopic techniques will be used to collect the different saponins and other chemicals in tea seed meal that have properties that kill JW. These fractions are then used in bioassays to determine if the chemical kills the JW at what concentration. Also, we will determine the variation in saponin types and concentrations in different bags of tea seed meal, which can vary tremendously.

Activity Milestones:

Description	Approximate Completion Date
Determine tea seed meal active ingredients and concentrations that kill JW	June 30, 2027

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Jim Calkins	MN Nursery and Landscape Association (MNLA), Roseville, MN	Dr. Jim Calkins is the MNLA Research Information Director and he will help us develop and run educational programs for state agencies, parks, and commodity groups to develop IPM programs to identify and manage jumping worms. MNLA will support commodity journal articles and help run the JW Advisory Group.	No
Prof Dr. Fathi Halaweisch, Provost Fellow	South Dakota State University Department of Chemistry & Biochemistry SAV 375 Box 2202 Brookings, SD 57007 Tel. 605-688-4269	Dr. Fathi Halaweisch will perform research to identify the active ingredients in tea seed meal, such as the saponin lancemeside A, that kills JW. Analytical techniques (GC HPLC) and bioassays will be used to determine active ingredients. We will work with USDA IR4 to label tea seed meal as a	Yes
Advisory Committee meet 2x year by zoom	Multiple state agencies, MDA, MN DNR, BWSR; Commodity groups, MNLA, MGCSA (MN golf course superintendents association); soil, mulch, and compost councils	Discuss research and outreach programs and facilitate implementation of new IPM methods for managing JW and reducing the spread of contaminated soils.	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?

The ultimate goal is reducing the spread of JW in native ecosystems, public and private landscapes, and nurseries. There are currently no effective options for controlling JW on a small- or large-scale, a serious research need. Thus, research on viable IPM options are desperately needed. Outreach programs will disseminate the research findings through in-person presentations, yearly workshops, online educational programs (workshops, videos), websites, articles in journals published by conservation agencies (MN BWSR, MDA, DNR, MN Conservationist, etc.), nursery and landscape associations (MNLA, MGSA), home gardens (MN State Hort Soc.), composite sites (county), as well as newspapers, radio, and television.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Invasive Species Biocontrol in Bee Lawns and Parklands	M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 06d	\$425,000

Project Manager and Organization Qualifications

Project Manager Name: Vera Krischik

Job Title: Associate Professor

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

Dr. Vera Krischik is a University of Minnesota professor and IPM specialist with 34 years of experience promoting Integrated Pest Management (IPM), biocontrol, and compatible insecticides to protect pollinators and other good bugs in green space, including greenhouses, nurseries, lawns, urban forests, parks, and restorations. Our lab's research identifies the best ways to manage pests through IPM to reduce non-target effects on native pollinators and biocontrol insects, such as parasitoids, lady beetles, native butterflies, and native bees, such as rusty patched bumblebee, *Bombus affinis*, and blue orchard bee, *Osmia lignaria*. Data from our site specific IPM and biocontrol program are promoted by sharing our research expertise at national, state, local research outreach meetings. Our lab was requested to be on a technical committee to help the Minneapolis Park Rec Board to develop IPM programs for their parks. We are members of two national committees on IPM for landscapes, two national committees on monarch and rusty patched bumblebee, USDA grant panels that review proposals associated with pollinators, and local efforts by businesses and municipalities to develop IPM programs. Every year we train pesticide applicators on how to correctly use pesticides in nine MDA, MNLA, UM workshops. We provide over 20 talks yearly to growers, commodity groups, and citizens on IPM and pollinators. We have an online training course on IPM and pesticides with the green industry group MNLA. We maintain an IPM website with technical information about pesticides and pollinators and an online 300 page IPM manual to identify pests and develop proper IPM at <https://pesticidecert.cfans.umn.edu/ipm-professionals>. We have another website devoted to IPM of pollinators, with information on pollinator identification, proper host plants, and IPM management of restorations at <https://ncipmhort.cfans.umn.edu/>. Yearly we publish research papers and articles for commodity journals.

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

Organization Description:

The University of Minnesota College of Food, Agricultural, and Natural Resources Sciences (CFANS) supports programs that promote agriculture, natural resource protection, agricultural commodity economics, and human needs related to agriculture. Through the CFANS Agricultural Experiment Station (AES) research lands are provided and maintained to support research and outreach programs that promote and solve issues related to agriculture and natural resource management throughout the state.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Post Doc		Works with the PI, Researcher3, and Undergraduate students in the lab and field, develops experimental designs, collects data, performs statistical analysis of the data, develops graphics, and peer reviewed research papers. Total = \$221,000 for 3 yr			25.7%	3		\$221,000
Researcher3		Works with the PI, Post Doc, and Undergraduate students to perform the research and deliver outreach programs. Total = \$213,000 for 3yr			32%	3		\$213,000
Undergraduate researcher		Works with the PI, Post Doc, and Researcher3 to help perform the research. 30 hr/wk x 10wk = 300 hr x \$16.67/hr=\$5,000 x 3yr. Total = \$15,000 for 3yr			0%	0.9		\$15,000
							Sub Total	\$449,000
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Equipment	Research: Fans, portable air conditioner for cooling the GH as JW cannot tolerate temperatures above 85F, refrigerator/freezer for chemicals solutions, pesticide storage cabinet for bulk chemicals storage in GH area, shade cloth to reduce GH temp. Total = \$4,000 for 3 yr	Research: Equipment is needed to perform the research in the greenhouse and in the field in mulch piles					\$4,000
	Tools and Supplies	Research: PPE (goggles, shields, disposable coverall, gloves, plastic GH shoes, spill kits, first aid kits, heat stress kits) for safety around chemicals, MS HPLC chemicals, bioassay chemicals, bioassay containers, insect netting, bagged soil, mulch, containers for bioassays, plants for phytotoxicity studies, lab cleaning supplies, new scale for lab and GH, tweezers, dissecting tools, etc; Total = \$16,000 for 3yr. GH space for research: \$400/mo x 6mo = \$2,400 x 3yr. Total = \$7,200 for 3yr. UMN soil testing	Research: Perform bioassays in the greenhouse in containers to determine if the chemicals kill JW and if mustard drenches cause the irritated beetles to aggregate; perform similar research in mulch piles in the field; finally take the best techniques to 6 field sites with JW and see if the procedure kills JW. Soil Analysis: Determine if the procedures					\$47,000

		lab: analyze soil for nutrients, organic matter, and texture, \$50/sample x 50 sites x 3yr = 150 samples x \$50. Total = \$7,500 for 3yr. USDA Gastonia Pesticide Lab: Verify pesticide solutions and bioassays for carbaryl, iron phosphate, sulfur, other pesticides. Total = \$4,000 for 3yr. Use analytical equipment that requires expertise and is very costly, to make HPLC-MS fractions of the tea seed meal to determine what is the active ingredient that kills JW. These fractions are sent to the UM Krischiklab where we bioassay them and see if they kill JW. Total = \$12,000 for 3yr. Total = \$47,000 for 3 yr	change soil parameters that might inhibit plant growth. Pesticide analysis: Perform research on the solutions of pesticides that are used to verify their concentration. Identify active ingredient in tea seed meal: Research with a phytochemist at SDSU to determine the active ingredient in tea seed meal and perform bioassays on the fractions obtained from tea seed meal.							
									Sub Total	\$51,000
Capital Expenditures										
									Sub Total	-
Acquisitions and Stewardship										
									Sub Total	-
Travel In Minnesota										
	Miles/ Meals/ Lodging	Instate travel: Summer travel use monthly UM rental car. Travel to research outreach workshops, field days, and meetings. \$330/mo x 5mo=\$1,650 plus mileage and other charges x 3yr = \$6,500. Total = \$6,500 for 3yr	Instate travel: Summer travel with monthly UM rental car. Travel to research sites and outreach workshops, field days, and meetings.							\$6,500
	Miles/ Meals/ Lodging	Instate travel: Outside summer months, use daily UM car rental. Travel to research sites and outreach workshops, field days, and meetings. \$60/day + (\$0.17/mi x 40 mi=\$8) = \$70/day x 7day= \$500 x 3yr = \$1,500. Total = \$1,500 for 3yr	Instate travel: For travel outside summer months, use daily UM rental car. Travel to research sites and outreach workshops, field days, and meetings.							\$1,500
									Sub Total	\$8,000
Travel Outside Minnesota										
									Sub Total	-

Printing and Publication								
	Printing	Outreach programs: Print materials for outreach programs at meetings, workshops, and field days to provide information to park managers, landscapers, mulch groups, and consumers on JW issues and management through IPM. Total = \$2,000 for 3yr	Outreach programs: Print materials for outreach programs at meetings, workshops, and field days to provide information to park managers, landscapers, mulch groups, and consumers on JW issues and management through IPM.					\$2,000
	Publication	Research: Pay page charges for publishing research in a peer-reviewed journal, 3 papers x \$2000/each. Total = \$6,000 for 3yr	Research: Pay page charges for publishing research in a peer-reviewed journal, 3 papers					\$6,000
							Sub Total	\$8,000
Other Expenses								
							Sub Total	-
							Grand Total	\$516,000

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	-

Attachments

Required Attachments

Visual Component

File: [e8480ad0-6b3.pdf](#)

Alternate Text for Visual Component

Mitigating the spread of invasive jumping worms, identification, distribution, and IPM tactics...

Optional Attachments

Support Letter, Photos, Media, Other

Title	File
Support letters from 9 collaborators: MN DNR, MDA, MNLA, Mulch and Soil Council, MN composting Council, US Composting Council, Bailey Nursery, Sargent's Nursery, Prescription Landscapes	1f1079a8-cbe.pdf
2023 UMN SPA Approval of proposal Mar 29	c304074b-846.pdf
Research References	07608b3a-6f8.docx

Administrative Use

Does your project include restoration or acquisition of land rights?

No

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

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 design, construction, or renovation of a building, trail, campground, or other capital asset costing \$10,000 or more?

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?

No