



# Environment and Natural Resources Trust Fund

M.L. 2024 Approved Work Plan

## General Information

**ID Number:** 2024-097

**Staff Lead:** Tom Dietrich

**Date this document submitted to LCCMR:** June 12, 2024

**Project Title:** Mitigating the Spread of Invasive Jumping Worms

**Project Budget:** \$470,000

## Project Manager Information

**Name:** Vera Krischik

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

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## Project Reporting

**Date Work Plan Approved by LCCMR:** June 20, 2024

**Reporting Schedule:** June 1 / December 1 of each year.

**Project Completion:** June 30, 2027

**Final Report Due Date:** August 14, 2027

## Legal Information

**Legal Citation:** M.L. 2024, Chp. 83, Sec. 2, Subd. 06b

**Appropriation Language:** \$470,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to develop integrated pest management strategies to mitigate the threat that invasive jumping worms pose to soil organic matter and seedlings in Minnesota forests.

**Appropriation End Date:** June 30, 2027

## Narrative

**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.

**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.

## 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

## Activities and Milestones

### Activity 1: Objective/Research Activity 1: Bioassays

**Activity Budget:** \$200,000

#### 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) on adults, and later eggs and cocoons. 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 EPA registration.

#### Activity Milestones:

Description	Approximate Completion Date
Use acute and chronic bioassays with different pesticides to reduce JW numbers in lab studies.	October 31, 2026
Test pesticides from milestone1 in the field mulch piles to reduce JW numbers.	October 31, 2026
Test pesticides from milestone1 in nursery containers to reduce JW numbers.	February 28, 2027
Determine pesticides and dose that kill JW and work with EPA to register.	February 28, 2027
Outreach to disseminate research results, updating websites, writing bulletins, giving talks, updating manuals.	June 30, 2027

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

**Activity Budget:** \$200,000

#### 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
Test pesticides from activity1 milestone1 on non-target beneficial insects in lab studies.	November 30, 2026
Test pesticides from activity1 milestone1 on native and ornamental plant growth, root mass, and mortality.	January 31, 2027
Test pesticides from activity1 milestone1 on non-target bees in lab studies.	May 31, 2027
Outreach to disseminate research results, updating websites, writing bulletins, giving talks, updating manuals.	June 30, 2027

**Activity 3: Determine tea seed meal active ingredients and concentrations that are effective in killing JW****Activity Budget:** \$70,000**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 (n=30).

**Activity Milestones:**

Description	Approximate Completion Date
Bioassay tea seed meal fractions/chemicals for activity to reduce JW numbers in lab studies.	September 30, 2025
Determine tea seed meal active ingredients and dose that affects beneficial insects in lab studies.	September 30, 2025
Determine tea seed meal active ingredients and dose and work with EPA to register.	January 31, 2027
Outreach to disseminate research results, updating websites, writing bulletins, giving talks, updating manuals.	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 and 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.	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

## 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.**

Outreach and research dissemination

All LCCMR grant products will be branded with the ENRTF LCCMR logo and associated language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgment Guidelines. For outreach and research dissemination, the LCCMR UM sponsored website will be updated with information about Jumping Worm IPM management, including identification, monitoring, cultural practices,

The collaborators will work together to develop outreach programs, IPM protocols, bulletins, and commodity journal articles that will be posted on the JW section at the Krischiklab Pollinator Conservation (PC) website <https://ncipmhort.cfans.umn.edu/>

1. The goal of the research and outreach program is to deliver an EPA approved label to manage JW that has limited non-target effects on soil-inhabiting insects or the roots and growth of native plants. This can be accomplished by testing efficacy of current EPA registered products and adding JW to the label of the pesticide. We will test for efficacy EPA registered biorational pesticides, including pesticides with saponins used for nematode control. Also, we will identify the saponins and their dose in Planet Turf tea seed meal, which has been used for worm control on golf courses for 50 years.

2. These outreach programs will be site specific, such as nursery pots, backyards, mulch piles, and golf courses. For instance, carbaryl drenches of soil in pots may kill JW and not have effects on pollinators feeding on the plants. However, in landscapes we would need to promote a different IPM program, such as mustard drenches and biorational pesticides to reduce non-target effects. We will perform research to determine the best chemical, dose, and irritant to manage JW. We will determine any plant phytotoxicity and effect on plant growth and flowering. We will determine if any chemicals have non-target effects of predators, soil decomposers, or bees.

3. We plan to develop a JW IPM program for 3 different sites: nursery pots, landscapes, and mulch piles discussed in 3 IPM bulletins posted on the Krischiklab PC website.

In bulletins published the first 2 years, we will discuss the program and current IPM strategies. After 2 years and when we have data to discuss practices and chemicals with the best efficacy.

4. We plan to write 3 commodity journal (published in commodity group journals, such as MNLA, MN nursery and landscape association; MN mulch council; US mulch council; US composting council; MGCSA, golf course managers; MN DNR; MN DA) articles a year and post them on the Krischiklab PC website.

5. We plan to write 2 newsletter articles for Master Gardener and Master Naturalist a year and post them on the Krischiklab PC website.

These UM outreach groups can disseminate information to consumers.

6. We plan to hold 2 workshops over 2 years on JW management through zoom and video each talk and post the videos and pdf of the slide shows on the website.

Commodity groups, state agencies, and UM groups will be invited to the zoom meeting. post We will post the workshops on the Krischiklab PC website.

7. We will provide 12 talks a year to the different commodity groups, state agencies, UM outreach groups, and consumers on JW management.

8. We will meet yearly for discussions with the Advisory Committee.

9. We will work with different groups in MN on JW management, such as: .Commodity groups,(MNLA, MN nursery and landscape association; MNGCSA, MN Golf Course Superintendent's Association; MN mulch council; US mulch council, US composting council); state agencies (MN DNR, MN DA, and MN Pollution Control); UM educational groups (Extension Educators, Master Gardeners and Master Naturalists); nurseries, and parks.

Collaborators and their roles in research and outreach.

Dr. Vera Krischik, Depart Entomology, UM, Assoc Pro and Extension Specialist, pesticides, toxicology, landscape ecology, beneficial insects, pollinators, IPM, biocontrol, will develop written protocols, experimental designs, statistical analysis, write reports, administer budget and purchases, write research papers, and organize outreach activities.

Dr. Jim Calkins, MNLA, regulatory affairs and former Department Plant Sciences, will act as the liaison between state agencies and commodity groups.

Dr. Brandon Miller, Depart Plant Sciences, UM, Assis Prof and Extension Specialist, plant health, will be a member of the Advisory Committee and help guide research and outreach.

Ms. Erin Buchholz, MN Landscape Arboretum, Horticulturist and JW researcher, PhD student on the grant will perform research and liaison with other JW research/outreach groups including the UWisconsin arboretum.

The lab manager or a PostDoc will be hired to perform the JW bioassays.

Dr. Fathi Halaweisch of South Dakota State University will research the active ingredients (AI) in tea seed meal through

HPLC and GC Mass and fractions will be bioassayed for activity against JW. After, we identify the AI we will purchase 30 bags of tea seed meal (Planet Turf, <https://genesissupplystore.com/products/tea-seed-meal>) at 3 seasonal times and determine the amount of AI in the different bags. From these data, we will work with the IR4 program and EPA on registering a tea seed meal product for JW management. Advisory Committee member's names are suggestions and have not been contacted yet.

The Advisory Committee will meet bi-annually to discuss the research and outreach program.

JWORM Working Group, at Cornell University with researchers from Colgate, Cornell, Yale NYISRI, SUNY Cortland, UW Madison.

UMN will apply for membership.

Cassie Larson Director and Dr. Jim Calkins, regulatory Affairs, MNLA

Erin Buchholz, IPM specialist, Minnesota Landscape Arboretum

Dr. Bradon Miller, Plant Sciences UM

Jean-Marc Versolato, Midwest Plant Health Manager, Bailey Nurseries, collaborators on pot and field study

Nick Sargent, owner and CEO, Sargent's Nursery, collaborators on pot and field study

Paulta LaPlanta, CSO and owner, Prescription Landscape, collaborators on pot and field study

Kaitlin Ryan, Manager Lake Harriet Rose Garden, Minneapolis Park & Recreation Board,

Frank Franciosi, Executive Director, U.S. Composting Council

Ginny Black, Board of Directors, MN Composting Council

Robert LaGrasse, Executive Director, Mulch and Soil Council

Chris Aumock, MN Golf Course Superintendent's Association

Ryan Murphy, Internationals Society of Arboriculture

Heidi Wolf, MN DNR, Ecosystem Management and Protection Section Manager

Laura Van Riper, MN DNR, Terrestrial Invasive Species Program Coordinator

Mark Abrahamson, MDA Plant Protection Director and State Regulatory Official

MN Pollution Control Agency (MPCA), regulates composting sites

Angie Gupta, University of Minnesota Extension, Forestry

Marissa Schuh, IPM landscapes, MN Extension, IPM

Julie Wisenhorn, University of Minnesota Extension, Horticulture

Lee Frelich, Professor, University of Minnesota, Forestry

UM Extension Educators, Master Gardener and Master Naturalist members

## 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

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Graduate student, 3yr		Works with the PI, other PostDoc, 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, update websites, engage in outreach. 3yr.			27.1%	3		\$226,255
PostDoc, or Lab manager 1.5yr		Works with the PI, other PostDoc, 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, update websites, engage in outreach. 1.5yr.			27.1%	1.5		\$108,756
Undergraduate researcher, 3yr		Works with the PI, Post Doc, and Researcher3 to help perform the research, update website, write bulletins, engage in outreach. 30 hr/wk x \$16.67/hr x 14 wk=\$9,600 x 3yr. Total = \$38,400 for 3yr.			0%	0.1		\$8,400
							<b>Sub Total</b>	<b>\$343,411</b>
<b>Contracts and Services</b>								
UMSoil testing Labthat is an internal fee to determine N,P, K, organic matter, %water, sand/silt/clay, and compactness, pesticide dose verification.	Professional or Technical Service Contract	UMSoil testing Lab to determine N,P, K, organic matter, %water, sand/silt/clay, and compactness, \$50 x 40 samples=\$2,000/yr x 3/yr= \$6,000; verify insecticide concentrations, \$200 samples x 10 samples=\$2,000. Total =\$8,000 for 3yr.				0		\$8,000
UMN greenhouse space for research that	Internal services or fees (uncommon)	Greenhouse space at UM. UMN GH space for research that is an internal service for fee, for research:\$400/mo x 5mo = \$2,000 x 3yr. Total = \$6,000 for 3yr.				0.6		\$6,000

is an internal fee.								
Contract to Dr. Fathi Halweisch, So. Dakota State University, Use a HPLC Gc to make fractions of teaseed meal and bioassay for activity to kill JW. Name the saponin and dose in tea seed meal that kills JW.	Professional or Technical Service Contract	Use a HPLC GC to make fractions of tea seed meal and bioassay for activity to kill JW. Name the saponin and dose in tea seed meal that kills JW.				1		\$30,000
							<b>Sub Total</b>	<b>\$44,000</b>
<b>Equipment, Tools, and Supplies</b>								
	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 = \$6,286 for 3 yr.	Research: Equipment is needed to perform the research in the greenhouse and in the field in mulch piles					\$6,286
	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 = 50,303 for 3yr.	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 change soil parameters that might inhibit plant growth. Pesticide analysis: Perform research on the					\$50,303

			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.					
							<b>Sub Total</b>	<b>\$56,589</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	Instate travel: Summer travel use monthly UM rental car. Travel to research outreach workshops, field days, meetings.UM rental car \$1100/mo x 6mo x 3yr= Total \$20,000= \$5,000 for 3yr.	Instate travel: Summer travel with monthly UM rental car. Travel to research sites and outreach workshops, field days, and meetings.					\$20,000
							<b>Sub Total</b>	<b>\$20,000</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Printing and Publication</b>								
	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 = \$1,000 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.					\$1,000

	Publication	Research: Pay page charges for publishing research in a peer-reviewed journal, 3 papers x \$1,650/each. Total = \$5,000 for 3yr.	Research: Pay page charges for publishing research in a peer-reviewed journal, 3 papers.					\$5,000
							<b>Sub Total</b>	<b>\$6,000</b>
<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	<b>\$470,000</b>

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...

### Supplemental Attachments

#### *Capital Project Questionnaire, Budget Supplements, 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	<a href="#">1f1079a8-cbe.pdf</a>
Research References	<a href="#">07608b3a-6f8.docx</a>
2023 UMN SPA Approval of proposal Mar 29	<a href="#">c304074b-846.pdf</a>
Research Addendum revised 2024-279_final	<a href="#">70ccecd1-0ff.pdf</a>

## Difference between Proposal and Work Plan

### *Describe changes from Proposal to Work Plan Stage*

The work plan has been updated with better descriptions of research and outreach, budget information based on a \$470,000 budget, and a new dissemination section.

Dec 15 2023 The work plan was updated based on the review comments. The timeline was edited with better predictions for finishing lab and field research. The words on ENTF acknowledgements were added. A larger section describing the dissemination and outreach program was added.



## Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

**Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?**

N/A

**Do you agree travel expenses must 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 agree to the UMN Policy.

**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