Environment and Natural Resources Trust Fund

M.L. 2024 Approved Work Plan

General Information

ID Number: 2024-172

Staff Lead: Tom Dietrich

Date this document submitted to LCCMR: June 7, 2024

Project Title: Sublethal Effects of Pesticides on the Invertebrate Community

Project Budget: $387,000

Project Manager Information

Name: Mingzi Xu

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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: July 31, 2028

Final Report Due Date: September 14, 2028

Legal Information

Legal Citation: M.L. 2024, Chp. 83, Sec. 2, Subd. 03p

Appropriation Language: $387,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to provide data on pesticide contamination in soil and the insect community across the state and the effect of insecticide exposure on insect reproduction. This appropriation is available until June 30, 2029, by which time the project must be completed and final products delivered.

Appropriation End Date: June 30, 2029

Narrative

Project Summary: This project seeks to provide data on insecticide contamination in the soil and the insect community across the state and the effect of sublethal insecticide exposure on insect reproduction.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Pesticides are widely used across the state. Spray drift and runoff of insecticides can enter waterbody, which in turn, contaminates soil and vegetation. Such environmental contamination of pesticides has non-lethal effect on the invertebrate communities. Low dosage insecticides have been shown to negatively affect insect reproduction. Ecological modeling predicts that even at an extremely low dosage, the impact can lead to population decrease. As insect community performs critical ecosystem services, such as decomposition, dung removal, nutrient cycling, pollination, and pest control, the non-lethal effect through interruption of reproduction can result in serious loss in ecosystem services. For example, it has been shown that insecticide can travel through the soil food chain to disrupt biological pest control and ultimately decrease soybean yield. Therefore, Minnesota-specific data on insecticide residue in the environment and insects from wild populations and how the detected level of contamination affect reproduction and population dynamics are much needed. Such data can provide critical guidelines for pesticide use in the state. Yet such data are lacking.

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 provide a status assessment, I will survey insecticide residue levels from soil and the arthropod community across the state. Sampling will be conducted from three types and a total of 12 sites: agricultural land, urban and suburban areas, and protected natural areas. Each sampling area will be roughly 500m in radius and can be located on both private and public land. At each site, I will collect topsoil and invertebrate samples. Agricultural sites will be sampled during both spring and fall application period and the rest will be sampled once. Chemical analysis will be done at USDA National lab using a custom panel compiled from application and sale record.

Additionally, I will conduct lab experiments to understand the effect of exposure to insecticide residue on insect mating using cricket G. pennsylvanicus as the model system. The Gryllus crickets can be exposed to insecticide residue through both contact and ingestion of contaminated organic matter. I will conduct assays on receptivity, male advertisement through song, female mate localization, copulation, as well as development of reproductive tissues, all are components crucial for mating success. All assays will follow established protocols developed in my lab.

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 field survey will provide data on the identity and concentration of insecticide residues from the environment across the state. For the agricultural sites, temporal data will also be generated to compare residue profile between spring and fall. The lab animal experiment on crickets will offer detailed data on how exposure to sub-lethal level of insecticides can affect overall mating success, as well as specific behavioral and physiological component through which the impact takes effect. All data will be delivered in the form of reports, publications, conference presentations, outreach flyers and posters, and a cricket song database.

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: Sampling of soil and insects for insecticide residue analysis across the state

Activity Budget: $273,420

Activity Description:
This activity will sample topsoil, the soil arthropod community, and a focal group, the Gryllus crickets from a total of 12 sites across the state. The sites will cover three site types: agricultural land, urban and suburban areas, and protected natural areas. Agricultural sites will be sampled twice, once in the spring and once in the fall and the rest of the sites will be sampled once. Three replicates of soil samples will be taken at each site. Soil arthropod samples will be collected adjacent to the locations where soil samples are collected. Cricket samples will be collected in the general area.

Residue analysis will be conducted at USDA Agricultural Marketing Service National Science Laboratories. I will implement a two-stage strategy. In the first stage, samples will be analyzed using a custom panel based on application and sale data. Depending on the finding from the first stage analysis, a more focused panel including the top detected groups chemicals and their primary metabolites will be analyzed. This design aims to achieve both coverage and detectability in residue analysis. Depending on the amount of arthropod tissue collected, samples may be analyzed by site or pooled as a combined sample.

Activity Milestones:

Description	Approximate Completion Date
identify sampling sites and obtain permits	December 31, 2024
collect soil and cricket samples from at least one site from each site type	November 30, 2025
residue analysis for the first batch of soil and cricket samples	May 31, 2026
complete soil, arthropod community and cricket sample collection	November 30, 2026
complete sample processing and residue analysis for all samples	May 31, 2027
resampling and residue reanalysis if needed	November 30, 2027
meet with statement and municipal officials to share findings and recommendations	November 30, 2027
report preparation and release online, prepare publications	June 30, 2028

Activity 2: investigating the effects of sublethal insecticide exposure on insect reproduction

Activity Budget: $113,580

Activity Description:
This activity will use lab experiments to determine the degree to which exposing to insecticide residue affect reproduction of insects. I will use the local field crickets belonging to the genus Gryllus for this activity. Crickets can be exposed to insecticide residue both through contact and ingestion of contaminated organic matter. Mechanistic pathways linking insecticides and mating behaviors have been established. Crickets have also been previously used to assess reaction to pesticide exposure.

For this experiment, we will focus on a top used insecticide, specific kind to be determined in Activity 1. The detected concentration, sale data, and whether there is an established mechanistic link between chemical and phenotype will be considered in the choice of the focal chemical. A dosage assay will be run first to determine the concentration to be used for the experiment. The experiment will investigate the effect of insecticide residue on four major components of mating success: development of reproductive tissue, receptivity, mate advertisement and localization, and copulation. Phenotypes of individuals exposed to the insecticides and controls will be compared. All types of assays will be conducted concurrently. Data from the first year will be analyzed immediately to inform whether adjustment is needed.

Activity Milestones:

Description	Approximate Completion Date
pilot methods for cricket collection, rearing, and experiment for control individuals	May 31, 2026
focal insecticide selection and dosage assays	November 30, 2026
complete assays for development, receptivity, advertisement and localization, and copulation	November 30, 2027
data analysis	May 31, 2028
report and publication preparation, meet with state officials, release song database	July 31, 2028

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.
The insecticide residue data and reproductive risk assessment data generated will be shared with Minnesota Department of Agriculture, Minnesota Department of Natural Resources, Minneapolis-St. Paul Metropolitan Area Long Term Ecological Research Program, and municipalities. Findings will also be communicated through peer-reviewed publications and presentations at conferences and symposiums. Datasets and song databases are also available to other organizations and the public through request. Environment and Natural Resources Trust Fund will be acknowledged in the trust fund logo or attribution language in all publications, conference posters, presentation slides or material for public outreach.

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?
Findings from this study will be published in peer-reviewed journals and disseminated through conference presentation and seminars. I will also share data with the Minnesota Department of Agriculture, Minnesota Department of Natural Resources, the Nature Conservancy in Minnesota, and municipalities. Information will also be disseminated to the public through outreach programs such as public talks and educational booths at farmer's markets.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Graduate Research Assistant		The GRA will be involved in all research activities of this project, including data collection, analysis and dissemination			38.1%	0.76		$77,338
Undergraduate assistant		The undergraduate assistant will assist in field sampling in activity 1 and insect rearing in activity 2			0%	0.44		$15,846
Project Manager		The project Manager will be in charge of project design, oversee and participate in data collection, data analysis, and data dissemination.			27.1%	0.24		$37,093
Lab technician		The lab technician will assist in field sampling and lab behavioral and physiological experiments.			25.1%	1.04		$74,038
							Sub Total	**$204,315**
Contracts and Services								
USDA Agricultural Marketing Service National Science Laboratories	Professional or Technical Service Contract	Pesticide residue analysis for a total of 240 soil and insect samples. Test fee is $625/sample total, including a full insecticide penal and an additional neonicotinoid panel. I estimate a total of $150,000 for all samples.				0		$150,000
							Sub Total	**$150,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	1) Field sampling equipment include tape measures, sampling jars, vials, soil core sampler, areal and aquatic insect nets, insect traps, flagging tapes, cooler, and GPS unit. 2) pesticide reference kit. 3) Rearing supplies (plastic binds, cricket food, N95 masks, air purifiers) 4) Chemical reagents. 5) General lab supplies (glassware, vials, pipetter tips, kim wipe, gloves, PPE)	1) They will be used for field sampling of water, soil, and invertebrates. 2) The pesticide reference kit will be used for GC/LC-MS analysis of pesticide residue from the samples. 3) Rearing supplies will be used to rearing crickets in the lab for physiological and behavioral experiments on the sub-lethal effect of pesticide exposure as well as PPE					$8,265

			for involved personnel. 4) Chemical reagents will be used in processing and cleaning up of field samples. 5) Lab supplies are for general lab activities and maintenance.					
							Sub Total	**$8,265**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	This include per diem, lodging and gas costs for travel to and from 12 sites. I will involve a 4 person team for the sampling effort, 4 days per site (including 2 days for travel and 2 days for sampling). Per diem and lodging is estimated at $100 per person per day total. Gas is estimated at $30 per travel day for a total of 24 travel days.	I plan to collect soil, and invertebrate samples from a total of 12 sites across the state.					$19,920
							Sub Total	**$19,920**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Publication costs	publication for peer-reviewed papers from this project					$4,500
							Sub Total	**$4,500**
Other Expenses								
							Sub Total	**-**

							Grand Total	**$387,000**

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				
In-Kind	Indirect costs associated with this proposal at 55% MTDC.	Indirect costs cover both facilities costs and administrative costs that are incurred by the University of Minnesota when conducting sponsored research, instruction, and public service projects.	Secured	$203,000
			State Sub Total	**$203,000**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**$203,000**

Attachments

Required Attachments

Visual Component

File: c8b5504d-dda.pdf

Alternate Text for Visual Component

Research plan for the two activities in the proposed project...

Supplemental Attachments

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

Title	File
authorization letter	fa0da317-2ba.pdf
Research Addendum revised 2024-172 - v3	f4dfd7d2-31d.pdf
Correction Addendum Revised 2024-172 - v4	50919dd6-e18.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

After consultation with MDA, I'm now focusing sampling efforts to soil and insects as MDA conducts routine water monitoring. I have also extended the completion date to July, 2028.

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