



Environment and Natural Resources Trust Fund

2024 Request for Proposal

General Information

Proposal ID: 2024-172

Proposal Title: Sublethal Effects of Pesticides on Invertebrate Community

Project Manager Information

Name: Mingzi Xu

Organization: U of MN - College of Biological Sciences

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Project Basic Information

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

Funds Requested: \$398,000

Proposed Project Completion: October 31, 2027

LCCMR Funding Category: Foundational Natural Resource Data and Information (A)

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.

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, such as Chlorpyrifos and Pyrethroids, the two top used insecticides in Minnesota, 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 integrated pest management (IPM) and mosquito control programs in the state, as well as offering assessment to health risks for humans. 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 proposed to obtain data on insecticide residue levels from waterbody, soil, and insect samples across the state. Such data will provide crucial recommendations for the design of buffer zone and application guideline and protocols for IMP.

Additionally, I plan to conduct experiments to understand how long-term and acute exposure to insecticides at the level observed in the field affects reproductive organ, development, mating behaviors of adults, and offspring development using crickets as a potential “canary in the coal mine” system. Cricket songs are a crucial part of their mating ritual and are highly sensitive to insecticide exposure. This renders cricket song an analogous tool as the “canary in the coal mine” for detecting non-lethal effects of pesticide exposure in the field. The proposed project will offer data for developing a phone app for identifying abnormal cricket songs after insecticide exposure and develop local crickets into a tool to be incorporated in citizen science projects on long-term monitoring of non-lethal effects from insecticides on insects.

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 status-quo of insecticide residue level in the environment and insects, including pollinators. These data can generate recommendations for developing guidelines for IPM as well as categorizing threaten level from insecticide exposure for different insect groups.

The animal experiment will offer data on how insecticide exposure affects insect reproduction through interrupting development of reproductive tissues and mating behaviors in adults. These data are crucial for estimating the impact on population dynamics and loss in ecosystem services. This activity will also generate data for developing local crickets as a tool for monitoring insecticide contamination.

Activities and Milestones

Activity 1: Sampling of soil, waterbody and insects for insecticide residue analysis across the state

Activity Budget: \$307,000

Activity Description:

This activity will collect data on insecticide residue levels in the environment (soil and waterbody) and the insect community from 20 sites in areas near farms, golf courses, mosquito control sites, and in natural areas. At each site, we will collect and analyze soil core and/or water samples. We will select two sites with the highest detected insecticide residue level and two sites with the lowest residue level as focal sites for insect sample collection. At each focal insect collection sites, insect samples will be collected using a random sampling protocol using insect traps and insect nets. At each site, 10 species with the highest abundance will be selected as focal species for residue analysis. Residue analysis will be conducted at USDA Agricultural Marketing Service National Science Laboratories.

Activity Milestones:

Description	Approximate Completion Date
collect environmental and insect samples	October 31, 2025
sample preparation and pesticide residue analysis	July 31, 2026

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

Activity Budget: \$91,000

Activity Description:

This activity will use lab experiments to determine the degree to which exposing to insecticide residue affect reproduction of insects, which in turn, can have strong downstream effects on population density, community composition, and ecosystem services.

We will use the local *Gryllus* crickets for this activity. Crickets are an ideal system for this study for several reasons. First, cricket mating behavior is mediate by male song, a characteristic that is easy to be quantified. Second, unlike bees, cricket mating system is similar to other insects, rendering findings from crickets generalizable to other insects. Third, crickets are common in the field in the state and its lifestyle renders them highly susceptible to insecticide residue.

For this experiment, we will focus on the top detected insecticide in insect samples from Activity 1. We will expose lab reared adult crickets to various levels of insecticide, including the average level detected in the field, and compare male singing, female choice, as well as mating success before and after insecticide application. Further, we will expose crickets to insecticide at different developmental stages, including eggs, nymphs, and adults, and examine the impact of exposure on reproductive tissue development.

Activity Milestones:

Description	Approximate Completion Date
collect data on the effect of insecticide exposure on male singing behavior	November 30, 2025
collect data on the effect of insecticide exposure on female mate choice behavior	June 30, 2027
collect data on the effect of insecticide exposure on reproductive organ development	June 30, 2027

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 Integrated Pest Management Program, Minnesota Department of Natural Resources, the Nature Conservancy in Minnesota, and the Metropolitan Mosquito Control District. The results have high potential to generate recommendations for developing guidelines for IPM and mosquito control programs as well as categorizing threaten level from insecticide exposure for different insect groups. I will coordinate with the IPM to implement the recommendations.

Project Manager and Organization Qualifications

Project Manager Name: Mingzi Xu

Job Title: Assistant professor

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

The project manager obtained a BSc in Biological Sciences from Fudan University in Shanghai, China and a Ph.D. in Ecology and Evolutionary Biology from University of Oklahoma. She then completed postdoc training at Cornell University and University of Minnesota (UMN). She is currently an Assistant Professor in EEB at UMN. Listed below are her qualifications that are crucial for the success of the proposed project.

- During her undergraduate study, she has conducted vegetation and insect survey in Inner Mongolia and the Tibetan Plateau for two summers. She has gained extensive experience leading a field team and conducting field sampling, skills important for the success of Activity 1.
- During her Ph.D., she worked on mating behaviors of damselflies, through which she has built expertise in insect mating and reproduction research. She then completed postdoc training at Cornell University and University of Minnesota, during which she worked on male singing and female song preference in crickets both in the lab and in the field. Through this experience, she gained deep understanding about cricket mating behaviors and built expertise in phenotyping and analyzing male songs and female preference, as well insect development and insect dissection. As an Assistant Professor in EEB at UMN, she has obtained experience exposing crickets to chemicals (juvenile hormone supplement) and investigating the effect of exposure to mating behavior, an experiment similar to that proposed herein. All these qualifications are critical for the success of Activity 2.
- Her past research projects on crickets have been published in top journals in her area, including Proceedings of the Royal Society B, Animal Behavior, Journal of Evolutionary Biology and Genetics.
- The project manager has experience leading research teams and mentoring undergraduate and graduate students at both Cornell University and UMN.

Organization: U of MN - College of Biological Sciences

Organization Description:

The College of Biological Sciences (CBS) at University of Minnesota is the primary college that conducts research and education in biology. The PI is from the Department of Ecology, Evolution and Behavior is one of the departments from CBS that conducts research in ecology, evolutionary biology and animal behavior.

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 both activities			24.09%	0.75		\$37,000
Postdoctoral Associate		A postdoc with expertise in environmental sampling and chemical residue analysis will be hired to focus primarily on Activity 1			20.45%	1		\$75,000
Undergraduate assistant		The undergraduate assistant will assist in field sampling in activity 1 and insect rearing in activity 2			0%	0.75		\$22,000
Project Manager		The project Manager will be in charge of project design, oversee and participate in data collection, data analysis, and data dissemination and implementation			26.9%	0.24		\$38,000
							Sub Total	\$172,000
Contracts and Services								
USDA Agricultural Marketing Service National Science Laboratories	Professional or Technical Service Contract	Pesticide residue analysis from water, soil and insect samples. Test fee is \$360/sample. I estimate a total of \$180,000 for all samples.				0		\$180,000
							Sub Total	\$180,000
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 rear crickets in the lab for physiological and behavioral					\$8,000

			experiments on the sub-lethal effect of pesticide exposure. 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	\$8,000
Capital Expenditures								
		two insect incubators	for rearing crickets for the proposed physiological and behavioral testing. The cost is \$10,000 per incubator.	X				\$20,000
							Sub Total	\$20,000
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	2 days to travel to 20 sites to and sample at each site, the traveling takes 40 days total. I request \$12,000 per diem for 3 persons for 40 days of sampling. In addition, I request \$30 per day, a total of \$1,200 for gas.	I plan to collect water, soil, and invertebrate samples from a total of 20 sites across the state.					\$13,000
							Sub Total	\$13,000
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
	Publication	Publication costs	publication for peer-reviewed papers from this project					\$5,000
							Sub Total	\$5,000
Other Expenses								

							Sub Total	-
							Grand Total	\$398,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Capital Expenditures		two insect incubators	The requested amount is for capital equipment purchase. Additional Explanation : The incubators will be used in continued monitoring of physiology and mating behaviors of crickets collected from the field beyond the proposed timeline.

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	\$186,000
			State Sub Total	\$186,000
Non-State				
			Non State Sub Total	-
			Funds Total	\$186,000

Attachments

Required Attachments

Visual Component

File: [080a0eee-789.pdf](#)

Alternate Text for Visual Component

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

Optional Attachments

Support Letter, Photos, Media, Other

Title	File
Authorization letter	cb956081-be5.pdf

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