# Environment and Natural Resources Trust Fund

2026 Request for Proposal

## General Information

**Proposal ID:** 2026-295

**Proposal Title:** Impact of Temperature and Microhabitat on Insect Reproduction

## Project Manager Information

**Name:** Mingzi Xu

**Organization:** U of MN - College of Biological Sciences

**Office Telephone:** (405) 412-1021

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## Project Basic Information

**Project Summary:** This project investigates the effect of winter temperature on insect mating behaviors and test hypothesis of microhabitat choice as a potential behavioral adaptation to temperature variation.

**ENRTF Funds Requested:** $450,000

**Proposed Project Completion:** June 30, 2030

**LCCMR Funding Category:** Resiliency (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.**

Temperature variation is becoming a major concern for insects. Although we have a plethora of knowledge about how temperature fluctuation affects physiology, survival, and demography of insects, much remains to be understood. First, many studies focus on the change in mean temperature rather than fluctuation of temperature, and studies that focus on the temperature regime specific to Minnesota are rare.

Second, questions regarding whether insects display behavioral adaptations to the changing temperature scene across different microhabitat and whether this information can help us generate guidelines for designing more gardens, parks and other green areas that promotes resilience to temperature variation for insects are unexplored.

Third, although many studies have examined how acute temperature fluctuation during adult stage affects reproduction, studies focusing on winter temperature earlier in life as eggs or larvae is rare. As a result, the link between winter temperature fluctuation and adult mating behaviors remains unclear. As in recent years, Minnesota has experienced some historic temperature abnormalities during the winter and spring season, assessing the impact on insect life and collecting data on behavioral adaptations that can potentially generate important insights for conservation is extremely important.

**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.**

This project includes three aims. First, I plan to collect temperature and humidity data across different microhabitat and ground cover type (e.g., bare soil, mulch, hay, turf, pebble), both in the Twin Cities and in rural areas.

Second, I will use field survey to answer the question whether insects exhibit behavioral adaptations to seek out suitable microhabitat within the range of their populations. I will use the local Minnesotan cricket Gryllus pennsylvanicus as a study system. I will survey cricket distribution across microhabitats and test effects of different ground cover on soil temperature using a field experiment. Using data collected, I will examine the relationship among characteristics of microhabitat, ground cover type, temperature, and cricket presence and activity level. These data can help generate insights for designing more resilient habitat for insects in gardens, parks and other green areas in the Twin Cities.

Third, as the mating behavior of acoustically communicating animals (e.g., singing insects and frog) is highly susceptible to temperature variation, I will use lab experiments to examine the effect of winter temperature variation on mate attraction, mate choice, and mate searching behavior using crickets as a

**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 generate fine-grained air and soil temperature data across microhabitats in Minnesota, offering insights about effect of microhabitat and ground cover on buffering temperature fluctuations. Habitat choice data can potentially provide insights for conservation and design of insect-friendly green areas that promotes resilience to temperature variation. This project will also provide assessment about the effect of winter temperature fluctuation on later adult mating behaviors. Although data are collected from crickets, the insights have the potential to be generalized to the larger insect community and anurans that communicate acoustically.

## Activities and Milestones

### Activity 1: Sampling of air and soil temperature across microhabitats

**Activity Budget:** $189,000

**Activity Description:**
This activity focuses on monitoring temperature and humidity data on a fine-scale of microhabitats. I will deploy temperature and humidity loggers to monitor soil temperature and relative humidity in across both urban and rural microhabitats, as well as both northern and southern part of the state for two years. Apart from vegetation cover, number and distance from concrete structures, soil type, I will focus on the type of ground cover as a factor potentially exhibiting different ability to buffer temperature variation.
The collected data will allow us to answer several important and novel questions:
1. How does the mean and variation in soil temperature and humidity vary between urban and rural environments?
2. How does mean and variation in soil temperature and humidity vary among different microhabitat types and ground covers?
3. What are the frequency and extend of temperature fluctuation experienced by insects that overwinter in soil?

**Activity Milestones:**

| Description | Approximate Completion Date |
|---|---|
| Identify sampling sites and obtain permits | August 31, 2026 |
| Deploy temperature and humidity loggers | September 30, 2026 |
| Revisiting and maintaining loggers and download data periodically | September 30, 2028 |
| Resampling if needed | May 31, 2029 |
| Meet with state and municipal officials to share findings and recommendations | June 30, 2029 |
| Report and publication preparation | June 30, 2030 |

### Activity 2: Behavioral adaptation of insects in relation to temperature variation

**Activity Budget:** $102,000

**Activity Description:**
I will identify field populations of local cricket Gryllus pennsylvanicus in both urban and rural environment. Within each population, I will use quadrants to survey microhabitat choice by using male song as a sign of adult activity. I will examine association between cricket presence and activity level and microhabitat parameters, such as type of ground cover, soil type, amount and type of vegetation cover, presence of overhead structures, and type and topology of concrete structures (if present). Soil temperature and humidity data will be collected at microhabitat surveyed (in conjunction with Activity 1) and I will compare soil temperature between microhabitats with and without cricket presence. For microhabitats where crickets are present, I will collect data on both seasonal and daily temperature variation and examine whether there is a relationship between temperature variation at these microhabitats and the level and diel pattern of adult activity.

**Activity Milestones:**

| Description | Approximate Completion Date |
|---|---|
| Identify populations for conducting field survey | October 31, 2026 |
| Acoustic monitoring of adult mating activity | October 31, 2028 |
| Transect survey of cricket site choice behavior | October 31, 2029 |
| Data analysis | March 31, 2030 |

| | |
|---|---|
| Report and publication preparation, data share and dissemination | June 30, 2030 |

## Activity 3: Effect of winter temperature variation on reproduction

**Activity Budget:** $159,000

**Activity Description:**
I will conduct lab experiments to examine the effect of the mean and variation of winter temperature during egg diapause on adult mating behaviors. To investigate the effect of temperature variation, I will divide eggs of full sibs between constant and variable winter temperature treatments, simulated by placing the developing eggs in refrigerators. To examine the effect of mean temperature, I will divide eggs of full sibs between high and low winter temperature. I will compare egg development and onset of reproductive behaviors between the treatments. In addition, male song, used for mate attraction, and female choice for male song will be examined and the degree to which male song and female preference coordinate will be evaluated. A mismatch would indicate an adverse effect on reproduction as the chance for adult to meet physically to initiate mating is reduced.

**Activity Milestones:**

| Description | Approximate Completion Date |
|---|---|
| Mate parental generation to generate eggs for experiment | November 30, 2027 |
| Temperature treatment for eggs | February 28, 2029 |
| Egg development and adult behavioral assay | June 30, 2029 |
| Potential repeating of the experiment | March 31, 2030 |
| Report and publication preparation | June 30, 2030 |

## 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?**

I will share data, conclusions and insights with the municipalities, Minnesota Department of Natural Resources, The Nature Conservancy, park districts, and MSP-Long Term Ecological Research Program. Findings will also be disseminated through peer-reviewed publications, regional, national and international conference presentations, outreach programs at the Bell Museum and Cedar Creek Lunch with a scientist, as well as to the general public in online data repository.

## Other ENRTF Appropriations Awarded in the Last Six Years

| Name | Appropriation | Amount Awarded |
|---|---|---|
| Sublethal Effects of Pesticides on the Invertebrate Community | M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 03p | $387,000 |

## 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.**

- She has over ten years of experience working on cricket mating behaviors. Cricket mating behaviors, like mating behavior of many other insects and anurans (frogs and toads), are highly susceptible to temperature fluctuation, she has obtained extensive experience in maintaining a constant temperature, measuring temperature in field microhabitats and understanding how adult behavior can be influenced by temperature. As opposed to viewing temperature fluctuation as noise in the experiment, this project specifically explores how temperature variation affects mating and reproduction of insects. The past knowledge and experience will be invaluable for all activities proposed herein.
- The Xu lab has been conducting research on behaviors of local cricket species for 2 years and have successfully established lab colonies that can be used for lab experiments. In addition, she has cumulated knowledge about distribution and microhabitat affinity of the local cricket species, essential for the success of this project.
- 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 extensive experience leading research teams and managing projects since her Ph.D. She has led research teams to conduct field experiments in Panama, the Upper peninsula of Michigan, and Minnesota. She currently manages a large lab group consisting of undergraduate students, graduate students, postdocs and lab technicians.

**Organization:** U of MN - College of Biological Sciences

**Organization Description:**

Department of Ecology, Evolution and Behavior at College of Biological Sciences is a department that leads cutting edge basic and applied research in the area of ecology, evolutionary biology and animal behavior.

## Budget Summary

| Category / Name | Subcategory or Type | Description | Purpose | Gen. Ineligible | % Benefits | # FTE | Classified Staff? | $ Amount |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | | | | | | | | |
| project manager | | Design and troubleshoot the project, obtain sampling location and permits, oversee all project activities, dissemination of findings | | | 26.8% | 0.24 | | $45,000 |
| Postdoc associate | | conduct and trouble shoot the project, data analysis, manuscript preparation, dissemination of data | | | 20.6% | 3 | | $255,000 |
| Graduate student | | participate in fieldwork and field experiments | | | 44.4% | 0.5 | | $62,000 |
| Undergraduate assistant | | Assist in fieldwork, lab work and cricket care | | | 0% | 1.89 | | $65,000 |
| | | | | | | | **Sub Total** | **$427,000** |
| **Contracts and Services** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Equipment, Tools, and Supplies** | | | | | | | | |
| | Tools and Supplies | Supplies for rearing crickets for 3 years, temperature and humidity loggers (20), audio recorder (2) and microphone (1) for field monitoring of cricket activity, thermo-imagine camera (1), and external hard drive (2) | These supplies are for field monitoring of temperature and cricket activity and lab rearing of crickets for the experiments | | | | | $14,000 |
| | | | | | | | **Sub Total** | **$14,000** |
| **Capital Expenditures** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Acquisitions and Stewardship** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Travel In Minnesota** | | | | | | | | |
| | Miles/ Meals/ Lodging | This is budgeted for gas and milage for 2 persons, 10 trips per year for three years | To set up and maintain loggers and conduct field survey and experiments | | | | | $3,300 |
| | Conference Registration Miles/ Meals/ Lodging | This is for supporting three persons to attend conferences | To disseminate findings from the project | | | | | $1,700 |
| | | | | | | | **Sub Total** | **$5,000** |
| **Travel Outside Minnesota** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Printing and Publication** | | | | | | | | |
| | Publication | This is to cover the open source and publication fee for two publications | To disseminate findings from the project | | | | | $4,000 |
| | | | | | | | **Sub Total** | **$4,000** |
| **Other Expenses** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| | | | | | | | **Grand Total** | **$450,000** |

## 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 | University of Minnesota | Overhead costs associated with this proposa | Potential | $232,000 |
| | | | **State Sub Total** | **$232,000** |
| **Non-State** | | | | |
| | | | **Non State Sub Total** | **-** |
| | | | **Funds Total** | **$232,000** |

**Total Project Cost: $682,000**

**This amount accurately reflects total project cost?**

Yes

## Attachments

### Required Attachments

*Visual Component*

File: 3d252113-a13.pdf

*Alternate Text for Visual Component*

Figure 1 describes the schematic design for surveying temperature and cricket activity across different microhabitats in the proposed project and Figure 2 described the experimental design to understand the effect of winter temperature on development and adult mating behavior....

### Supplemental Attachments

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

| Title | File |
|---|---|
| Approval letter | 9b42551c-8e4.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:**

N/A

**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