Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-337

Proposal Title: Bee Minnesota II: Protect our Native Bees

Project Manager Information

Name: Declan Schroeder

Organization: U of MN - College of Veterinary Medicine

Office Telephone: (612) 626-1916

Email: dcschroe@umn.edu

Project Basic Information

Project Summary: Our goal is to protect two keystone Minnesotan native bees, Bumblebees and Sweat bees from Iflavirus associated diseases and population declines.

ENRTF Funds Requested: $865,000

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

Narrative

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

There are thousands of insect pollinator species in Minnesota, including over 500 species of native bees. Bees are the most efficient pollinators because their bodies are designed to collect and store pollen to feed to their young. Pollinators are integral parts of functioning environments. The plants they pollinate provide food and habitat for animals, buffer waterways, and store carbon. Without pollinators, we would not have many nutritious fruits and vegetables. Pollinator conservation provides economic benefits through improved crop pollination, and intrinsic value in beautiful, flowering landscapes. Numerous pollinators are in decline with disease being a major leading cause. Through our initial surveillance efforts (ENRTF 2021-309: Bee Minnesota – Protect our Native Bumblebees, and ENTRF 2024-198: Early Detection of Invasive Viruses in Native Pollinators) we were the first to uncover two new iflaviruses not previously known to infect bumblebees, mainly Bombus impatiens, and the Sweat bee, Agapostemon virescens. We know that iflaviruses kill honey bees, yet their prevalence and impact on bumblebee and sweat bee health is not fully understood. Here we wish focus our efforts on the two keystone Minnesota native bees to describe the viral infection, to eventually mitigate their impact on our bees and thus pollination services.

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.

We propose to collect prevalence data of iflavirus infection status in Minnesota Agapostemon (sweat bees) and Bombus (bumblebee) populations, conduct a threat analysis, identify the cellular site of infection and create a lab-based infection model to further study the iflavirus infection dynamic in bumblebees. Our first objective is to setup an iflavirus surveillance monitoring program in five independent locations across Minnesota for both bee groups. These were selected because 1) we have a good understanding of their habitat and distribution in Minnesota and 2) we know the first location where the iflaviruses were discovered. Our second and third objectives are to use single-cell 10X genomics coupled with the Oxford Nanopore Technologies metagenome sequencing and the Xenium platform to describe the cellular and spatial quasi-species iflavirus infection dynamic in infected bees. This will allow us to understand the evolution, site of infection and threat of virus spillover to other bees in Minnesota. Finally, we will establish a lab-based bumblebee Iflavirus infection model system to fully characterize the disease threat that ilflaviruses pose on the health and longevity of our two keystone Minnesota native bee families, Halictidae and Apidae.

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 complements previous and ongoing research funded by ENRTF by fully characterizing an emerging ifllavirus native bee pathogen in Minnesota pollinators. By understanding the prevalence and threat of the virus to two keystone bee species, this project will create new insights into the life cycle and disease progression in Minnesota's native bee pollinator communities. Data from common species can help us to protect vulnerable pollinator species, such as the yellow-banded bumblebee. Our lab-based bumblebee model system will provide unique opportunities to test future mitigation solutions to better protect Minnesota's native bee populations from emerging iflavirus infections and related diseases

Activities and Milestones

Activity 1: Sampling and cataloging of Agapostemon (Sweat bees) and Bombus (bumblebees) species collected across Minnesota

Activity Budget: $311,100

Activity Description:
Dr Cariveau will lead and draw on his firsthand knowledge gained through previous USDA and US Fish and Wildlife Service funded projects, to collect Sweat and Bumblebees across Minnesota from five locations. This will be achieved by mentoring and supervising a graduate student and field technician who will collect live bees over a two year period. These five locations were selected because 1) we have a good understanding of their habitat and distribution in Minnesota and 2) we know the first location where the iflaviruses were discovered in both Agapostemon virescens and Bombus impatiens in Minnesota. Bees will be curated, speciated under the supervision of Dr Portman and transferred to the correct containers before delivering them to the Schroeder Virology Lab, where a dedicated postdoctoral Research Associate will screen for the iflavirus infection status using RT-qPCR.

Activity Milestones:

Description	Approximate Completion Date
Collection of Sweat bees and Bumblebees over 2 summers	June 30, 2029
Curation and taxonomic identification of native bees collected	July 31, 2029
Synthesize an agency report of samples collected	October 31, 2029

Activity 2: Screening for iflaviruses in Sweat bees and Bumblebees by applying RT-qPCR and single-cell 10X Genomic plus ONT sequencing technologies

Activity Budget: $243,230

Activity Description:
Screening using high through-put DNA/RNA extraction systems on individual bees per location (Activity 1) for iflavirus infection status will be achieved using commercially available Viral DNA/RNA Isolation Kits plus Schroeder Lab designed iflavirus specific probes. We will then apply a custom designed 10x Genomics single-cell ONT-sequencing pipeline. Briefly, four iflavirus positively confirmed bees and one uninfected bee from each family will be sectioned into heads, abdomen and thorax. Tissues will be disrupted in a dissociator and clarified to produce a single-cell suspension. A total of 30 samples will be submitted for a detailed single-cell view of the cellular iflavirus infection state for both Sweat bees and Bumblebees to uncover cell specific infection status and any host genetic processes deployed to respond to the infection. The 10x Genomic workflow will be a modification on a previous study carried out on honey bees. We will aim for 10x more cells by collecting ~10,000 cells per sample for sequencing and using the ONT long-read platform. Outputs include the identify of genes that are differentially expressed by comparing the number of transcripts expressing each host gene from infected and uninfected cells in each cell type. Iflavirus cellular target will be identified.

Activity Milestones:

Description	Approximate Completion Date
Positive identification of infection status and prevalence of infection.	September 30, 2029
10x Genomics library creation and ONT sequencing database.	January 31, 2030
Bioinformatic assessment of infection for both bee species	June 30, 2030
Submit draft manuscript to free and open access online preprint server such as bioRxiv	June 30, 2030

Activity 3: Spacial in situ localization of ilflavirus infection in both Sweat bees and Bumblebees

Activity Budget: $198,830

Activity Description:

Spatial genomics is a revolutionary tool that will allow the Schroeder Lab to examine the expression of specific bee genes as it relates to iflavirus infection at the tissue and single-cell levels. This has significant added advantages over just doing 10X Genomics single-celled analysis which homogenize diverse cell and tissue types, forcing us to draw conclusions based on averaged expression levels. Spatial transcriptomics platforms unlock the details of healthy and diseased tissues, offering insights into cell-cell interactions, the resident cell types of diverse tissues, and complex interactions in different tissues found in bees. An output will the the special images visualizing the infection dynamic of iflaviruses on bee health.

Activity Milestones:

Description	Approximate Completion Date
Complete the custom 480 probes for bee and virus genes	February 28, 2030
Producing the initial images of virus infection	May 31, 2030
Final synthesis of result for manuscript submission and final report	June 30, 2030

Activity 4: Bumblebee infection model to study iflavirus mitigation strategies

Activity Budget: $111,840

Activity Description:

Dr Evans will establish pathogen-free Bombus impatiens colonies (reared from wild-caught queens) in our University of Minnesota BSL-2 containment facility. Bee colony and brood models are essential for standardized, controlled studies of bee diseases, allowing us to evaluate the impacts of pathogens such as this new emerging Iflavirus on larvae and emerging bees. These models facilitate testing in controlled environments, providing accurate data on disease dynamics, developmental issues, and, monitor how the infection affects their overall health and reproduction. Virus will sticks will either be sourced for diseased bees as uncovered in Activity 1 or synthesized (IDT) from the 10x Genomic ONT sequencing assemblies. Challenge studies under these controlled and contained conditions will eliminate risk of virus escaping and negatively impacting virus-free bee populations on Minnesota.

Activity Milestones:

Description	Approximate Completion Date
Collect bumblebee starter colony from virus negative field sites	July 31, 2029
Establish bumblebee colony in BSL-2 growth chambers	August 31, 2029
Harvest pupae for iflavirus infection experiment to describe disease in brood.	June 30, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Daniel Cariveau	University of Minnesota	Co-I, responsible for native bee collection and for co-mentoring the graduate student	Yes
Elaine Evans	University of Minnesota	CoI, responsible for maintaining bumblebee species in the lab	Yes
Zach Portman	University of Minnesota	Co-I, responsible of native bee identification from field samples	Yes

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.
CVM and the Bee Lab manage several active social media channels as well as a website and an electronic newsletter. In addition to using these communication tools to disseminate project data, D. Schroeder, E. Evans and D. Cariveau frequently present to public, wildlife, conservation and pollinator communities throughout Minnesota and the US. We will also disseminate information using well developed communication channels within the Minnesota Extension system. Where appropriate, communications will acknowledge ENRTF as per ENTRF Acknowledgment guidelines.

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 data generated in this project will create new data on iflavirus associated diseases and prevalence in two keystone native bee pollinator communities in Minnesota. The College of Veterinary Medicine, University of Minnesota, has an active Extension and Outreach program that who will continue to disseminate results after project completion. Drs. Schroeder, Evans and Cariveau will publish research findings and present to communities in Minnesota. Funds from this project will build on federal resources being used to pursue these goals, greatly expanding the scope of our efforts.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Bee Minnesota – Protect Our Native Bumblebees	M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 03h	$650,000
Emerging Issues: Highly Pathogenic Avian Influenza Virus in Wildlife (23)	M.L. 2023, , Chp. 60, Art. 2, Sec. 2, Subd. 10b-2	$382,000
Early Detection of Invasive Viruses in Native Pollinators	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 06d	$200,000
Emerging Issues: Highly Pathogenic Avian Influenza Virus in Wildlife (24)	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 10b-1	$885,000

Project Manager and Organization Qualifications

Project Manager Name: Declan Schroeder

Job Title: Professor

Provide description of the project manager's qualifications to manage the proposed project.
Dr Schroeder was first appointed in February 2018 as an Associate Professor of Virology and then promoted with tenure to Full Professor in May 2024 in the Veterinary Population Medicine Department in the College of Veterinary Medicine at the University of Minnesota. He previously held a position of Chair in Viral Metagenomics (2017-2022) in the School of Biological Sciences at the University of Reading, UK. Before that, he held the position of Senior Research Fellow in Viral and Molecular Ecology (2001-2018) at the Marine Biological Association of the UK. He is proud of his accomplishments as a PI, which is based on his high impact contributions to One Health and the opportunity to make a difference in helping our global food system become more sustainable. His team's overarching research objectives are to develop molecular-based research approaches and tools, rooted in both the Life Sciences and Veterinary Medicine, to provide a mechanistic understanding as how to best intervene or mitigate the negative impact that viruses may have on wild-life and key food animal species. He collaborates with other researchers (regionally, nationally and internationally), and produced several high impact peer-reviewed publications (Nature & Science papers). To date, he has published over 130 peer-reviewed publications and 14 book chapters. He is currently ranked in the top 1% of Loop Frontier authors, and in the top 12% of scientists (out of 4,922) in the UMN based on his publication record (AD Scientific Index 2025). He is driven to conduct meaningful, high impact research that contributes toward solving complex problems associated with viruses in MN pollinators. Honeybees and Native bees are essential pollinators and food producers in MN but more than 40% of them die on an annual basis. In 2025, this number increased to an alarming 60%. He has successfully completed two LCCMR projects.

Organization: U of MN - College of Veterinary Medicine

Organization Description:
"The University of Minnesota (UMN) is the state's land-grant university and one of the most prestigious public research universities in the nation. It was founded in the belief that all people are enriched by understanding; is dedicated to the advancement of learning and the search for truth; to the sharing of this knowledge through education for a diverse community; and to the application of this knowledge to benefit the people of the state, the nation, and the world." University of Minnesota mission statement.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Project Manager		Dr Schroeder will project manage and to oversee and implement the molecular screening protocol previously developed in his lab. In addition, he will be directly responsible for all communication for the team			36.8%	1.8		$151,780
Dr Cariveau		Responsible for co-ordinating sample collection, co-mentor graduate student and research technician, and assist in data analysis, communication and writing publications			36.6%	0.3		$40,420
Dr Evans		Responsible for establishing the bumblebee lab-based model			36.6%	0.16		$22,010
Dr Portman		Responsible for bee curation and speciation during sample collection			32.3%	0.1		$9,250
TBN Research Field Technician		To support Dr Cariveau and the Graduate Student in sample collection in years 1 and 2. In year 3, to assist Dr Evans in bumblebee rearing.			32.3%	0.54		$31,960
TBD Postdoctoral Research Associate		To perform the 10XGeniomics, ONT sequencing & 10X Spacial infection analysis. Too synthesize all the data and to write the final publication.			26.1%	2		$227,400
TBN Graduate Student		Responsible for study design, sample collection and bee speciation. Project write-up, project communication/extension and contribute to publication			24.2%	1		$134,590
							Sub Total	**$617,410**
Contracts and Services								
Contribution to the annual maintenance contract (for 2 years) on the ONT	Service Contract	Servicing and maintenance of GridION sequencing machine				0		$24,000

GridION sequencer								
10XGenomics Chromium	Service Contract	Used to create single-cell samples of 10,000 cells per sample.				-		$24,000
10xGenomics Xenium	Internal services or fees (uncommon)	Usage charge for centralized equipment to visualize infection on 4 slides				-		$40,000
BSL-2 containment facility	Internal services or fees (uncommon)	Use of BSL-2 bio-containment facility to establish bumblebee model colony for infection study				-		$3,200
							Sub Total	**$91,200**
Equipment, Tools, and Supplies								
	Tools and Supplies	Supplies to setup and collection of field samples	For the purchasing of nets, collection tubes and preservation material.					$14,700
	Tools and Supplies	Virus screening molecular consumables (Virus extraction, Nucleic acid extraction, molecular grade chemicals, RT-qPCR etc.) for bee samples	Surveying the iflavirus pathogen in Sweat bees and Bumblebees					$27,000
	Tools and Supplies	Molecular plastics for bee curation and speciation	Handling of samples to prevent bee damage and cross contamination					$4,000
	Tools and Supplies	10x Genomics single-cells sequencing chemistry	For creating the 10,000 single-cell suspensions and libraries for sequencing					$29,000
	Tools and Supplies	ONT sequencing PromethION sequencing flow cells and chemistry	Used to sequence the 10XGenomics library on the PromethION/GridION cluster in the Schroeder Lab. This will create the genomic datasets for the 30 samples of the 10 bees.					$22,800
	Tools and Supplies	10X genomics, Xenium 480 bee & iflavirus markers	Markers are used to map the infection in whole bee samples to create an in situ visual overview of the infection in bees.					$33,000
	Tools and Supplies	Iflavirus isolation/synthesis & RT-qPCR	Create the virus inoculum for the bumblebee colony infection model.					$4,860
	Tools and Supplies	Equipment required to establish Bumblebee colony in BSL-2 containment	Establish a Bumblebee colony model system					$3,000
							Sub Total	**$138,360**

Capital Equipment								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Conference Registration Miles/ Meals/ Lodging	Travel expenses to 3 events per year, for 3 people to MN conservation meetings and workshops	Give presentations and communicate results to stakeholders					$7,310
	Other	Sample collection for Sweat bee and Bumblebees across Minnesota for 2 summers	Travel to five sites (6 times per year), which includes vehicle rental or mileage, and gas use.					$4,920
	Miles/ Meals/ Lodging	Field trip to collect queen bees	Queens used to establish bumblebee colonies in BSL-2 facility					$800
							Sub Total	**$13,030**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Scientific publication in open access journal	Outreach and publication of results					$5,000
							Sub Total	**$5,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$865,000**

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				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $865,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 80816ac1-70f.pdf

Alternate Text for Visual Component

A newly constructed family tree based on the two new iflaviruses discovered in the ENTRF projects 2020-003 & 2024-198 showing their relatedness and close proximity to the deadly deformed wing virus family known to kill honey bee colonies. This raises key questions regarding their prevalence and impact on native Minnesota bees....

Supplemental Attachments

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

Title	File
Regents of Minnesota Letter	6857d164-db7.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?

Yes

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

Yes

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

No

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

No

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:

Brett Carlson and Jenavieve Olson, University of Minnesota

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

Yes, I understand