Environment and Natural Resources Trust Fund

M.L. 2020 Approved Work Plan

General Information

ID Number: 2020-003

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: August 19, 2021

Project Title: Bee Minnesota – Protect Our Native Bumblebees

Project Budget: $650,000

Project Manager Information

Name: Declan Schroeder

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Project Reporting

Date Work Plan Approved by LCCMR: August 20, 2021

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: June 30, 2024

Final Report Due Date: August 14, 2024

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 03h

Appropriation Language: $650,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to protect native bee health by investigating the potential to mitigate against pathogens that may be transmissible between honeybees and wild bees and by promoting best practices to beekeepers and the public. This appropriation is subject to Minnesota Statutes, section 116P.10.

Appropriation End Date: June 30, 2024

Narrative

Project Summary: Our goal is to protect native pollinators by screening and neutralizing bee pathogens, and promoting best honey bee management practices to prevent pathogen spillover into native bees.

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

Native bumblebees, Bombus spp., are important pollinators of wild flowering plants and crops such as tomatoes and berries, and are appreciated for their beauty. Unfortunately, five of Minnesota's twenty-three species of native bumblebees are considered vulnerable, endangered, or critically endangered by the International Union for Conservation of Nature. The global decline in bee populations has been attributed to habitat loss, pesticides, parasites, and pathogens. For some bumblebee species, a leading problem may be infectious diseases. For example, the spread of the bumblebee pathogen, Nosema bombi, exacerbated through commercial rearing and distribution of Bombus impatiens across the U.S., was associated with declining bumblebee species. Another emerging threat is viral pathogen transmission among pollinator species as they forage on common flowers. For example, there is evidence that Deformed wing virus (DWV), may be transmitted from honey bees to bumblebees if diseased honey bees deposit viruses on flower parts (spillover) and other bees subsequently pick them up when visiting the same flowers. Very little is known about pathogen prevalence in bumblebees in Minnesota.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

The prevalence of DWV and Nosema ceranae and Nosema bombi in bumblebees in Minnesota has not been previously examined. While it is suspected that honey bees may play a role in increasing the prevalence of pathogens in bumblebees, we currently have no information on existing pathogen level in Minnesota bumblebees. Minnesota is an important place to examine the relationship between honey bee and bumblebee pathogen levels because as a top honey producing state, there are areas of Minnesota with high densities of honey bee colonies and Minnesota is one of the last states still housing the endangered rusty-patched bumblebee. To first understand and then mitigate further declines in these important pollinators, it is critical to collect baseline data on archetypal pathogens in our local populations of honey bees and bumblebees. Finding a solution or even a cure to bee pathogens is a high priority for our assembled team; therefore, we propose to run an innovative pilot study in an attempt to neutralize DWV. Finally, we will protect our native pollinators by educating beekeepers about the critical "public health" need to keep managed bees as healthy as possible.

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?

Minnesota's bee diversity boasts over 450 species and includes both native and non-native, managed and wild species. While we recognize the important role of managed bees in Minnesota, it is critical to provide outreach regarding the importance of our native bee pollinators and how unmindful honey bee management might negatively impact native bee health. We propose an educational campaign that increases understanding of the roles of native and managed bees in Minnesota. Additionally, we will engage backyard beekeepers in the cities of Minneapolis and Rochester to participate as beekeeper citizen scientists via local pathogen and pest sampling campaigns.

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: Screen for Deformed Wing Virus and Nosema in bumblebees and quantify potential for virus transmission between honey bees and bumblebees.

Activity Budget: $475,000

Activity Description:
There is potential for pathogens to be transmitted from honey bees to bumblebees while foraging on flowers, but the extent of this transmission in nature has not been explored. In three locations where we manage honey bee colonies (8 colonies per location: Minneapolis, the MSP airport, and in Rochester), we will use a new sequencing assay, first developed in the Schroeder Lab, to quantify the prevalence and abundance of DWV and Nosema in three species of bumblebees collected while foraging. We also will monitor pathogen load in honey bees foraging on the same species of flowers during early, mid, and late summer and throughout the year in our managed honey bee colonies. Furthermore, we will also set out pathogen-free Bombus impatiens colonies (reared from wild-caught queens) in the same locations to monitor possible infection over the season, and how the infection affects their health and reproduction.

Activity Milestones:

Description	Completion Date
Screen for DWV and Nosema in three common bumblebee species and surrounding honey bee colonies	October 31, 2023
Monitor potential for virus transmission into B. impatiens colonies and quantify effects on bumblebee health	December 31, 2023

Activity 2: Explore potential to neutralize DWV in bees.

Activity Budget: $88,500

Activity Description:
Currently, there are no specific treatments for DWV infections in bees. The Schroeder Lab has previously reported on a phenomenon known as Superinfection Exclusion in which infection by one virus variant infers protection against other more virulent variants. Application of this phenomenon in honey bees is controversial and is still the subject of much debate. Another yet not commonly explored option to inhibit virus propagation in bees is the application of a foreign antibody. Here we will run laboratory-based cage and cell culture assays to determine if DWV can be neutralized in honey bees and bumblebees. It was recently reported that an effective treatment for a related virus of DWV, namely Sacbrood virus, was discovered. This treatment is based on a specific antibody raised from egg yolk against the virus which was used to immunize honey bee pupae. This work will be repeated here to determine whether DWV can be neutralized in both honey bees and bumblebees. Antibody synthesis, formulation, and production will be carried out in collaboration with Dr Ben Hause (vaccine production specialist).

Activity Milestones:

Description	Completion Date
Preparation, synthesis, formulation, and testing of DWV specific antibodies in bee tissues	July 31, 2022
Application of DWV antibodies in caged honey bees and bumblebees	May 31, 2023

Activity 3: Beekeeper and community “public health” education about native and non-native bees in Minnesota.

Activity Budget: $86,500

Activity Description:

Minnesota's bee diversity boasts over 450 species and includes both native and non-native, managed and wild species. While we recognize the important role of managed honey bees in Minnesota, it is critical to provide outreach regarding the value of our native bee pollinators and how unmindful bee management might negatively impact native bee health. We propose an educational campaign (Bee Minnesota) that increases understanding of the roles of native and managed bees in Minnesota. Additionally, we will engage backyard beekeepers in the cities of Minneapolis and Rochester to participate as beekeeper citizen scientists via pathogen and pest sampling in their honey bee colonies. Everyone will be kept updated as to progress made throughout the project by means of a well-managed and curated website.

Activity Milestones:

Description	Completion Date
Provide education via a bee public health campaign to promote practices to protect native bees	April 30, 2024
Establish and disseminate updated beekeeping best management practices to protect wild, native bees in Minnesota	June 30, 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr Ben Hause	Tallgrass Biologics	Tallgrass Biologics created antibodies in eggs against DWV and has preliminary evidence supporting its specificity for DWV and therefore its potential application as an oral immunoglobulin's therapy against DWV (Patent filed). Here we will conduct controlled lab-based studies to determine the effectiveness of the antibodies against DWV	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.
The Bee Lab and Bee Squad 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, M. Spivak, E. Evans, R. Masterman and several Bee Squad team members frequently present to both the public and beekeepers throughout Minnesota. Both E. Evans and R. Masterman are Extension Educators within Minnesota Extension. They will 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 be funded?
The data generated through Bee Minnesota will create a new body of work that could predict how pathogens spillover into native pollinator communities. The Bee Lab at the University of Minnesota has an active Extension and Outreach program run by Dr. Elaine Evans (native bees, especially bumblebees) who will continue to disseminate results after project completion. Drs. Schroeder and Spivak will publish research findings and present to scientific communities. Funds from this project will build on federal resources being used to pursue these goals, greatly expanding the scope of our efforts

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 between the team and the Minnesotan company Tallgrass Biologics to effectively deliver on Activity 2 of the proposal.			36.5%	0.36		$69,192
Co-investigator		Dr Spivak will advise on the experimental design for surveying and collecting honey bees and bumblebees (Activities 1 and 3) and will assist with data analysis and publication, and with all dissemination of results and outreach.			36.5%	0.03		$4,046
Co-investigator		Dr Evans is an UMN Extension Educator and Bee Researcher working on pollinator education and research relating to bee conservation. She will be responsible for bumble bee surveys and rearing to support Activity 1 due to her expertise in native bees, particularly bumble bees. In addition, she will be responsible for developing and delivering content to increase awareness and protection of native pollinators in Activity 3.			36.5%	0.6		$52,754
Co-investigator		Dr Masterman the Bee Squad for the University of Minnesota Bee Lab and is also a Minnesota Extension Educator. She will lead the Bee Squad in collecting the honey bee samples for analysis in Activity 1 as well as coordinating the beekeeper citizen science sampling effort in Activity 3. Additionally, Masterman will collaborate with Dr. Evans on the educational campaign and will lead the dissemination of information to beekeepers in Minnesota in Activity 3.			36.5%	0.6		$56,501
Molecular postdoc		Responsible for running the sequencing assays for DWV & Nosema. And carrying out the antibody neutralization experiments.			25.4%	3		$189,563

Molecular tech		To support and assist the postdoc in running the molecular assays during the heavy data generation periods in Activity 1 & 3.			31.8%	1		$45,260
Bee squad research tech 1		Responsible for co-ordinating the Bee Squad tech team, setting up the field experiments, managing the honey colonies and collecting the managed and wild bees. Also involved in communication to beekeepers and providing resources to community			31.8%	0.3		$24,686
Bee squad research tech 2		As as of team assist in setting up the field experiments, managing the honey colonies and collecting the managed and wild bees. Also involved in communication to beekeepers and providing resources to community			31.8%	0.24		$10,975
Bee squad research tech 3		As part of a team assist in setting up the field experiments, managing the honey colonies and collecting the managed and wild bees. Also involved in communication to beekeepers and providing resources to community			31.8%	0.24		$11,496
Bee squad research tech 4		As part of a team assist in setting up the field experiments, managing the honey colonies and collecting the managed and wild bees. Also involved in communication to beekeepers and providing resources to community			31.8%	0.24		$13,877
Bumblebee lab tech		To assist Dr Evans in setting up bumblebee lab and field experiments			31.8%	0.03		$1,381
							Sub Total	**$479,731**
Contracts and Services								
Tallgrass Biologics	Professional or Technical Service Contract	Tallgrass Biologics have a patented therapeutic method to use antibodies to DWV from chickens. Egg samples will be collected from egg laying hens at the time of first vaccination. Final antibody purification, formulation and production will be carried out by Tallgrass Biologics for use in this study.		X		0.5		$10,000
Design of new website pages	Professional or Technical Service Contract	A professional, accurate and informative website will have have the greatest reach for disseminating the outcomes of our research.				0.1		$2,500

							Sub Total	**$12,500**
Equipment, Tools, and Supplies								
	Tools and Supplies	Supplies to setup and collection of field data	For the purchasing bee packages, nets, containers, hive equipment, tools, tubes, preservation material etc.					$8,800
	Tools and Supplies	Pathogen screening molecular consumables (Nucleic acid extraction, molecular grade chemicals, RT-PCR, NGS sequencing etc.) for 2,250 bee samples	Surveying the pathogens in bee material collected.					$106,614
	Tools and Supplies	Bee packages, cages, molecular grade chemistry & plastics - 300 assays	Neutralization assays for the removal of DWV					$35,300
							Sub Total	**$150,714**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Setting up and maintenance of sentinel colonies, release and collecting of bees in the field.	Throughout the 3 years, travel to and from three field sites (Minneapolis, the MSP airport, and in Rochester). Surveying floral diversity and bumblebees colony health. Carry out community surveys and outreach activities. To reduce costs, many activities will be co-ordinated.					$3,680
							Sub Total	**$3,680**
Travel Outside Minnesota								
							Sub Total	**-**

Printing and Publication								
	Printing	Leaflets	An universal and accessible communication tool especially for those communities that do not have easy access to computers and the internet.					$375
	Publication	Peer reviewed scientific journal papers	We aim to publish our findings in open access journals. These journals charge publication fees.					$3,000
							Sub Total	**$3,375**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$650,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Contracts and Services - Tallgrass Biologics	Professional or Technical Service Contract	Tallgrass Biologics have a patented therapeutic method to use antibodies to DWV from chickens. Egg samples will be collected from egg laying hens at the time of first vaccination. Final antibody purification, formulation and production will be carried out by Tallgrass Biologics for use in this study.	Tallgrass Biologics is developing a novel therapeutic method and will all record specific expenses as it relates to this project (detailed in subcontract with the university). If generally ineligible expenses are to be made, this will first be cleared through the University of Minnesota finance office and the them confirmed with LCCMR before purchasing. **This is a single source contract.**

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: 7d2b3e04-99a.pdf

Alternate Text for Visual Component

Overview of the project...

Optional Attachments

Support Letter or Other

Title	File
LCCMR Background Check Certification	7cde7d5d-4a8.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Over the past year we automated our molecular virus screening workflow which means that we can reduce our molecular consumable budget for this project.

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, 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

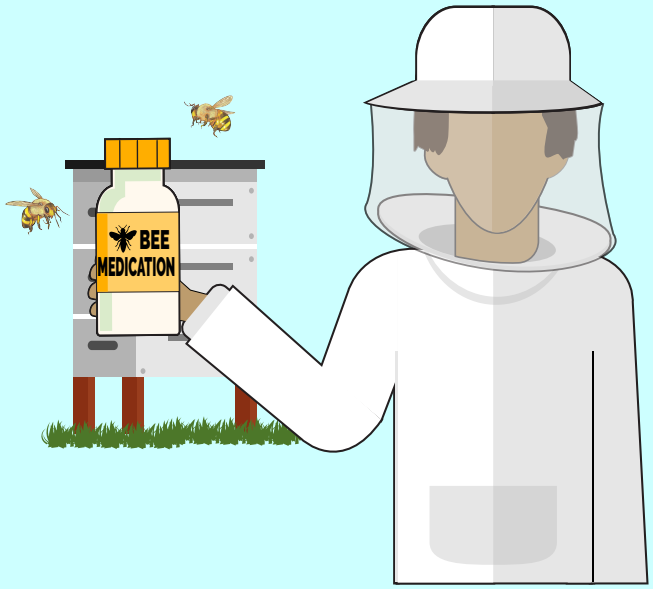
BEE MINNESOTA
Protect our Native Bumblebees

I. Screening honey bees and bumblebees for pathogens

1. Pathogens from honey bees onto flowers
2. Bumble bees visit same flowers
3. Pathogen spillover

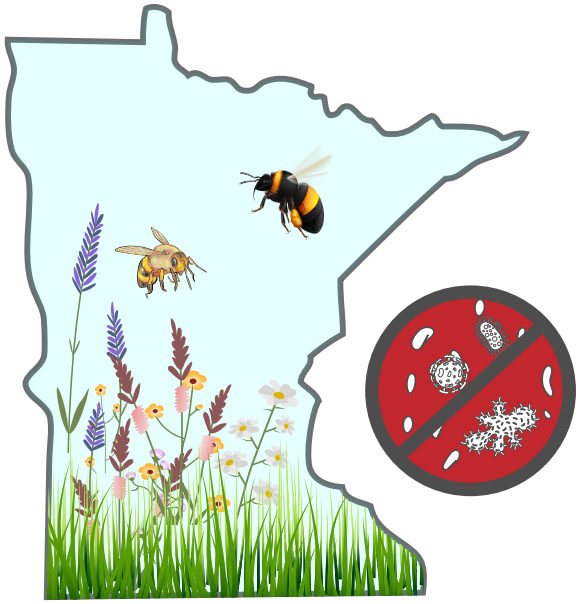
Pathogens pose a serious risk to declining bumblebees, such as the Rusty Patched Bumblebee.

II. Disease Prevention



Vaccination of bees against pathogens

III. Public Bee Health



Sharing information to increase health of honey bees and native bees