Environment and Natural Resources Trust Fund

M.L. 2022 Approved Work Plan

General Information

ID Number: 2022-185

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: June 14, 2022

Project Title: Protecting Minnesota's Spruce-Fir Forests from Tree-Killing Budworm

Project Budget: $189,000

Project Manager Information

Name: Brian Aukema

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Reporting

Date Work Plan Approved by LCCMR: June 27, 2022

Reporting Schedule: March 1 / September 1 of each year.

Project Completion: June 30, 2025

Final Report Due Date: August 14, 2025

Legal Information

Legal Citation: M.L. 2022, Chp. 94, Art. , Sec. 2, Subd. 03i

Appropriation Language: $189,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to evaluate conditions contributing to Minnesota's uniquely high population of the native and lethal spruce budworm to provide better management options for protecting the state's spruce-balsam fir forests.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: Spruce budworm is native to Minnesota and the most significant tree killer in spruce-balsam fir forests. This project studies why populations increase to improve management opportunities in affected forests/regions.

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

Spruce budworm is the most significant tree killer in spruce and balsam fir forests in North America. It is a native moth, and thus ineligible for project consideration by the Minnesota Invasive Terrestrial Plant and Pests Center. Caterpillars devour buds and needles on balsam firs and white spruce. Sustained feeding causes extensive tree mortality, especially to balsam firs. Budworm hotspots affect forest structure, wildlife, fire risk, and timber production.

Aerial surveys of northeastern Minnesota have noted budworm activity for 68 consecutive years. Budworm is always present. In contrast, other forests in eastern North America document regular outbreaks every 35 years with peaks lasting 5-6 years. Records of budworm outbreaks in eastern North America date back to the 1700s.

We do not know why budworms are so active and prominent in northern Minnesota, or how spruce budworm impacts cascade through spruce-fir forests. There are multiple possible factors: warm weather, dispersal of mating adults, forest structure and tree condition, and more. Insights from forests in eastern North America suggest that changes in the natural enemy (i.e., biological control) complex and greater ability to find mates as populations increase are likely responsible at least in part for increasing budworm numbers.

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 understand why Minnesota's populations are so high, we seek funding to:

1. Survey beneficial natural enemies in budworm populations within the state. It is hypothesized that buildup of generalist natural enemies in outbreaking populations, in concert with a decline in foliage abundance and quality, contribute to outbreak collapse. Surprisingly, the natural biological control agents in spruce budworm-affected forests have never been studied in Minnesota.

2. Characterize mating success of female budworms within mainland Minnesota sites undergoing population phase transitions. Mate-finding failure may contribute to "Allee effects" and slow population phase transitions from endemic to epidemic levels. Although spruce budworm can disperse great distances, it is thought that localized mixing from dispersal from surrounding forests enhances mating success and encourages population phase transitions to outbreak levels.

3. LEVERAGED FUNDING OPPORTUNITY (FYI; NO FUNDS REQUESTED). We will integrate this work with a new federal National Park Service / US Forest Service project on Isle Royale (with introduced Minnesota wolves!)

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 current state of knowledge is how many trees will be killed when budworm populations are high, but not root causes of why populations fluctuate. Determining the prevalence, abundance, and type of natural enemies present in increasing or decreasing budworm populations, and how mating success contributes to outbreaks, moves us toward population forecasting tools with short- and long-term benefits. For example, St. Louis County, the DNR, and the USDA Forest Service currently incorporate aerial survey data of spruce budworm defoliation and mortality into Community Wildfire Protection Plans (standing dead conifers with needles increases wildfire risk).

Project Location

What is the best scale for describing where your work will take place?

Region(s): NE, Central,

What is the best scale to describe the area impacted by your work?

Region(s): Central, NE,

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Screen budworms for biological control agents

Activity Budget: $96,000

Activity Description:
We will work with DNR Forest Health Team partners to select sites in northern Minnesota. Exact number will be determined by annual budworm activity, site access, and statistical power. We will used published methods from other states and provinces to collect budworms, rear them on diet within the laboratory, and collect emerging natural enemies. Parasitoids will be identified to species and we will compare 1) number, 2) diversity, and 3) feeding breadth (i.e., generalists that can prey on other insects vs. specialists that only feed upon budworms) in increasing vs. decreasing populations. We will also analyze hyperparasitoids (i.e., parasites of parasitoids) if any, which are hypothesized to interfere with primary control in budworm-affected forests and may be associated with sustained outbreak behavior.

The activity will be conducted by a graduate student. Data will be analyzed by standard statistical techniques such as analysis of variance and regression, and results will be shared in oral and written form at appropriate venues (workshops, scientific journals, etc.).

Activity Milestones:

Description	Approximate Completion Date
Recruit graduate student to project, find suitable sites in northern MN	June 30, 2023
Collect and rear out parasitoids from high vs. low budworm sites (two years)	June 30, 2024
Identify and analyze diversity, numbers, and feeding guild differences, including hyperparasitoids if any	June 30, 2025

Activity 2: Characterize mating success of female budworms within mainland Minnesota sites undergoing population phase transitions

Activity Budget: $93,000

Activity Description:
We will follow methodology of Régnière et al.(2012) and select eight sites separated by a minimum of ten kilometers to reduce potential duplicate counts of male budworm. Thirty virgin females will be reared on an artificial diet and then either tethered or caged at each site without compromising male access. Following exposure for 3-4 days to field populations, females will be recovered and returned to the lab. In the lab, they will be dissected to verify the presence of spermatophores that indicate mating success.

We will do similar on Isle Royale (separate project), where we expect populations of budworm and mating success will be lower. In both locations, budworm population levels will be measured by standard methodology similar to Régnière et al. (2019) as described in Activity 1.

The activity will be conducted by a graduate student (likely the same one as Activity 1). Mating success between locations will be compared using logistic regression.

Activity Milestones:

Description	Approximate Completion Date
Recruit graduate student and identify sources of female moths to test	June 30, 2023
Complete first year of female mate-finding experiments	June 30, 2024

Determine how mate-finding success increases budworm populations	June 30, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
St. Paul Field Office	US Forest Service	Collaborators who will help secure aerial survey data for tree mortality	No
Forest Health Team	Minnesota Department of Natural Resources	Collaborators will help find field sites in areas of highest budworm activity	No

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.
We will disseminate research results at regional, national, and international conferences; some participation of which is made possible by funds from other agencies leveraged by this grant. Candidate venues include the North Central Forest Pest Workshop, the Northern Silviculture Workshop, Western Forest Insect Work Conference, Entomological Society of America, IUFRO division workshops, Sustainable Forest Education Cooperative webinars, Cloquet Forest Research Review, and more. Work published in scientific journals or highlighted by mass or social media will acknowledge the partnership and support of the ENRTF.

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?
Despite being Minnesota's top native tree-killer of balsam fir and white spruce, LCCMR has not invested in a study of spruce budworm to date. We are requesting a three-year appropriation in the small project category ($189K). The investment will be integrated with a related but distinct project with the National Park Service and the US Forest Service. That work ($90K; exclusive of LCCMR funds) will take place on neighboring Isle Royale in Lake Superior but has direct relevance to Minnesota spruce-fir forests and moose-wolf ecology.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
MITPPC #2: Mountain Pine Beetle, Phase II: Protecting Minnesota	M.L. 2015, Chp. 76, Sec. 2, Subd. 06a	-
MITPPC #5: Optimizing Tree Injections Against Emerald Ash Borer	M.L. 2015, Chp. 76, Sec. 2, Subd. 06a	-
MITPPC #9: Dispersal Characteristics of Gypsy Moth Larvae to Improve the Effectiveness of Quarantines	M.L. 2015, Chp. 76, Sec. 2, Subd. 06a	-
Emerald Ash Borer Biocontrol - Phase III	M.L. 2017, Chp. 96, Sec. 2, Subd. 06b	$729,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Graduate student		Conduct the parasitoid surveys and climatic analyses (3 yrs). Amount includes tuition (3 yr total $57,670).			19.9%	1.5		$132,680
Faculty member		Oversee project experiments and analyses (partial time in summer)			36.5%	0.3		$45,000
Undergraduate student helper		Help in rearing biological control agents from field samples			0%	1		$8,320
							Sub Total	**$186,000**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	Vials, insect rearing diet, identification guides, misc. field supplies	Executing the biological control agent sampling and identification					$600
							Sub Total	**$600**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Annual workshop travel to disseminate results (field travel covered by non-LCCMR funds); est. 2 people, 2 days: $300 hotel, $150 vehicle rental, $200 per diems, $100 registration = $750 total x 3 years	Sharing results with Minnesota's forest resource community					$2,250

							Sub Total	**$2,250**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Printing	Printing outreach materials	Dissemination of results on research poster at workshop/conference					$150
							Sub Total	**$150**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$189,000**

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	Waived UMN overhead	35% for non-federal agencies	Secured	$139,300
			State Sub Total	**$139,300**
Non-State				
Cash	Federal funds	Three year grant from US Forest Service / National Park Service staff to cover field travel and expenses on integrated project on tree mortality and forest recovery from spruce budworm at Isle Royale National Park. This project complements LCCMR objectives and pays for field work in Minnesota.	Secured	$90,000
			Non State Sub Total	**$90,000**
			Funds Total	**$229,300**

Attachments

Required Attachments

Visual Component

File: 16b20e13-12a.pdf

Alternate Text for Visual Component

Photo of spruce budworm and spruce-fir forests, overlaid by smaller photos of aspects of proposal leveraged with other funding agencies (e.g., moose and wolves at Isle Royale National Park with National Park Service)...

Optional Attachments

Support Letter or Other

Title	File
Letter of support from Sustainable Forests Education Cooperative	2b93f5a8-359.pdf
Letter of support from National Park Service / Isle Royale	6d937773-fd7.pdf
Authorization to submit - University of Minnesota	db618ab3-af1.pdf
Approved research addendum, post-review	49a93d1c-c50.pdf
Background Check Certification Form	f5b36ff6-cd0.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Activity 2 has changed from "climatic analysis" to "mating success." This change takes advantage of funds leveraged since the proposal was submitted, is closely tied to testable theory, and was reviewed favorably in this project's research addendum.

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

2022 Project Proposal

Spruce Budworm

Protecting Minnesota's spruce-fir forests from tree-killing budworm

Spruce budworm is native to Minnesota and the most significant tree-killer in spruce-balsam fir forests, affecting forest structure, wildlife, and fire risk

Project Lead: Dr. Brian Aukema

(Forest Insect Lab, University of Minnesota)

Activity 1: Screen budworms for biological control agents

Activity 2: Determine climatic predictors of enhanced budworm activity

Three Years, $189K