



Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-185

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

Project Manager Information

Name: Brian Aukema

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

Office Telephone: (612) 624-1847

Email: BrianAukema@umn.edu

Project Basic Information

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.

Funds Requested: \$189,000

Proposed Project Completion: June 30 2025

LCCMR Funding Category: Small Projects (H)

Secondary Category: Foundational Natural Resource Data and Information (A)

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

Narrative

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 are likely responsible at least in part for increasing budworm numbers.

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.

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. Quantify spring climatic signatures associated with increased defoliation. Warm and dry spring weather is hypothesized to increase survival of overwintering budworms, such that they escape biological control by specialist natural enemies. We will analyze historic defoliation data curated by the US Forest Service and the DNR Forest Health Team to uncover key climatic predictors associated with high budworm populations. We have a demonstrated track record of success in this area (e.g., eastern larch beetle and tamarack forests).
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!) examining whether wolves enhance regeneration of young trees after budworm outbreaks by restricting excessive moose browse.

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 the climatic signatures associated with high outbreak years, 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 risks).

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 use 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), 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	Completion Date
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	June 30 2025

Activity 2: Determine climatic predictors of enhanced budworm activity

Activity Budget: \$93,000

Activity Description:

We will rasterize historic defoliation data of spruce budworm curated by the US Forest Service and the DNR Forest Health Team. Climatic data will be obtained from the PRISM climate group at Oregon State University, who have developed methods to interpolate temperatures across the continental United States. (We have used PRISM products with great success for biogeoclimatic studies of other forest insects in Minnesota, such as the invasive larch casebearer). Based on literature surveys and discussions with other experts, we will define several climatic variables biologically relevant to spruce budworms and natural enemies noted in Activity 1 (e.g., accumulated degree days in the spring before a certain date may reflect spring warming that activates young budworm larvae from their overwintering shelters they construct among the conifer needles). We will use spatiotemporal regression techniques to examine which variables are most closely associated with different budworm population levels.

The activity will be conducted by a graduate student. Results will be shared in oral and written form at appropriate venues (workshops, scientific journals, etc.).

Activity Milestones:

Description	Completion Date
Integrate historic aerial survey data with PRISM climate data	June 30 2024
Determine climatic signatures associated with high vs. low 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

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?

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

Project Manager and Organization Qualifications

Project Manager Name: Brian Aukema

Job Title: Professor of Forest Insect Ecology

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

Dr. Brian Aukema directs the Forest Insect Laboratory in the Department of Entomology at the University of Minnesota. Prof. Aukema and his students work on both native and invasive species threatening the state of Minnesota and region (e.g., mountain pine beetle on pines, emerald ash borer on ash, gypsy moth on oak and aspen, eastern larch beetle and larch casebearer on tamarack, and more). Students he has taught can be found in a wide variety of resource professional positions, from city arborists to industry, NGOs, and state and federal government positions.

Prof. Aukema joined the Department of Entomology as their Forest Insect specialist in the fall of 2010. Prior to this, he was a research scientist with the government of Canada and was responsible for a program managing large-area insect outbreaks. Prof. Aukema has successfully administered more than \$2 million in research project funding from a wide variety of state, federal and industrial sources in his career. He has received early career awards for Creativity and Innovation (Government of Canada) and a McKnight Land-Grant award from the University of Minnesota.

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

Organization Description:

The University of Minnesota-Twin Cities, founded in 1851, is the largest campus within the University of Minnesota system with an enrolment of just over 50,000 students. As a historic land-grant university, the University of Minnesota's mission is to engage students and faculty to address Minnesota's most pressing issues.

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,	Sharing results with Minnesota's forest resource community					\$2,250

		\$200 per diems, \$100 registration = \$750 total x 3 years						
							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				
			State Sub Total	-
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	\$90,000

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
Authorization to submit - University of Minnesota	db618ab3-af1.pdf
Letter of support from National Park Service / Isle Royale	6d937773-fd7.pdf
Letter of support from Sustainable Forests Education Cooperative	2b93f5a8-359.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

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

