

Final Abstract

Final Report Approved on October 1, 2025

M.L. 2022 Project Abstract

For the Period Ending June 30, 2025

Project Title: Bugs Below Zero: Engaging Citizens in Winter Research

Project Manager: Rebecca Swenson

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Website: <https://cfans.umn.edu/>

Funding Source:

Fiscal Year:

Legal Citation: M.L. 2022, Chp. 94, Sec. 2, Subd. 05e

Appropriation Amount: \$198,000

Amount Spent: \$198,000

Amount Remaining: -

Sound bite of Project Outcomes and Results

More than 3,000 Minnesotans learned about stream food webs, live insects, and environmental research at Bugs Below Zero events. Our team launched a community science program and developed digital resources to engage K–16 classrooms and adults in fieldwork, linking winter active aquatic insects, trout, weather, and environmental stewardship.

Overall Project Outcome and Results

This project strengthened public understanding of aquatic ecosystems and the important role of winter active insects in Minnesota's trout streams. Bugs Below Zero engaged more than 3,000 K12 classrooms, teachers, and adults in interactive presentations with live insects and scientific experts at our in-person events, hosted with partners at the Bell Museum, Belwin Conservancy, and Minnesota Valley Wildlife Refuge. These events ranged from our "Insects and their Habitats" field day that brought 47 students and two teachers from Battle Creek Elementary to Afton, Minnesota to collect insects, examine leaf packs, measure water velocity and turbidity, and discuss winter insect adaptations to our "Candlelight Night" at the Bloomington Visitor Center, in which more than 350 kids, parents, and adults learned about stream ecology at interactive stations equipped with live insects, microscopes, and environmental science experts. Teachers praised the events for their engaging content and expert access.

To expand reach and access, the team developed a wide range of digital resources—including videos, virtual events, lesson plans, and podcasts —available at BugsBelowZero.com, which has drawn over 4,700 unique visitors.

The project team also created a new community science program enabling volunteers collect and share key field data about winter active insects, stream conditions, weather, and other ecological observations. Hosted on an open web platform, the program provided a new outdoor learning experience and chance to get involved in fieldwork in the winter, a time when experiential learning opportunities are limited. Data was submitted from volunteers across different areas of Minnesota, including from Lake, Clearwater, Hubbard, Washington, Lyon, St. Louis, Fillmore, and Olmsted counties. Participants reported increased appreciation for aquatic insects, deeper ecological knowledge, and stronger environmental stewardship. One participant wrote, “I am fascinated and curious about aquatic ecology... excited to contribute and gain new skills, experiences, and contacts.”

Project Results Use and Dissemination

Throughout this project, we have shared content via our partner listservs and events, including those hosted by University of Minnesota, Southwest Minnesota State University, Bell Museum, Belwin Nature Conservancy, Minnesota Valley Wildlife Refuge, and Minnesota SeaGrant. We mailed packets of materials to Minnesota teachers and presented insights about this program at academic conferences and in academic journals. Minnesota news media - including KARE-11, Duluth News Tribune, and Minnesota Conservation Volunteer - have produced stories about this project. The Bugs Below Zero web page continues to share videos, podcasts, presentations, webinar recordings, images, lesson plans, classroom activities, and other educational materials.



Environment and Natural Resources Trust Fund

M.L. 2022 Approved Final Report

General Information

Date: November 12, 2025

ID Number: 2022-162

Staff Lead: Lisa Bigaouette

Project Title: Bugs Below Zero: Engaging Citizens in Winter Research

Project Budget: \$198,000

Project Manager Information

Name: Rebecca Swenson

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

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Project Reporting

Final Report Approved: October 1, 2025

Reporting Status: Project Completed

Date of Last Action: October 1, 2025

Project Completion: June 30, 2025

Legal Information

Legal Citation: M.L. 2022, Chp. 94, Sec. 2, Subd. 05e

Appropriation Language: \$198,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to raise awareness about the winter life of bugs, inspire learning about stream food webs, and engage citizen scientists in research and environmental stewardship.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: Bugs Below Zero raises awareness about the winter life of bugs, inspires citizens and classrooms to unlock secrets of stream food webs, and engages new citizen scientists in research.

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

Bugs are everywhere in the summer, but have you considered what happens to them in the winter? To increase public support of environmental science and engagement in stewardship efforts, it is important that citizens understand and value the year-round dynamics of aquatic ecosystems. Despite the long Minnesota cold season, there is little awareness of cold-adapted insects and their critical role in groundwater-fed streams and trout populations. This project expands access to educational resources that raise awareness about the winter life of bugs, inspires citizens and classrooms to unlock some secrets of winter food webs, and engages new citizen scientists in winter research efforts.

This proposal builds upon early success with a program called Bugs Below Zero, piloted in 2020-2021 by a multi-disciplinary team of University of Minnesota faculty and students, in which participants learn about, observe, and photograph insects on the snow. New activities proposed here expand outreach and strengthen the potential for community-building, engagement, and data-sharing with participants of Bugs Below Zero. This project also provides new virtual field trips and outdoor learning experiences for a diverse set of classrooms and citizens that will take place in the winter, a time when experiential learning opportunities are often limited.

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 helps new audiences understand the value of cold-adapted insects to Minnesota streams and provides a hands-on way to help protect Minnesota resources and support global scientific work. Minnesota's climate is unique and it helps researchers across the globe better understand interactions between weather, water, insects, and food webs. The work of the research team and Bugs Below Zero participants is important, for if the climate continues to warm, insects that emerge in winter may disappear, and so will trout that depend upon insects for food. Involving students and public audiences will deepen their appreciation of aquatic ecosystems, and in turn, inspire new and continued participation in other forms of environmental stewardship.

Specifically, we are seeking funding to:

- Expand outreach to new potential participants in the Bugs Below Zero program, including classrooms, outdoor recreationalists, and environmental educators.
- Strengthen community-building, engagement, data sharing, and communication systems with citizen science participants.
- Implement a series of virtual field trips and in-person events that raise awareness about cold-adapted insects and their connection to stream food webs and inspire involvement in citizen science projects.

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?

There are two major overarching outcomes for this project: 1) to increase research capacity and 2) to inspire environmental learning and stewardship in all seasons. The field season to study cold-adapted insects is short and often dependent on snow cover. Data submitted by Bugs Below Zero participants will strengthen knowledge of when and where winter insects emerge and will make field site selection more efficient for UMN researchers. Participants will learn new insights about insect life on the snow and ice and help researchers build knowledge that can be used to best manage water and trout resources.

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: Host a series of in-person and virtual events to expand Bugs Below Zero program

Activity Budget: \$118,800

Activity Description:

We propose a series of events for K12 students, teachers, conservation organizations, and families. Using interactive presentations by UMN experts and hands-on demonstrations with insects from Wet Bugs LLC, event content will increase understanding of stream food webs and connections between healthy water habitats, aquatic insects, and trout populations, as well as provide training and inspiration to get involved with the Bugs Below Zero citizen science program. In-person events will be held at educational centers (like the Bell Museum, Belwin Conservancy, and Minnesota Valley National Wildlife Refuge). Digital materials are an important component of educational resources and not all schools have the ability or funding to join on-site events, thus we will also host a virtual field trip and create digital resources with similar content. For the virtual field trip, educators will join live via social media channels to view streaming content, presentations, and demos, and ask questions with their classrooms. Additionally, virtual field trip content will be archived for later use by educators and can be leveraged as a resource by organizations like Trout in the Classroom. The proposal leaders have experience doing similar virtual field trips with dairy and turkey farms.

Activity Milestones:

Description	Approximate Completion Date
Host 1-2 events with the Bell Museum, create virtual field trip resources, share with educators	June 30, 2023
Host 1-2 events with Belwin, create digital resources, share with educators	June 30, 2024
Host 1-2 events with MN Valley Natl Wildlife Refuge, share digital resources with educators	June 30, 2025

Activity 2: Strengthen Bugs Below Zero communication channels, build community, and strengthen data sharing with participants

Activity Budget: \$79,200

Activity Description:

Initial Bugs Below Zero educational materials – including a website (www.bugsbelowzero.com), videos, and classroom activities – and trial system for public collaboration and participation in research were created in 2020-2021 and shared with small groups of students, landowners, and outdoor recreation enthusiasts. Participants of all ages shared their excitement, as one student commented, “I’ve gained a greater awareness and interest in winter bugs, especially down by the stream!” An adult participant shared their desire to use Bugs Below Zero information to “teach my grandchildren and make them more comfortable in the outdoors.” These early participants also gave feedback and ideas on how to effectively build the program and maintain engagement.

With this proposal, we will strengthen efforts to connect with Bugs Below Zero participants, build community, improve data collection systems, and increase data sharing with citizen science volunteers. We will create social media content, blog posts, and newsletters to share participant stories, researcher highlights, data insights, training tips, and insect facts. With consistent communication, classrooms and citizen volunteers will stay engaged with the Bugs Below Zero program and outreach can motivate ongoing learning and environment stewardship. We will assess learning outcomes and engagement for continued improvement of citizen science activities.

Activity Milestones:

Description	Approximate Completion Date
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Create communication channels, develop plan for specific content and stories, share information	June 30, 2023
Engage outdoor recreationalists, educators, and classrooms with Bugs Below Zero communication content	June 30, 2024
Continue sharing content, assess learning outcomes and evaluate engagement of participants	June 30, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dean Hansen	Wet Bugs, LLC	Hansen is an aquatic entomologist and owner of Wet Bugs, which provides interactive educational workshops. He will provide interactive, live demonstrations of aquatic insects and related equipment during the events.	Yes
Research staff	University of Minnesota	Graduate researchers will help plan and execute events, provide entomology and water expertise to event and communication materials, interact with Bugs Below Zero volunteers, and review data provided by program.	Yes
Amy Schrank	University of Minnesota Sea Grant	Schrank will help plan and execute events, provide fisheries expertise to events and materials, and help communicate event and educational materials through University of Minnesota Sea Grant channels.	Yes
Troy McKay	University of Minnesota, Agricultural Education & Communication	McKay is a digital media instructor who will help support the virtual field trip event, as well as the creation of digital educational resources (like videos, podcasts, and photo tours) that result from the virtual field trip.	Yes
Bruce Vondracek	University of Minnesota	Vondracek is an emeritus professor in the Department of Fisheries, Wildlife, and Conservation Biology at the University of Minnesota. He will help plan and execute events.	No
Holly Menninger	University of Minnesota Bell Museum	Menninger will be the contact person for the Bell Museum and will coordinate staff support, facilities, and communication support for potential Bell Museum events.	Yes
Susan Haugh	Belwin Conservancy	Haugh will be the contact person for the Belwin Conservancy and will coordinate staff support, facilities, and communication support for potential Belwin Conservancy events.	Yes
Vicki Sherry	Minnesota Valley National Wildlife Refuge	Sherry will be the contact person for the MN Valley National Wildlife Refuge and will coordinate staff support, facilities, and communication support for potential MN Valley National Wildlife Refuge events.	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 ENTRF Acknowledgement Requirements and Guidelines.

Our team will maintain a website connected to the Bugs Below Zero project. We will also disseminate our information using our partner websites and social media channels (Bell Museum, Belwin Conservancy, and MN Valley National Wildlife Refuge, and University of Minnesota). We will also use established email lists that reach Minnesota educators. Additional communication and dissemination efforts are described in the main narrative. On all communication, the Environment and Natural Resources Trust Fund will be acknowledged through use of the trust fund logo and attribution language on project print and electronic media, publications, signage, and other communications. We will follow the 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?

Educational resources created by this project will be publicly available and continue to be hosted on the Bugs Below Zero website. Videos, tours, blog posts, infographics, and other stories will serve as ongoing resources for educators and families interested in learning more about winter dynamics of aquatic insects and stream food webs. We anticipate

sharing any broader insights about citizen science engagement, especially for projects focused on winter, with education and communication journals and environmental stewardship organizations.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Improve Trout-Stream Management by Understanding Variable Winter Thermal Conditions	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 03i	\$400,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount	\$ Amount Spent	\$ Amount Remaining
Personnel										
Project Director - Rebecca Swenson		Serve as project director			36.5%	0.4		\$76,232	-	-
Co-PI - Amy Schrank		help plan and execute events, provide fisheries expertise to events and materials, and help communicate event and educational materials through University of Minnesota Sea Grant channels.			36.5%	0.06		\$7,429	-	-
Co-PI - Digital Media Instructor - Troy McKay		help support the virtual field trip event, as well as the creation of digital educational resources (like videos, podcasts, and photo tours) that result from the virtual field trip.			36.5%	0.2		\$30,204	-	-
Bell Museum Public Science Events Manager		provide support for two events in year 1; Coordinate Spotlight Science in-person event at Bell Museum, featuring Bugs Below Zero experts and hands-on activities			36.5%	0.02		\$1,297	-	-
Gallery Program Manager		provide support for two events in year 1; Develop and implement Bugs Below Zero content and activities for Bell Museum Outdoor Learning Landscape			36.5%	0.02		\$1,312	-	-
2 undergraduate students		will help draft communication content, run video equipment, assist with video editing, edit the Bugs Below Zero website, support event planning and			0%	2.4		\$47,476	-	-

		execution, and interact with researchers from communication, entomology, and fisheries, in order to help understand the research and translate insights for public audiences								
							Sub Total	\$163,950	\$163,950	-
Contracts and Services										
Dean Hansen	Service Contract	Funds are requested for contractual services to Wet Bugs, LLC., an interactive workshop provided by Dean Hansen. Wet Bugs is a private business that specializes in interactive, educational workshops with live insects. These funds will allow us to include the Wet Bugs interactive workshop at in-person and virtual events.				-		\$1,800	\$1,800	-
MN Valley Wildlife Refuge	Subaward	Funds are requested to cover expenses at educational centers in year 3. Funds will be used to cover facility costs, staff time, and communication expenses at these educational centers (\$3,000/year for in-person and virtual events).				0		\$3,000	\$3,000	-
Belwin Nature Conservancy	Subaward	Funds are requested to cover expenses at educational centers in year 2. Funds will be used to cover facility costs, staff time, and communication expenses at these educational centers (\$3,000/year for in-person and virtual events).				0		\$3,000	\$3,000	-
Dr. Alyssa Anderson	Service Contract	support events, provide entomology expertise to event and communication materials,				0		\$20,657	\$20,657	-

		interact with Bugs Below Zero volunteers, and review data provided by program								
							Sub Total	\$28,457	\$28,457	-
Equipment, Tools, and Supplies										
	Tools and Supplies	Vial Kits - \$8.25 per vial; 100 kits per year; 3 years	Funds are requested for pre-packaged vial kits for insect collection. Volunteers will be given these vials at events and kits will be shared with classrooms, so participants can practice fieldwork and collect insects on the snow. (\$8.25/kit, 100 kits per year).					\$490	\$490	-
	Tools and Supplies	Materials and equipment - \$200 per event; 2 events	Bell Museum materials and equipment in support of hands-on demos and events for two events in year 1. (\$200 per event; a total of \$400)					\$400	\$400	-
							Sub Total	\$890	\$890	-
Capital Expenditures										
							Sub Total	-	-	-
Acquisitions and Stewardship										
							Sub Total	-	-	-
Travel In Minnesota										
	Miles/ Meals/ Lodging	6 people; \$100 per person per year	Funds are requested for the project team to travel to events, including pre-event site visits (mileage, vehicle). This also includes funds to travel to locations for the virtual events and for any interviews or photo/video shoots needed to create digital resources. (Funds are					\$503	\$503	-

			budgeted at approximately \$100/year for Swenson, Schrank, McKay, Ferrington, and both undergraduate students).							
							Sub Total	\$503	\$503	-
Travel Outside Minnesota										
							Sub Total	-	-	-
Printing and Publication										
	Printing	promotional materials and educational handouts	To conduct the event at the Bell Museum these promotional materials and educational handouts will be used by the project team					\$200	\$200	-
	Printing	communication material development - \$500 per year	We are requesting approx \$1000/year to cover the cost of printing and mailing of communication materials (postcards, flyers) to share details about the Bugs Below Zero program, classroom resources, and to send follow-up information to participants. We are also requesting funds to cover the cost of website hosting required to develop and share digital resources.					\$2,900	\$2,900	-
							Sub Total	\$3,100	\$3,100	-
Other Expenses										
		Insect guide - \$39.95 each; ~36 copies needed	Funds are requested for copies of a guide that we have developed for Citizens Monitoring of Aquatic Invertebrates of the Upper Midwest (http://midge.dl.umn.edu/midwest-guide) to classrooms or high performing citizen volunteer participants. We will also use the guide as a prize during interactive games at events. We anticipate sharing 10-14 copies of the guide per					\$1,100	\$1,100	-

			year. (Copies of guide, \$39.95/each, ~36 copies total).							
							Sub Total	\$1,100	\$1,100	-
							Grand Total	\$198,000	\$198,000	-

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	\$ Amount	\$ Amount Spent	\$ Amount Remaining
State						
			State Sub Total	-	-	-
Non-State						
In-Kind	University of Minnesota	Waived Indirect Costs	Secured	\$108,900	\$108,900	-
			Non State Sub Total	\$108,900	\$108,900	-
			Funds Total	\$108,900	\$108,900	-

Attachments

Required Attachments

Visual Component

File: [1ffc12d0-9e9.pdf](#)

Alternate Text for Visual Component

This is a screenshot of the Bugs Below Zero website. The website homepage features a description of the Bugs Below Zero team and information about winter aquatic insects....

Supplemental Attachments

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

Title	File
Bell Museum letter of support	c3d26753-a6e.doc
Belwin Conservancy	c06fa527-24f.pdf
Annual Report_2020	e90c6c1d-9cb.pdf
Sponsored Projects Administration Letter	2628b0ad-774.pdf
Background check form	6b954d6d-5b7.pdf

Media Links

Title	Link
Bugs Below Zero webpage	www.bugsbelowzero.com
Video: Favorite insect	https://www.youtube.com/watch?v=dXldFKA7MGE
Video: Winter Insects	https://www.youtube.com/watch?v=e56_tHCt_Ps&list=TLGGJMkVIUiYpkQwOTA3MjAyNQ&t=4s
Video: The Stream Environment	https://www.youtube.com/watch?v=w_WJOVuwuU&list=TLGGfKkSmbqHHiQwOTA3MjAyNQ&t=1s
Podcasts: Stoneflies, Caddisflies, and Dragonflies	https://www.bugsbelowzero.com/videos-and-presentation
MN Conservation Volunteer article: Snow Crawlers	https://www.dnr.state.mn.us/mcvmagazine/issues/2025/jan-feb/bugs.html
Kare11: Bugs Below Zero	https://www.kare11.com/article/news/local/kare11-extras/bugs-below-zero-discovering-secret-life-winter-active-insects/89-dba08e57-286c-47fe-b990-7626db5e5ff9
About Bugs Below Zero (half-page)	https://drive.google.com/file/d/1w9qQFKbMs3p1Jez_UZTmrCr3LrQc_wlQ/view?usp=drive_link
About BBZ (trifold)	https://drive.google.com/file/d/1FQtm86J_mtaS6cN7LojRkK6xS2-0pvOx/view?usp=drive_link
Image folder: BBZ Images	https://drive.google.com/drive/folders/10pJaMyrW8RzzsqGU7iH2-fm9g7p963k?usp=drive_link

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

The following changes have been made from the proposal to work plan stage:

- Len Ferrington has been replaced by graduate researchers with expertise in water and entomology. Their role and budget has stayed the same.
- We converted the 'Contract or Service Type' from 'Professional or Technical Service Contract' to 'Subaward' for the MN Valley Wildlife Refuge and Belwin Nature Conservancy line items, as requested.
- We provided a range of the approximate number of events to be hosted at each location in the Activities and Milestones section, as requested.
- We added the waived overhead from the UMN to the budget, as requested.

- The background form has been uploaded.
- Additional details about dissemination have been added.
- We added the statement about how the Environment and Natural Resources Trust Fund will be "acknowledged through use of the trust fund logo and attribution language on project print and electronic media, publications, signage, and other communications" to the dissemination plan.

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 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?

No

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

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

Not acknowledged

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Explanation & justification for Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	• Budget • Other • Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Printing and Publication	We would like to move the funds from "UMN Graduate Research Staff" to a professional technical contract, fulfilled by Dr. Alyssa Anderson. The graduate research staff is unavailable and Dr. Anderson has the entomology research background needed to support the project.	February 27, 2024	Yes	March 1, 2024
2	Amendment Request	• Budget • Other • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Printing and Publication	We would like to move \$1,400 from "Capital Expenditures, Equipment, Tools, and Supplies Details - Vial Kits" to "Printing & Publication - Communication material development." Due to the lack of snow in recent years, our team did not need as many vials as planned to collect insects in the snow and instead we are spending more time developing communication content and educational resources.	March 20, 2025	Yes	March 26, 2025
3	Amendment Request	• Budget • Budget - Personnel • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Other	We would like to move \$585 from Tools - Vials and Supplies, \$1297 from Travel, and \$375 from Insect Guides and place these funds in the Personnel category. Our Personnel expenses were slightly more than anticipated. Due to lack of snow, we did not need as many vials as planned. The insect guides were slightly less expensive than anticipated. The team did more day trips rather than overnight trips which reduced costs.	July 30, 2025	Yes	August 7, 2025

Status Update Reporting

Final Status Update August 14, 2025

Date Submitted: July 9, 2025

Date Approved: August 7, 2025

Overall Update

The Bugs Below Zero project successfully inspired new groups to participate in winter field research, engage in hands-on environmental learning opportunities, and explore winter stream food webs - an often overlooked ecological season. More than 3,000 people attended in-person events that raised awareness about cold-adapted insects and their critical role in groundwater-fed streams and trout populations. To expand access, the project also generated new digital resources, including videos, webinars, narrated slides, podcasts, images, and educational activities, housed on a website that has received more than 4,700 unique visitors.

A new community science program was launched to engage volunteers in observing winter stream ecosystems. Participants walk along stream banks during the winter months to document insect activity, weather conditions, and stream characteristics. The program includes structured activities that provide researchers with valuable data on the diversity, abundance, and behaviors of winter-active insects in relation to ecological conditions. All project data is publicly available and contributes to ongoing research on the biology of winter-active insects, the impacts of changing weather patterns, and patterns of habitat use. The Bugs Below Zero project fostered appreciation for the natural world, environmental responsibility, and community-building during a season with few experiential learning programs.

Activity 1

Throughout our grant period, the Bugs Below Zero team created interactive educational events featuring live insects, microscopes, and science experts that engaged more than 3,000 people in learning about year-round dynamics of Minnesota's aquatic ecosystems. Partnerships with the Bell Museum, Belwin Conservancy, and Minnesota Valley Wildlife Refuge enabled in-person events reaching K-16 classrooms, families, conservation organizations, and other community members. We created virtual webinars, videos, podcasts, and other resources to expand access and deepen understanding of healthy streams, insects, and trout in all seasons.

Since our last update, we produced new digital content for educators and classrooms, including a video highlighting favorite macroinvertebrates from event attendees. The video explains why macroinvertebrates are important, where they're found, and how to access educational resources. At Minnesota Valley Wildlife Refuge's request, we created a permanent educational display focused on identifying insects and their role in stream food webs. A similar permanent educational display is also featured in Southwest Minnesota State University's Natural History Museum. We also delivered interactive presentations about the Bugs Below Zero project, winter-active aquatic insects, and trout populations for the Fur, Fin, and Feather Club, at the Minnesota Chapter of the American Fisheries Society's annual meeting, and at SMSU.

(This activity marked as complete as of this status update)

Activity 2

The Bugs Below Zero team launched a new community science program using Anecdota, an online platform for citizen science projects, that enables volunteers to track and share observations of insects in snowy environments. Participants from across Minnesota—including Lake County, Clearwater County, Hubbard County, Washington County, Lyon County, St. Louis County, Fillmore County, and Olmsted County—submitted data on winter-active aquatic insects, stream conditions, weather, and other ecological insights in their regions.

Since our last report, the Bugs Below Zero team has mailed educational packets and resources to Minnesota teachers, conservation agencies, research institutes, and outdoor recreation centers. We also developed new classroom activities, blog posts, social media content, podcasts, and website materials. Additionally, we reviewed evaluative feedback gathered through events and integrated into our data collection protocol. Project participants shared that they enjoyed observing insect behaviors and differences, exploring beautiful stream environments, and engaging in educational activities. Event attendees were often surprised to learn about the winter activity of insects. Many expressed motivation to further explore stream food webs and an interest in additional resources and programs.

(This activity marked as complete as of this status update)

Dissemination

The Bugs Below Zero team built a website, BugsBelowZero.com, as a hub for the new educational materials, classroom activities, community science program, images, videos, and other digital content created throughout this project. The site has received more than 4700 unique visitors.

To broaden our outreach, our team also shared content on social media channels, created brochures and flyers, hosted in-person and virtual events, and mailed packets of information to engage our targeted audiences: K-16 students, teachers, families, outdoor enthusiasts, and conservation agencies.

To further raise public awareness, we connected with media outlets, resulting in coverage in local newspapers, magazines, podcasts, and television stories about our project. We also presented insights at academic conferences and contributed to journal articles.

Our dissemination efforts were supported by leveraging the communications networks of our partners—including social media, newsletters, websites, and listservs—such as the University of Minnesota College of Food, Agricultural, and Natural Resource Sciences (CFANS), Minnesota Sea Grant, Southwest Minnesota State University, the Bell Museum, Belwin Conservancy, Minnesota Valley National Wildlife Refuge, and other collaborating organizations. We acknowledged the Environment and Natural Resources Trust Fund (ENRTF) throughout our dissemination efforts. (Some of our communication materials are shared in the attachments section.)

Status Update Reporting

Status Update March 1, 2025

Date Submitted: February 28, 2025

Date Approved: March 26, 2025

Overall Update

Bugs Below Zero increased awareness of winter-active aquatic insects and fostered new appreciation for environmental stewardship of our streams in all seasons. We hosted a series of engaging, interactive events with live insects, strengthened our participatory science program, and created new educational resources. During this reporting period, we reached nearly 2,000 students, teachers, families, and outdoor enthusiasts of all ages during our in-person events. We also increased knowledge of potential connections between weather, streams, insect adaptation, and fish health with new educational materials, lesson plans, videos, podcasts, and displays. New participants in our community science program got outside and collected data near Minnesota streams. We expanded opportunities for new winter-based outdoor learning experiences by sharing curriculum resources with new teachers and classrooms. Bugs Below Zero activities continue to support environmental education and expand community appreciation of Minnesota's water resources. As one of our event attendees said, "I learned a lot more about the streams near us. The fact that there are so many insects that are active in the winter is amazing. This was great."

Activity 1

A few highlights of our work to support Activity One include a partnership with the Minnesota Valley Wildlife Refuge for two major public outreach events. We hosted more than 230 attendees at the "Light and Seek Luminary Walk" held at the Rapids Lake Education and Visitor Center in Carver, Minnesota, on January 11th and over 350 attendees at the "Candlelight Night" held at the Bloomington Visitor Center. Through interactive stations equipped with microscopes, iPads, and live insects, Bugs Below Zero experts helped community members meet Minnesota's winter aquatic insects, understand the important role insects play in winter stream food webs, and learn about ways to get involved in participatory science programs. One teacher who attended our events said, "This is fantastic. Mind blown about bugs' lifespan and bugs in the snow." Another teacher said, "I love it all. I really enjoyed the variety of insects and access to experts." Bugs Below Zero experts also created interactive demonstrations on insect adaptations for the Southwest Minnesota Soil & Water Conservation District's Environmental Fair. This event, held at the Lyon County Fairgrounds in Marshall, Minnesota, attracted over 1600 students and teachers from more than 10 schools.

Activity 2

As part of our efforts to support Activity Two, the Bugs Below Zero team presented insights from the Bugs Below Zero participatory science program to academic audiences during a poster session at the Entomological Society Association conference in Phoenix, Arizona. We also submitted an article for *CHIRONOMUS: Journal of Chironomidae Research* about the Bugs Below Zero project; the article is accepted pending revisions. Our team also published an article titled, "Snow Crawlers: Wintertime is the right time for some unusual insects to thrive in Minnesota" in the January/February issue of the Minnesota Conservation Volunteer magazine, which was also shared via the social media channels of several different organizations. To build connections and community, we distributed educational resource packets to K12 teachers interested in incorporating new winter science activities into their classrooms. Bugs Below Zero information was also shared at the Minnesota Association for Environmental Education conference. Our team continued to enhance our data collection protocol and profile on the Anecdota app, ensuring robust data gathering and management.

Dissemination

Our team developed a variety of new communication materials, including new podcast content, posters, social media posts, brochures, presentations, event displays, and website content. We collaborated with partners like the Minnesota Valley Wildlife Refuge, Cedar Creek Ecosystem Science Reserve, Minnesota Master Naturalists, and Minnesota Sea

Grant; these partners amplified our reach by sharing our content on their channels and at their events. These connections helped us connect with new community members and expand our impact. The Bugs Below Zero team also gathered images, video footage, audio clips, and other content during our events for future virtual resources.

Status Update Reporting

Status Update September 1, 2024

Date Submitted: August 19, 2024

Date Approved: October 1, 2024

Overall Update

During this reporting period, the Bugs Below Zero project team hosted events, developed new classroom resources, created communication materials, and gave presentations with the goal of increasing understanding and interest in winter streams, aquatic insects, and trout. Through a combination of both virtual and in-person events, we shared stream research, conservation practices, educational information about winter-active aquatic insects, and the impact of seasonal and climate changes on trout and their potential food sources. We had new audiences adopt our data collection tool and collect new information via the Ancedata app. The Bugs Below Zero team built new website content, wrote new blog posts, developed curriculum, produced videos, designed flyers and postcards, posted new content on social media channels, and used email listserv to raise awareness and interest in Minnesota's stream food webs.

Activity 1

Our Bugs Below Zero team hosted a new virtual event during this reporting period, titled "A Virtual Stream Tour with Bugs Below Zero," in partnership with the Minnesota Master Naturalist program and Southwest Minnesota State University. Using new video footage, our team was able to give participants a virtual tour of a Minnesota stream and then host a live conversation with participants about connections between aquatic insects and trout health.

Our team also presented a series of sessions at the International Society for Freshwater Science organization's annual meeting in June in Philadelphia, Pennsylvania. The "Bugs Below Zero: Communicating Science and Engaging the Public with Winter Active Aquatic Insects and Stream Food Webs" session shared details about our community science program and successful outreach events for K-12 educators, students, community members, nonprofit organizations, and higher education institutions. The "Importance of Bugs Below Zero - A Summary of Twenty-Five Years of Winter Research in Groundwater-Dominated Trout Streams" session shared an overview of insights from research conducted on aquatic insects. These in-person and virtual events have helped us raise awareness about the importance of aquatic insects, trout, and conservation practices among new audiences.

Activity 2

Our team worked to strengthen communication, education, and outreach with potential participants and classrooms. We sent email communication to K12 and higher education instructors to update them on Bugs Below Zero activities and opportunities for involvement. The Bugs Below Zero team also worked to share the data collection protocol and new classroom resources with new audiences, especially educators who might consider incorporating Bugs Below Zero information into lesson plans. It is exciting to see others who are adding data and their observations about insects, weather, and stream conditions using our tool. We also created new videos that capture the stream environment and impact of seasonal changes. Our team also wrote new blog posts, created new website content, gathered new digital images, updated video resources, created new educational resources and lesson plans for teachers, and designed new flyers and postcards. Our work for activity two also included planning for additional new educational videos and lesson plans.

Dissemination

Our dissemination plan continues to center upon email listservs, social media channels, flyers, events, drafting media articles, and sharing information on our website. Distributing handouts at events and collaborating with our partner organizations have been an effective way to reach our target audiences. For example, a single Facebook post about a Bugs Below Zero event was shared by accounts owned by the Agricultural Education & Communication department at the University of Minnesota, Minnesota Sea Grant, the Chironomidae Research Group, Belwin Nature Conservancy,

ENRTF, and a few individuals. Facebook estimates the post reached an estimated 1,216 people. Media outreach also resulted in connections with news organizations. In addition, website stats indicate the Bugs Below Zero website had approximately 2,017 site sessions, and 1,544 unique visitors from September 1-July 26th.

Status Update Reporting

Status Update March 1, 2024

Date Submitted: February 27, 2024

Date Approved: March 1, 2024

Overall Update

The Bugs Below Zero project team continued our work to raise awareness of winter-active aquatic insects and their important role in stream food webs in Minnesota. We developed new classroom resources, hosted additional interactive and educational events, created new digital tools, and supported our participatory science program. Our interdisciplinary team from the agricultural and environmental sciences, entomology, fisheries, wildlife, and conservation biology disciplines connected with outdoor recreation enthusiasts, conservationists, nature and environmental education centers, K-12 classrooms, and higher education institutions. Despite challenges posed by a winter with little to no snow cover, we were still able to successfully complete work related to activities 1 and 2 during this reporting period. For example, we supported 5 events held in different counties that reached approximately 350 people during this reporting period. We also finished refining our community science protocol and have connected with new classrooms and individuals who are interested in participating. Our team strengthened our science communication outreach efforts, which included new website content, blog posts, flyers, postcards, email communication, and social media posts during this reporting period. These different interactive, educational events and activities are described in more detail in the Activity 1 and 2 sections.

Activity 1

Our team hosted several events to support activity one. First, Bugs Below Zero experts joined the Belwin Outdoor Science program staff to create and run the “Insects and their Habitats” field day for 47 elementary students and two teachers from Battle Creek Elementary (STEAM-focused magnet school, 90% minority enrollment, 82% FRPL eligible, in St. Paul, Minnesota) at the Belwin Nature Conservancy in Afton, Minnesota. Students identified a variety of aquatic insects, collected insects in the field, explored leaf packs, and measured water velocity and turbidity, and discussed challenges insects face during the winter season and unique adaptations to overcome these challenges. In February, the Bugs Below Zero team also joined Belwin Nature Conservancy staff at the “Midwinter Family Fun” event, which attracted 223 people this year. Along with guided hikes, campfires, and stargazing opportunities, attendees of all ages were able to learn about aquatic insects, winter habitat and animal adaptations, and the impact of weather on stream food webs through demonstrations, live stations, crafts, and digital stories. Bugs Below Zero also presented interactive educational sessions at the Southwest MN 4H Wildlife Day, which was hosted in Redwood Falls, Minnesota on February 10, 2024 for 18 students in grades 3-13.

Activity 2

To support activity two, the Bugs Below Zero team refined our data collection protocol, which is hosted on the Anecdota web platform and app. Our data collection tool allows community volunteers and students to share observations about winter active insects, stream conditions, and weather, and examine data collected by others. To share information about the community science program, Bugs Below Zero team members presented a webinar to 45 Minnesota Master Naturalists in January. The webinar covered research on aquatic insects, the ecological importance of Minnesota’s winter active chironomids, connections between the diet of trout and local streams, and how to get involved in citizen science opportunities; a recording of the presentation is available on the West Metro Chapter of Master Naturalist’s website at: <https://westmetromasternaturalists.weebly.com/west-metro-master-naturalists-webinars.html>. To strengthen awareness of the community science program, Bugs Below Zero team also presented a workshop for 8 naturalists at the Eagle Bluff Environmental Learning Center in Lanesboro, Minnesota. The event included a detailed

overview of the biology and ecology of winter active aquatic insects as well as an afternoon in the field visiting multiple local spring-fed streams to search for winter-active insects utilizing the Bugs Below Zero citizen science protocol.

Dissemination

Project updates, new resources, and event information were shared on social media channels and via partner organization email lists. Our new teacher guides, videos, classroom activities, blog posts, and other content was posted to the Bugs Below Zero website. We distributed flyers and postcards with details about the website, educational resources, community science program, and upcoming opportunities to get involved in the project during our live events. KARE-11 television station attended our event at Belwin with the St. Paul School district, interviewed Bugs Below Zero team members, and captured footage of Bugs Below Zero team members and undergraduate students doing field research; the reporter expects a segment on the Bugs Below Zero project to air in March. Bugs Below Zero team members were also interviewed for a story on the project, titled “Citizen Scientists Needed to See What Happens in Trout Streams in Winter,” which ran in the Duluth News Tribune on January 5, 2024.

Status Update Reporting

Status Update September 1, 2023

Date Submitted: August 24, 2023

Date Approved: September 27, 2023

Overall Update

We are continuing to make progress on our goal to raise awareness about aquatic insects, trout streams, and winter weather. We have hosted new experiential events that allow attendees of all ages to touch and observe aquatic insects and learn about their important role in stream food webs. We also have produced virtual events and supporting educational resources that classrooms and other public audiences can access asynchronously. To date, our team estimates that live and virtual events have reached over 700 people. Our team has expanded the network of classrooms and higher education faculty involved in creating and piloting a tool to collect and analyze data, so we are now working with high school teachers and faculty from both 2-year and 4-year institutions. Stakeholders from these networks have indicated that there is a lack of winter experiences and research resources, especially for high school and 2-year programs. Our team gathered important insights into how to best integrate winter-related citizen science programs into a variety of classrooms and how to create educational resources that will motivate further learning among different students.

Activity 1

For Activity 1, our team hosted a virtual event for K12 classrooms and nature centers, titled “Macroinvertebrate Mania.” After the live webinar, our team created a video, teacher guide, and other educational resources, so teachers can access the content as needed and asynchronously integrate the Macroinvertebrate Mania event recording and supporting resources into their classrooms. This content is available to the public on our Bugs Below Zero website. Our work for activity one also focused on evaluating all events that occurred last winter and planning for next winter’s activities. We met with our partners at the Belwin Conservancy to discuss their goals and programming priorities for 2023-2024. Our team started brainstorming plans for our in-person and virtual events that could fit with the Belwin’s plans, which are tentatively planned for February of 2024.

Activity 2

For Activity 2, our team finalized a data collection and sharing tool that can be used by citizen volunteers, higher education classrooms, and high school students to make observations about winter active insects, weather, and stream conditions. After incorporating early feedback from Southwest Minnesota State University, we worked with team of 11 educators (from high schools, 2-year institutions, and 4-year institutions) to review our citizen science data collection tool and gather feedback. The tool is ready to share with additional classrooms and students.

Dissemination

We are continuing to share updates on social media channels and via partner organization email lists, including those owned by the University of Minnesota, Bell Museum, Trout in the Classroom, and Minnesota Ag Instructors. We have also created new teacher guides, videos, classroom activities, blog posts, and other content that is shared on the Bugs Below Zero website. We have also shared flyers about the website and example educational resources during our live events.

Status Update Reporting

Status Update March 1, 2023

Date Submitted: March 9, 2023

Date Approved: March 17, 2023

Overall Update

The Bugs Below Zero project focuses on increasing research capacities and inspiring environmental learning. We have made progress towards these goals by developing a wider network of faculty at higher educational institutions within Minnesota that teach classes related to water and insects. This group of faculty has offered feedback and input on a research protocol to collect data about the winter activity of insects. Our second goal, focused on inspiring environmental learning, has been moved forward by our work to host events that encourage classrooms and community members to learn more about winter stream food webs. More specific details about these two activities are shared below.

Activity 1

Within Activity 1, our grant team proposed a series of events for K12 students, teachers, organizations, and families, including at least one in-person and one virtual event each year. Our team hosted two in-person events at the Bell Museum:

- Spotlight Science: Bugs Below Zero. On Saturday, December 10th, 2022, the Bugs Below Zero grant team hosted an interactive, in-person event with partners at the Bell Museum. Attendees were able to meet Minnesota's winter aquatic insects in a living stream demonstration, create a life cycle at the winter food web station, and learn about different species with crafts and digital stories. The event was hosted in the main atrium of the Bell Museum, which estimates we had 569 visitors come through stations and exhibits that day.

- SNOW-MUCH-FUN. During the week of 12/26-12/30, Bugs Below Zero grant team members were part of a Bell Museum camp, designed for students in grades 3-5. The goal was to demonstrate how nature adapts to changing weather conditions. During our session, students were able to learn about winter active insects, what winter stream food webs look like, and the impact of changing winter weather conditions.

Activity 2

Within Activity 2, our grant team proposed developing communication channels, classroom activities, and data collection systems that can expand research done on winter active insects. Our grant team has been meeting with government organizations, nonprofit organizations, and faculty at other higher education institutions within Minnesota to gather feedback on a new data collection protocol and platform that can be more widely used by citizens, organizations, and classrooms to systematically gather observations about insect activity, weather and water conditions. Faculty at Southwest Minnesota State University piloted an early version of this form over the winter, to make sure it can be used by undergraduate students and classrooms for research projects.

Dissemination

The work in Activity 1 and 2 has been shared on social media channels, including those run by UMN AECM, CFANS, Minnesota SEAGRANT, and the Bell Museum. Messages about Bugs Below Zero events and resources have also been shared on email lists that reach Minnesota educators, including the Trout in the Classroom and Minnesota AgInstructors groups.