

Final Abstract

Final Report Approved on May 1, 2026

M.L. 2022 Project Abstract

For the Period Ending June 30, 2025

Project Title: Restoration of Eastern Hemlock, Minnesota's Endangered Tree Species

Project Manager: Marcella Windmuller-Campione

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

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Funding Source:

Fiscal Year:

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

Appropriation Amount: \$199,000

Amount Spent: \$181,536

Amount Remaining: \$17,464

Sound bite of Project Outcomes and Results

This project had the opportunity to explore and expand current knowledge on locations of planted hemlock tree across the state using a broad survey. Additionally, we quantified growth and survival of planted hemlock across a climatic range of conditions in Minnesota with different stock type - underplanting was most successful.

Summary of Project and Outcomes

Eastern hemlock is a long lived conifer that reaches its range margins in Minnesota. Hemlock is considered an endangered species in Minnesota but is widely distributed in Wisconsin. Hemlock can provide multiple ecosystem services and restoration of hemlock can provide managers with another long-lived conifer to plant in Minnesota. The current knowledge related to hemlock distribution in Minnesota has mostly focused on wild (or naturally regenerating individuals). However, hemlock is a widely planted species in many spaces (individual homes, more natural areas, and private landowners on their forested lands). We surveyed individuals and observed hemlock planted and surviving across Minnesota - hemlock can survive on a variety of soil types and conditions and planted individuals are reaching sexual maturity (producing cones). We also selected 4 locations to plant hemlock of various stock types to test survival of relatively local genetic stock - stock from Wisconsin and Michigan. We planted these with and without a nurse log - a

nurse log as been shown to help reduce stress by creating shade and more moisture. Mortality was high in the first three years of sampling (2 years funded through LCCMR) a 3rd completed in fall of 2025. Some of the seed sources had less than 40% survival by year 3. However, in general individual planted next to the nurse log had higher survival. Additionally, survival and growth were best in a site that was underplanted and relatively moist. Additional sampling will be conducted to provide survival results for year 5 which are in line with management recommendations used by natural resource managers. This will provide information on if and how this species could be used as a restoration tool for forests within Minnesota

Project Results Use and Dissemination

We have shared results broadly within the forestry communities through local and regional webinars and conferences. Kira Pollack graduated and her thesis is currently available. We are working to finish up the manuscript on the survey results that were the first chapter in Kira's thesis. We will collect additional data on hemlock survival and growth (not funded by lccmr) and publish management recommendations based on those longer term results.



Environment and Natural Resources Trust Fund

M.L. 2022 Approved Final Report

General Information

Date: August 18, 2026

ID Number: 2022-193

Staff Lead: Noah Fribley

Project Title: Restoration of Eastern Hemlock, Minnesota's Endangered Tree Species

Project Budget: \$199,000

Project Manager Information

Name: Marcella Windmuller-Campione

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

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Project Reporting

Final Report Approved: May 1, 2026

Reporting Status: Project Completed

Date of Last Action: May 1, 2026

Project Completion: June 30, 2025

Legal Information

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

Appropriation Language: \$199,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to develop guidelines for restoring eastern hemlock, Minnesota's only endangered tree species, by testing methods and seed sources at different sites across northern Minnesota.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: This project will develop planting guidelines for eastern hemlock, Minnesota's only endangered tree species from four different seed sources planted on four different sites across northeast and north central Minnesota.

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

Eastern hemlock is Minnesota's rarest tree species, numbering about 50 mature wild trees in the state. In the early 1900's it was more prevalent but overharvesting, wildfire and severe weather events have dropped the number of trees precipitously. Two populations, near Paupores, MN and Mile Lacs Lake have disappeared entirely while the Hemlock Ravine in Jay Cooke State Park has suffered losses due to rain induced landslides. As a result of these losses hemlock was listed as a species of great concern in 1984 and state endangered in 2013.

Eastern hemlock is a long-lived, shade tolerant conifer with high wildlife value. It provides excellent winter cover and food for birds, deer and moose and is suitable for fisher habitat. In Wisconsin, it is a valuable commercial species, utilized for pulp, saw timber and veneer. In northern Wisconsin and western Michigan hemlock exists in larger numbers and regenerates readily as seedlings, often benefiting from cooler, moister conditions near downed logs.

In Minnesota there is growing interest in restoration of hemlock through planting but there is little information on forest restoration techniques. Data are needed to make recommendations on how site quality, weather conditions, and planting techniques influence restoration success.

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.

Our proposal will provide natural resource professionals with recommendations about site selection and planting methods to maximize the survival and growth of eastern hemlock seedlings. We will assess current and historical eastern hemlock sites in the state for soil type and weather conditions (precipitation, temperature, etc.) to understand the range of conditions hemlock seedlings prefer.

We will then establish an eastern hemlock restoration experiment on four sites across northeast and north central Minnesota. Sites will be located collaboratively with Fond du Lac Natural Resources, Carlton County Land Department and University of Minnesota Research and Outreach Centers and cover a range of environmental and site conditions. The goal is to test restoration efforts on sites similar to previous eastern hemlock populations and are likely to support the species in the future. Within each site we will plant seedlings with and without 'nurse blocks', small blocks of wood designed to mimic the cooler, moister conditions provided by downed logs.

While eastern hemlock provides excellent habitat for many wildlife species as mature individuals, as seedlings, it can be heavily browsed. To protect seedlings from browse and to assess the potential site for restoration, all eastern hemlock seedlings will be fenced.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

This project will provide some of the first information on restoration strategies and treatments for eastern hemlock, a species considered endangered in Minnesota. Our information is vital to forest management agencies and private landowners as they seek to provide multiple ecosystem services including wildlife habitat, species diversity, and forest productivity.

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): NE, Central,

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Identify site conditions that promote survival and growth of eastern hemlock seedlings in Minnesota.

Activity Budget: \$38,000

Activity Description:

Through an email survey of natural resource organizations and city foresters in the state and a search of published records such as journal articles, dissertations, popular press, websites, herbarium samples from the Minnesota Biodiversity Atlas and forest inventory analysis records, identify the latitude and longitude of current and historic eastern hemlock sites. Use these geo-referenced locations to find online soils information and weather records for each site and create a description of the type of site favored by eastern hemlock. This information will be specific to Minnesota and more informative than a range map and a standard textbook description of eastern hemlock site preferences.

Activity Milestones:

Description	Approximate Completion Date
Create and send email survey regarding location of any existing hemlock in Minnesota	August 31, 2022
Search published accounts for historic or current existence of eastern hemlock in Minnesota	August 31, 2022
Analyze results of email survey and published accounts and create description of preferred hemlock sites	December 31, 2022

Activity 2: Establish four eastern hemlock seedling trials across northeastern and north central Minnesota

Activity Budget: \$44,000

Activity Description:

This activity identifies the four sites, plants the seedlings, and establishes the experiment. Identify four planting sites on collaborator lands that meet the Minnesota specific eastern hemlock site preferences found in Activity 1. Prepare the sites for planting seedlings by herbicide or mechanical removal of grass, weeds, brush and/or trees if necessary. Purchase seedlings, fencing, fence posts, wooden 'nurse blocks', and planting supplies. Seedlings will come from four different sources, three from near local Wisconsin sources and one from a distant source to test the value of locally sourced hemlock seed. Plant a total of 480 seedlings across four sites (30 seedlings from each of four different seed sources planted at four different locations or $30 \text{ seedlings} \times 4 \text{ sources} \times 4 \text{ sites} = 480 \text{ seedlings}$). Install 'nurse blocks' on half of the seedlings and fence each site.

Activity Milestones:

Description	Approximate Completion Date
Identify four locations on collaborator lands to plant seedlings that fit favored sites description	March 31, 2023
Acquire fencing supplies, nurse blocks, seedlings	May 31, 2023
Prepare sites for planting by removing competing vegetation	June 30, 2023
Plant seedlings, install nurse blocks, establish trials, fence trials on four sites	June 30, 2023

Activity 3: Collect seedling survival and growth data, analyze data, create planting recommendations and disseminate results

Activity Budget: \$117,000

Activity Description:

During this phase of the project sites are visited three times during each of two growing seasons (2023 and 2024) to collect seedling data, manage competing vegetation, and fix any fencing issues. At the beginning, middle and end of each growing season the following data is collected: survival, height growth, needle coloration, bud set, bud break, frost damage and winter injury. Collectively this tells us how well the seedlings are growing on the sites we chose, the impact of 'nurse blocks' and whether local seed sources are better for early seedling survival and growth. After the first growing season data can be analyzed and preliminary results presented at conferences. Early spring second year data will have important information about winter injury and survival with a new analysis each time data is collected. Data collected at the end of the second growing season will be the most informative and after analysis will be used to write restoration method articles for land management agencies and make formal presentations.

Activity Milestones:

Description	Approximate Completion Date
Visit each site three times during first growing season; collect data, check vegetation, fix fencing.	October 31, 2023
Preliminary analysis and presentations of preliminary results	February 28, 2024
Visit each site three times during second growing season; collect data, check vegetation, fix fencing.	October 31, 2024
Analysis of second year data, write restoration methods articles, make formal presentations, summary of findings.	June 30, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Marcella Windmuller-Campione	University of Minnesota Twin Cities	Assist with site determination, experimental design, co-mentor graduate student	Yes
Christian Nelson	Fond du Lac Natural Resources	Identify host site based on site criteria, direct site preparation if any, assist with planting,	No
Mark Westphal	Carlton County Land Department	Identify host site based on site criteria, direct site preparation if any, assist with planting.	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.

This project will generate data on conditions favorable for growth of eastern hemlock in Minnesota and two solid years of data on survival and growth of planted seedlings. All in-person meetings, presentations and publications would be based on data collected during the course of the project. Presentation of results will be made at conferences in state such as the Society of American Foresters annual meeting (statewide gathering of forestry professionals) and the Sustainable Forests Education Cooperative's annual Research Review. In person presentation allows for direct contact with practicing professionals and the ability to answer questions efficiently and effectively. First year data is better suited for non-peer reviewed journals and magazines such as Conservation Volunteer, Tree Planters Notes, the Great Lakes Silviculture Library (online only) or an Extension publication like My Minnesota Woods. Even though second year survival and growth data would be considered 'preliminary' for a long-lived species it will be sufficient for peer reviewed publication. Target journals would be Forest Ecology and Management, Forests, Ecological Restoration or Journal of Sustainable Forestry. These choices of conferences, in person meetings and publication choices are designed to reach those natural resource managers that are most likely interested in planting eastern hemlock and either read or attend professional or semi-professional meetings. For all communications (print, presentation, media, etc) the Environment and Natural Resources Trust Fund will be acknowledged through use of the trust fund logo or attribution language per the ENRTF Acknowledgment Guidelines. Specifically for print publications recognition of Environment and Natural Resources Trust Fund funding will be provided as an acknowledgement (typically in an acknowledgement section). For in person or electronic presentations acknowledgement will be made verbally and with the assistance of the ENRTF logo, while media interviews would receive a verbal recognition.

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?

Ultimately the results of this project will be implemented by other land managers and researchers who will use this information to successfully plant eastern hemlock. To get this information into the hands of practitioners we will make presentations at annual meetings of professional organizations in the state (Society of American Foresters, Wildlife Society), offerings through the Sustainable Forests Education Cooperative, on site tours and written summaries in scientific journals and Extension publications and non-scientific outlets such as MyMinnesotaWoods.com. Monitoring and reporting beyond this period can be handled through undergraduate internships and research opportunities provided through the University of Minnesota.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount	\$ Amount Spent	\$ Amount Remaining
Personnel										
Graduate Student - TBD		Involved in all aspects of Activities 1, 2 and 3			11%	1.25		\$114,469	-	-
Andrew David		Project manager, co-advise graduate student, assistance with surveys, experimental design, plantation establishment, knowledge of seed sources			36.5%	0.07		\$12,464	-	-
Undergraduate student - TBD		Assist with data collection, data entry, vegetation management, fix fencing as needed			0%	0.5		\$15,600	-	-
Marcella Windmuller-Campione		Co-advise graduate student, assistance with site selection, experimental design, knowledge of silvicultural methods			36%	0.1		\$25,638	-	-
							Sub Total	\$168,171	\$162,930	\$5,241
Contracts and Services										
Forestry contractor for site preparation - TBD	Service Contract	Company(ies) to provide site preparation (removal of grass, brush, trees) as required by site conditions to make site plantable. Contractor at each site to be determined independently. Total cost of site preparation at all four sites not to exceed \$4000				0.2		\$4,000	-	\$4,000
							Sub Total	\$4,000	-	\$4,000
Equipment, Tools, and Supplies										
	Tools and Supplies	56 rolls of 60 inch x 5 ft fencing	Main fencing to deter deer					\$3,080	\$3,080	-
	Tools and Supplies	112 rolls of 36 inch x 25 foot poultry fencing	Secondary fence to keep small mammals out of trial					\$1,680	\$179	\$1,501

	Tools and Supplies	20 treated wooden posts 10 foot long	Create corners of fence and 1 extra for gate					\$326	-	\$326
	Tools and Supplies	168 metal fence posts 7 foot long	Primary support for fencing, spaced approximately every 15 feet					\$1,008	\$1,008	-
	Tools and Supplies	2 spools of high tensile wire 14 gauge 1/4 mile long	Provides rigidity to top of fence					\$60	\$60	-
	Tools and Supplies	20 bags of poultry fencing clips	Attaches fencing and poultry fencing to metal fence posts					\$100	-	\$100
	Tools and Supplies	2 clip bender tools	Specialized tool that attaches poultry fencing clips faster than pliers					\$40	-	\$40
	Tools and Supplies	4 different sources of 500 eastern hemlock seedlings (minimum size order)	Required as seedlings for the experiment					\$1,200	\$1,200	-
	Tools and Supplies	60 timbers 8 foot x 6 inches x 6 inches aspen or pine	Will be cut into 2 foot sections to make 'nurse blocks'					\$1,440	\$1,040	\$400
	Tools and Supplies	48 rods of 10 foot long #3 rebar	Need two pieces of rebar one foot long each to hold 'nurse blocks' in place					\$240	\$150	\$90
	Tools and Supplies	Blades for cutting wood and rebar	Will require replacement blades for table saw and sawzall					\$50	\$50	-
	Tools and Supplies	Misc supplies, pin flags, markers, tape measure, spray paint	Supplies for laying out seedling planting spots and corners of fencing					\$500	\$500	-
							Sub Total	\$9,724	\$7,267	\$2,457
Capital Equipment										
							Sub Total	-	-	-
Acquisitions and Stewardship										
							Sub Total	-	-	-
Travel In Minnesota										

	Miles/ Meals/ Lodging	6 people, 4 sites, 8 days, 2 vehicles, 540 miles round trip travel St Paul to Carlton County to Cloquet area to Ely to Grand Rapids and back to St Paul.	Planting seedlings, installing 'nurse blocks', install fencing at 4 sites.					\$7,853	\$6,225	\$1,628
	Miles/ Meals/ Lodging	2 people, 4 sites, 4 days, 1 vehicle, 540 miles round trip St Paul, Carlton, Cloquet, Ely, Grand Rapids and back to St Paul. 5 trips over 2 summers..	Measure survival and growth and condition of seedlings, manage vegetation and fix fencing as needed.					\$7,552	\$5,114	\$2,438
	Conference Registration Miles/ Meals/ Lodging	1 person to present at two conferences, 2 days per conference, registration and mileage estimated	Present project and findings at two professional conferences of natural resource professionals	X				\$1,700	-	\$1,700
							Sub Total	\$17,105	\$11,339	\$5,766
Travel Outside Minnesota										
							Sub Total	-	-	-
Printing and Publication										
							Sub Total	-	-	-
Other Expenses										
							Sub Total	-	-	-
							Grand Total	\$199,000	\$181,536	\$17,464

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel In Minnesota	Conference Registration Miles/Meals/Lodging	1 person to present at two conferences, 2 days per conference, registration and mileage estimated	I am requesting an explicit approval for in state conference attendance including: travel, lodging, per diem and conference registration for 1 person AND ONLY if it relates to a formal presentation of project findings, i.e. the person and the title of the presentation are part of an official agenda. I am making this request based on the wording above under "Generally ineligible expenses unless explicitly approved:" specifically the description, "... except if to participate in formal presentation of project findings."

Non ENRTF Funds

Category	Specific Source	Use	Status	\$ Amount	\$ Amount Spent	\$ Amount Remaining
State						
In-Kind	University of Minnesota North Central Research and Outreach Center University of Minnesota Hubachek Wilderness Research Center	Long-term usage of land for eastern hemlock project - one site replication at each location.	Secured	\$5,000	\$5,000	-
			State Sub Total	\$5,000	\$5,000	-
Non-State						
In-Kind	Carlton County Land Department	In kind contribution of land for experimental site in Carlton County, time spent identifying parcel from land base, field checking and assistance with planting seedlings. Reimbursement waived via email.	Secured	\$5,000	\$5,000	-
In-Kind	Fond du Lac Forestry	In kind contribution of land for experimental site in Carlton County, time spent identifying parcel from land base, field checking and assistance with planting seedlings. Reimbursement waived via email.	Secured	\$5,000	\$5,000	-
In-Kind	University of Minnesota	Indirect costs waived by University of Minnesota;	Secured	\$109,450	\$109,450	-
			Non State Sub Total	\$119,450	\$119,450	-
			Funds Total	\$124,450	\$124,450	-

Attachments

Required Attachments

Visual Component

File: [3d055076-813.docx](#)

Alternate Text for Visual Component

Title: Restoration of eastern hemlock; Minnesota's endangered tree species. LCCMR 2022-193. Silhouette of Minnesota with the three major terrestrial biomes, tallgrass aspen parkland / prairie grasslands (west), eastern deciduous forest (central and southeast) and eastern coniferous forest (northeast and north central), four planting locations, seedling and nurseblock to protect from sun....

Supplemental Attachments

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

Title	File
UMN approval to submit	01495f39-ad2.pdf
David_2022-193_Restoration of eastern hemlock Minnesotas endangered species	583a7cad-791.pdf
Background check certification form	b7540d50-198.pdf
University of Minnesota waived indirect costs / overhead (see Line #19)	43425ca6-01d.pdf
Pollack Thesis	d1a8c08d-b70.pdf
Data Analysis for Hemlock 2023-2024 (2025 will be added)	2bab6cae-369.docx

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

After peer review the proposal required no changes. After legislative consideration the proposal was fully funded (whew!)

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?

Yes

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	Justification For Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Project Manager	Previous Manager: Andrew David (david046@umn.edu) New Manager: Marcella Windmuller-Campione (mwind@umn.edu)	Previous PM retired	August 29, 2024	Yes	August 29, 2024
2	Amendment Request	• Budget • Project Collaborators - Project Manager Info • Other	This amendment would shift \$4,000 from contract to UMN salary for undergrad field tech to complete the work this will be more efficient and allow survival and competition control to be completed together.	June 11, 2025	Yes	July 9, 2025

Status Update Reporting

Final Status Update August 14, 2025

Date Submitted: March 11, 2026

Date Approved: March 12, 2026

Overall Update

We observed hemlock growth and survival over three spring seasons. We will be taking a 3rd year measurement in October to complete the growing season (not funded by LCCMR). During the LCCMR grant, hemlock survival variable across sites and seed source. Hemlock that was underplanted had survival that was over 85% on average and the nurse block resulted in little difference. However, in open conditions hemlock survival with a nurse block was on average 45% compared to without a nurse block was only 25%. A nurse block or piece of wood can greatly increase the chance of hemlock survival in open conditions. Survival, height growth, and diameter growth were variable across the different seed stock. Stock sourced from the Forest Service and the Wisconsin DNR had good survival, height growth, and diameter growth. These represent seed stock local to the Great Lakes Region. We will add a 3rd year of data in October 2025 which will be used to create the management plan and presentation from Activity 3.

Activity 1

This activity was previously marked complete.

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

Activity 2

This activity was previously marked complete.

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

Activity 3

Completed measurements in June of 2025, additional measurements were completed in October 2025 (the end of the 3rd growing season), these results will be analyzed and used to develop planting recommendations. Seedlings that were planted in more open environments resulted in less growth and more stress than individuals planted in more mesic shaded environments. Tree tubes can be effective means to reduce deer browse compared to fencing which is more expensive and also can be reused more easily. The additional measurements were taken in October 2025 which represent the end of the growing season. Mortality was high in year 1 and 2 and while some mortality has been lower in year 3, additional years of data are needed and would be in line for forest management organizations who certify regenerate numbers at year 5. We will have an unmet outcome of developing management recommendations based on the 3 years of data but will continue to monitor hemlocks (not part of LCCMR - through other grants M. Windmuller-Campione or undergrad research opportunities.)

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

Dissemination

We have not shared any new results since that last update. A manuscript related to survey data is preparation and is expected to be submitted to a journal by December 2026. We will continue to monitor hemlock seedlings in year 4 and year 5, Data will be completed in October 2027 and data will be analyzed and recommendations complete by March 2028. All work will reference funding and support of the LCCMR

Status Update Reporting

Status Update March 1, 2025

Date Submitted: June 11, 2025

Date Approved: July 9, 2025

Overall Update

We are moving into the final stages of the project and are on task to complete the project requirements by June 30th. In February, a new researcher was brought on the project and will be assisting with data analysis and while report preparing. We completed end of growing season measurements in October and have observed that approximately 50% of the hemlock have survived for 2 years. Survival was greater when there was some level of overstory and also in general with a nurse object. Additionally, survival was generally greater for larger seedlings.

Activity 1

This activity was previously marked complete.

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

Activity 2

This activity was previously marked complete.

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

Activity 3

We completed end of growing season measurements in October of 2024. We are analyzing results and are observing trends related to the seed sources and type and also planting environment. Hemlock seedlings that were older and larger (3 year old seedlings) compared to 1 year old seedlings survived and grew more. Also, nurse logs helped all types of seedlings survive better. We were able to identify poor survival in one of our seed sources (Vans) and would not recommend it being considered for restoration. We will do one more round of survival measurements in early June before the end of the grant.

Dissemination

We are in the process of completing final reports and will also do another round of measurements (outside of the grant period) before publishing data on growth and survival. We are in the process of writing up a manuscript related to Activity 1 (the survey of hemlock planting).

Status Update Reporting

Status Update September 1, 2024

Date Submitted: September 6, 2024

Date Approved: November 26, 2024

Overall Update

Over the past two growing seasons, we have been able to connect with individuals about hemlocks. Hemlocks have been planted by individuals in Minnesota we increased the number of known hemlocks and have extended their range north and west in Minnesota. Planted hemlock is able to grow under a wide range of soil conditions and in some cases is successfully able to regeneration. During our planting study, we have tracked hemlocks over two very distinct growing seasons and will be able to provide initial information and growth and survival. Hemlock as a long-lived conifer has the potential to be another species within the foresters tool box within Minnesota

Activity 1

This activity was previously marked complete.

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

Activity 2

This activity was previously marked complete.

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

Activity 3

During summer 2024, the seedlings were visited twice to quantify survival. End of year measurements will be completed in October. Increased precipitation during the growing season allowed for better survival than 2023. Data will be entered and analyzed this fall. During summer 2024, Kira Pollack the graduate student on the project successfully defended her thesis. Her thesis included year 1 measurements and results from the survey from activity 1.

Dissemination

Presentation on survey results at Association of Natural Resource Extension Professionals in Hershey, PA (LCCMR funding not used for conference travel)

Thesis presentation by Kira Pollack

MS thesis - Hunting for Hemlock: Locating, restoring, and expanding eastern hemlock (*Tsuga canadensis* (L.) Carr.) presence in Minnesota

Status Update Reporting

Status Update March 1, 2024

Date Submitted: March 1, 2024

Date Approved: May 8, 2024

Overall Update

As of 29 Feb 2024 we have completed Activities 1 and 2 and Milestones 1 and 2 of Activity 3. All that remains are Milestone 1 of Activity 3 - Second year measurements and data entry and and Milestone 2 of Activity 3 - Analysis of second year data, writing papers and additional presentations of findings. The preliminary analysis has provided some of the first strategies for successful planting of eastern hemlock in Minnesota. These results have been presented at a recent meeting of practitioners and scientists and was well received. We are on time and on budget.

Activity 1

This activity was previously marked complete.

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

Activity 2

This activity was previously marked complete.

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

Activity 3

We visited all 4 sites 7 times during summer taking measurements on survival, height and diameter growth. This completes milestone #1. The data has been entered and preliminary analysis has been completed. Two presentations to research scientists and forest managers have been made using the preliminary analysis. This completes milestone #2. Currently two of the four milestones have been completed. The remaining two milestones (2nd year site visits, additional data collection, additional analysis, and formal presentations) are being worked on by the graduate student with undergrad assistance. We are on track to finish in the time and budget allotted.

Dissemination

Kira Pollack the graduate student made the following presentations at state and national forestry meetings. In both cases the materials were co-branded with UMN and ENTRF logos and verbal acknowledgement of the funding source and our partners.

Pollack, K., David, A. & Windmuller-Campione, M. (2023). Hunting for Hemlock: Locating and restoring eastern hemlock in Minnesota. Society of American Foresters lightning presentation, SAF National Convention, Sacramento, CA. October 26, 2023.

A Helping Hand for Hemlock: Restoring *Tsuga canadensis* in Minnesota. SFEC Research & Practice Review Lightning presentation. Cloquet, MN, February 21, 2024.

Status Update Reporting

Status Update September 1, 2023

Date Submitted: September 5, 2023

Date Approved: September 27, 2023

Overall Update

So far we have hit all our milestones in a timely manner. In this reporting period we established and fenced the four sites using 5 seedling sources (one additional compared to the proposal) and 36 seedlings per site (6 additional compared to the proposal). Activity 2 is now complete. We have now started Activity 3 which is data collection, analysis and reporting. We anticipate being in Activity 3 throughout the remainder of the projects' life.

Activity 1

This activity was previously marked complete.

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

Activity 2

Each site has a similar split block experimental design of 18 blocks and 36 replications. Each replication contains five randomized seedlings; one each of the five seedling sources (Ottawa National Forest, Hiawatha National Forest, Wisconsin DNR, Vans Nursery, Evergreen Nursery). Nurse blocks of wood were randomly assigned to one of the two replications in each block. Total trees planted per site is 180 (36 replications x 5 seedling sources) plus a border row. Grand total trees planted is 720 (180 x 4 sites).

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

Activity 3

Immediately after planting seedling height and stem diameter were recorded. Subsequent measurements taken at 2, 4 and 8 weeks after planting included survival, total height and stem diameter for each seedling. Lack of rain and drier than normal soils prompted us to plant reserve trees at Grand Rapids NCROC for out-planting early in spring 2024.

Dissemination

Graduate student, Kira Pollack, and the investigators partnered with CFANS communications specialist Emily Evans to publish an overview of the project for a lay audience (<https://cfans.umn.edu/news/boosting-eastern-hemlock>)

Status Update Reporting

Status Update March 1, 2023

Date Submitted: March 8, 2023

Date Approved: March 23, 2023

Overall Update

We are making progress and hitting our target dates on all activities. Activity 1 is now complete and work on Activity 2 has been initiated. Activity 3 begins once Activity 2 is complete. At this point we have not hit any roadblocks or issues that require a change to the project design or budget. We identified and hired a graduate student who started shortly after funds became available. They have been actively engaged in the project since they arrived. Recently we interviewed and hired an undergraduate who will start work on the project in May after spring semester concludes.

Activity 1

This first activity involved creating and disseminating a survey designed to identify any eastern hemlock in Minnesota. Specifically, we were interested in location, size of tree, number of trees, number of seedlings, proximity to water, predominately sunny or shady, evidence of seedlings, and any information the person knew about that particular tree(s). The location information was tied to soil surveys and weather data which helped us determine site selection (Activity 2). Although the survey remains open, we reported on findings to date at the Sustainable Forestry Education Cooperative's Research Review in Jan 2023. Over 350 eastern hemlock were reported in the survey and they occurred throughout the forested portion of the state except the extreme northwest and northeast. Two major hotspots of planting occurred in the Twin Cities metro area and Grand Rapids. Although the seed sources of these trees are not known the fact that so many exist across multiple portions of the state suggests that eastern hemlock can withstand a wider variety of site conditions and weather than is suggested by our native population.

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

Activity 2

Information gleaned from the survey in Activity 1 is being used to identify four planting locations for eastern hemlock seedlings. We have worked with our project partners at Fond du Lac Natural Resources and Carlton County Land Department to identify two appropriate sites for planting eastern hemlock seedlings. We are working through our FDL colleague to get final approval for the FDL site and feedback on a data sharing plan so Tribal Natural Resources is fully aware of the planting, the data collected and our findings. We have identified a third site which will be located near Grand Rapids on University of Minnesota North Central Research and Outreach property and a fourth site designed to test winter hardiness at UMN Hubachek Wilderness Research Center near Ely, Minnesota. These four sites have a variety of soil types and soil moistures all of which are capable of supporting forest seedlings. Establishment of the four sites is expected in spring 2023.

One of the suggestions from the panel review was to increase the number of seedling seed sources if at all possible. As approved the project called for four sources and we were able to locate a 5th source of seedlings.

Activity 3

Not applicable until sites in Activity 2 are established.

Dissemination

The survey of eastern hemlock seedlings was created as a Google form and co-branded with the University of Minnesota and ENRTF logos. Emails went out to natural resource professionals identifying the project and inviting them to fill out the survey. Additionally, we used electronic newsletters of various organizations (MyMinnesotaWoods, Master Naturalist, SFEC, Minnesota Tree Improvement Cooperative, etc) to advertise the project and invite any reader to fill out

a survey. Again, these announcements were co-branded. The graduate student presented the results of the seedling survey in an oral and poster presentation to attendees at the SFEC Research Review on 11 January 2023 with both acknowledging the support of ENRTF.