Final Abstract

Final Report Approved on October 28, 2026

M.L. 2022 Project Abstract

For the Period Ending June 30, 2026

Project Title: Status of Minnesota Blueberries and Related Berry Species

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Funding Source:

Fiscal Year:

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

Appropriation Amount: $191,000

Amount Spent: $185,849

Amount Remaining: $5,151

Sound bite of Project Outcomes and Results

We evaluated land management and the genetic health of wild populations of dwarf bilberry, lingonberry, blueberry in northern Minnesota to understand what drives a good berry crop. Active land management practices promote berry production in blueberries, but not in dwarf bilberry or lingonberry, where the key factors are still unknown.

Summary of Project and Outcomes

Despite the popularity of wild blueberries and the importance of their close relatives, we know little about what maintains healthy populations in terms of genetic diversity and berry production. This is a critical gap in our knowledge because these species can spread by both sexual and clonal (vegetative) growth, with implications for berry production and population survival. In this project, we surveyed the reproductive and genetic health of 42 populations of dwarf bilberry (Vaccinium cespitosum), lingonberry (Vaccinium vitis-idaea), and two species of blueberry (Vaccinium angustifolium and Vaccinium myrtilloides) in northern Minnesota. We evaluated the relationship between land management, genetic health (clonality), and reproductive health (flowering and berry production). We found that disturbances like prescribed burns promoted berry production in the blueberries, which supports current land management practices. However, we also found that land management did not promote reproductive health in dwarf

bilberry or lingonberry, and that all four species have low rates of reproduction, with fewer than 25% of individuals producing flowers in most populations. All four species depend on clonal reproduction to some degree, with lingonberry showing the lowest levels of genetic health. Contrary to expectations, the genetic health of populations was unrelated to the history of land management, although it did show a predictable pattern based on species growth form, with lingonberry showing the lowest genetic health (highest clonality) and the blueberries showing the highest genetic health (lowest clonality). Overall, our results confirm the use of current land management to promote berry production in blueberry species, but open questions about the drivers of reproductive heath in other species and genetic health across all four species.

Project Results Use and Dissemination

Project results were shared with state, federal, and tribal agencies managing populations of dwarf bilberry, lingonberry, blueberry in northern Minnesota. The results support the agencies' current land management strategies to promote berry production in blueberries. However, they also show that further investigation is necessary to understand the berry production in blueberry relatives.

Environment and Natural Resources Trust Fund

M.L. 2022 Approved Final Report

General Information

Date: November 2, 2026

ID Number: 2022-109

Staff Lead: Tiffany Schaufler

Project Title: Status of Minnesota Blueberries and Related Berry Species

Project Budget: $191,000

Project Manager Information

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Project Reporting

Final Report Approved: October 28, 2026

Reporting Status: Project Completed

Date of Last Action: October 28, 2026

Project Completion: June 30, 2026

Legal Information

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

Appropriation Language: $191,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota, Duluth, to assess how land management practices impact the genetic health and reproduction of several native edible blueberry and related berry species of Minnesota. This appropriation is available until June 30, 2026, by which time the project must be completed and final products delivered.

Appropriation End Date: June 30, 2026

Narrative

Project Summary: Northeastern Minnesota is home to several native, edible blueberries and related berries. This project will assess how land management practices impact the reproductive and genetic health of four key species.

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

Northeastern Minnesota is home to multiple species of blueberries and their close relatives, all of which are native, wild, and produce edible berries. These include:
- Lowbush blueberry (Vaccinium angustifolium): wild blueberry
- Velvet-leaf blueberry (Vaccinium myrtilloides): wild blueberry
- Lingonberry (Vaccinium vitis-idaea): berries used in jams and sauces
- Dwarf bilberry (Vaccinium cespitosum): larval host plant to the rare Nabokov's blue butterfly

Despite the popularity of wild blueberries and the importance of their close relatives, we know little about the genetic and reproductive health of Minnesota populations. This is a particularly critical gap because each of these species can spread by clonal (vegetative) growth, so populations that appear large and healthy might actually consist of only one genetic individual, meaning there is no genetic diversity. Indeed, previous genetic work on Minnesota lingonberry shows that some populations are dominated by only 2-4 clones. If a population consists of only a few clones, this can have two negative consequences: 1) Lack of genetic diversity to respond to environmental changes (poor genetic health), and 2) Low berry production when most pollen comes from the same clone (poor reproductive health). Both of these consequences can ultimately result in population collapse and species decline.

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 will assess the genetic and reproductive health of Minnesota blueberries and their relatives, and how these measures of health are impacted by land management.

Genetic Health: Genetic data has been gathered for lingonberry (UMN funded) and is in progress for dwarf bilberry in the Superior National Forest (EPA GLRI funded). In this project, we will extend the dwarf bilberry genetic work across northeastern Minnesota and generate data for the two species of wild blueberry. This will allow us to determine whether populations are genetically diverse (healthy) or highly clonal (unhealthy), and we will test whether genetic health is influenced by land management history.

Reproductive Health: Reproductive health controls berry production and is influenced by both genetic health and land management. We will monitor flower and berry production in populations of the two species of wild blueberry, as well as lingonberry and dwarf bilberry across northeastern Minnesota for multiple years. This will allow us to determine whether populations are producing berries in proportion to the number of flowers they produce (healthy), or whether berry production is low compared to flower number (unhealthy). We will test whether land management history or genetic health best predicts reproductive health.

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?

Picking blueberries and their relatives is a memorable outdoor experience for many Minnesotans. Although it is clear that a forest clearing event (fire or logging) is followed by a good berry crop, we know little else about the reproductive health and genetic diversity of these species in Minnesota. This study will fill a critical gap about the genetic and reproductive health of Minnesota's blueberries and blueberry relatives. The information will allow land managers to choose practices that promote genetic diversity and high berry production in wild populations and also facilitate the long-term conservation of these species in Minnesota.

Project Location

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

Region(s): NE

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

Region(s): NE

When will the work impact occur?

In the Future

Activities and Milestones

Activity 1: 1. Reproductive Health of Blueberry and Blueberry Relative Populations

Activity Budget: $79,500

Activity Description:
We will survey 12 populations of each of the four species (two species of wild blueberry, lingonberry, and dwarf bilberry) in locations spread across northeastern Minnesota (12 populations x 4 species = 48 locations). In the first year we will focus on one species of blueberry and dwarf bilberry, and in the second year we will add the second species of blueberry and lingonberry. Populations will be selected along a north/south latitudinal gradient based on DNR Releve surveys and in consultation with land managers. Whenever possible, we will select sites with known management histories (e.g., time since timber harvest or burning) to assess how these factors correlate with berry production.

Standardized plots within these populations will be selected along a transect, and plots will be flagged and geolocated. Each population will be visited multiple times each year to count the flowers and berries per plot. Flower production, berry production, and berry per flower production will be measured for each population to estimate reproductive health. Populations with a high ratio of berries to flowers are considered "reproductively healthy". Reproductive health will be compared to land management history and genetic health from Activity 2 to determine which factors best predict reproductive

Activity Milestones:

Description	Approximate Completion Date
Reproductive health populations identified in consultation with land managers	November 30, 2022
Year 1 reproductive surveys complete	November 30, 2023
Year 2 reproductive surveys complete	November 30, 2024
Analysis of the effect of land management and genetic health on reproductive health	December 31, 2025

Activity 2: 2. Genetic Health of Blueberry and Blueberry Relative Populations

Activity Budget: $111,500

Activity Description:
Genetic health of Minnesota lingonberry populations was assessed in a previous study (see Visual Component), and genetic assessment of dwarf bilberry populations in the Superior National Forest is underway. We will generate genetic data for dwarf bilberry populations outside of the Superior National Forest and also for the two species of wild blueberry using the Restriction-enzyme Associated DNA sequencing (RAD-seq) approach. The sampled populations will include all the populations being surveyed in Activity 1, and we will select additional populations in the same manner, prioritizing populations with known management histories.

We will generate RAD-seq data for approximately 14 populations of each of the three species, with approximately 24 individuals per population. The RAD-seq data will allow us to identify the number of genetically distinct individuals in each population (i.e., that population's dependence on clonal reproduction) and estimate the genetic diversity of each population. Populations made up of genetically distinct individuals (low dependence on clonal reproduction) with high genetic diversity are considered "genetically healthy".

Activity Milestones:

Description	Approximate Completion Date

Genetic health populations identified in consultation with land managers, begin sampling	November 30, 2022
Sampling complete	June 30, 2023
Genetic data generation complete	June 30, 2024
Analysis of genetic health and its relationship to land management and reproductive health	December 31, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Jack Greenlee	US Forest Service, Superior National Forest	J. Greenlee is the lead on a Great Lakes Restoration Initiative (GLRI) funded project to test how land management impact the genetic diversity of dwarf bilberry in the Superior National Forest. The GLRI project is complimentary to the broader project proposed here.	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.
Our yearly progress on the project will be shared with land managers during our annual virtual meetings, and at these times we can also incorporate additional information and suggestions from these stakeholders. We will present all results to this group at the end of the project and provide a technical report of the initial results. These initial results will be followed by a peer-reviewed publication and presentations at scientific meetings and public outreach events. We anticipate that this project will result in further collaborations to answer other questions about these key species.

Raw data generated as a result of this work will be made available through public data-hosting services, including the Data Repository for the University of Minnesota (DRUM) and the National Center for Biotechnology Information Sequence Read Archive (NCBI SRA). Sharing the data through these free, accessible servers will ensure its stability through time and allow other individuals to examine and analyze the data.

The Environment and Natural Resources Trust Fund will be acknowledged through use of the trust fund logo and/or attribution language in all presentations at virtual or in-person meetings (for either outreach or at professional meetings), and the ENRTF will be acknowledged in any news coverage of the project. Attribution language will be added to peer-reviewed publications to acknowledge the ENRTF as a funding source.

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?
All study results will be shared with the MN DNR, the US Forest Service, Minnesota tribes, and any interested private or non-profit land managers to facilitate both conservation and management for berry production. We will share a project summary in a written form at the conclusion of the study and will also host short virtual meetings each year to solicit suggestions and questions from land managers and keep them updated on the project progress, including a presentation of final results. We plan to seek external funding in the future to compare Minnesota populations to other states and countries.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Conserving and Monitoring of Minnesota's Rare Arctic Plants	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 08d	$135,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Field Technicians		Locate populations, collect samples, collect reproductive health data			24%	1.26		$72,353	-	-
Undergraduate Research Student		Assist in sample and data collection			0%	0.75		$27,422	-	-
Project Manager		Project design and data analysis, supervision and training of employees for sample and data collection			27%	0.06		$10,942	-	-
							Sub Total	**$110,717**	**$109,264**	**$1,453**
Contracts and Services										
University of Minnesota Genomics Center	Internal services or fees (uncommon)	RAD-seq genetic data generation at the University of Minnesota Genomics Center. Cost includes DNA extraction, library preparation, and sequencing.				-		$61,558	$60,425	$1,133
							Sub Total	**$61,558**	**$60,425**	**$1,133**
Equipment, Tools, and Supplies										
	Tools and Supplies	Supplies include 1.5 mL tubes, ziplock bags, freezer boxes, forceps, scissors, ethanol, and dry ice.	Supplies are for collecting and storing plant samples for genetic analysis.					$1,835	$1,335	$500
							Sub Total	**$1,835**	**$1,335**	**$500**
Capital Equipment										
							Sub Total	**-**	**-**	**-**
Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**

Travel In Minnesota										
	Miles/ Meals/ Lodging	Milage/vehicle rentals/meals/camping expenses for two technicians to visit 24 populations 3x per year for 2 years for reproductive health surveys, and visit additional populations for sample collection.	Repeated visits for reproductive health surveys and single visits to populations for sample collection.					$16,590	$14,825	$1,765
							Sub Total	**$16,590**	**$14,825**	**$1,765**
Travel Outside Minnesota										
							Sub Total	**-**	**-**	**-**
Printing and Publication										
							Sub Total	**-**	**-**	**-**
Other Expenses										
		Overnight shipping of frozen samples to the University of Minnesota Genomics Center from Duluth, MN.	Genetic data for evaluation of genetic health of populations.	X				$300	-	$300
							Sub Total	**$300**	**-**	**$300**
							Grand Total	**$191,000**	**$185,849**	**$5,151**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Other Expenses		Overnight shipping of frozen samples to the University of Minnesota Genomics Center from Duluth, MN.	Shipping frozen samples overnight is more affordable than refunding the cost of round-trip milage for a trip to St. Paul from Duluth.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount	$ Amount Spent	$ Amount Remaining
State						
In-Kind	University of Minnesota unrealized indirect cost returns.	These funds would normally be used for the maintenance of laboratory space and staff for budget administration and compliance to state policies.	Pending	$96,016	-	$96,016
			State Sub Total	**$96,016**	**-**	**$96,016**
Non-State						
			Non State Sub Total	**-**	**-**	**-**
			Funds Total	**$96,016**	**-**	**$96,016**

Attachments

Required Attachments

Visual Component

File: 23ba2e41-1ad.pdf

Alternate Text for Visual Component

This visual has two elements. One element is a map showing the genetic health of Minnesota lingonberry populations assessed in a previous study. At least 10 plants were sampled from each of 14 populations. The four populations marked in purple contained no more than four genetically unique individuals, indicating high dependence on clonality and low genetic health. The other element is a set of four photos showing the two species of wild blueberry, lingonberry, and dwarf bilberry....

Supplemental Attachments

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

Title	File
Submission Approval	23cfdfeb-84a.pdf
2022-109_ResearchAddendum	3354e79e-98d.pdf
Background Check	59f1a0cc-3a5.pdf
2024 Vaccinium poster - Botany meeting	081dc22f-915.pdf
2024 Vaccinium presentation - Botany meeting	d21133f6-043.pdf
2026 Vaccinium presentation - Botany meeting	dea5d048-19f.pptx
Technical report	643675d3-83f.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

There are two main changes from the proposal to workplan stage:
1. An extension of the end date for the project to Dec. 31st, 2025.
2. A change in the timing and number of population samples for reproductive health in Activity #1. The original proposal included sampling 6 populations of all four species for two years each. In response to suggestions from peer-reviewers, we changed this to 12 populations of each of the four species, but shifted the timing so that only two species would be sampled in the first year of the project, and the remaining two would be added in the second year. This increases the total number of populations to be measured, but it means that two of the species will be measured for only one year. This is still a useful measure of reproductive health - a single year is used in many studies. See page 6 of the Research Addendum for details.

Update, 6/15/2022: I have attached the background check statement and updated the dissemination section to include how the ENRTF will be acknowledged.

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

N/A

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	Amendment Request	• Budget - Personnel • Budget - Travel and Conferences	Personnel: A Graduate Student was not recruited, so this reallocation will allow for the continuation of field work by Field Technicians and Undergraduate Students for sample and data collection. No new positions proposed. Travel: Added “vehicle rental” to the description to allow renting vehicles. Technicians have been using personal vehicles for travel, but need access to rentals to increase flexibility when their personal vehicles are not available.	August 21, 2025	Yes	August 21, 2025
2	Completion Date	Previous Completion Date: 12/31/2025 New Completion Date: 06/30/2026	More time is requested to complete the last step of genetic data collection and write the final report for the project. This is not a legislative extension, as the appropriation ends in June 2026.	November 24, 2025	Yes	November 24, 2025
3	Amendment Request	• Budget - Personnel • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences	Reallocate $500 from “Travel” to “Supplies” to cover the cost of tubes and boxes used to transfer berries/leaf samples for additional measurement. These supplies will arrive before the project end date and can be immediately utilized in the lab for final measurements. Reallocate $3000 from “Travel” to “Personnel” to cover the cost of technician time for data collection and analysis for the final report.	June 11, 2026	Yes	June 16, 2026

Status Update Reporting

Final Status Update August 14, 2026

Date Submitted: August 14, 2026

Date Approved: October 16, 2026

Overall Update
Our goal in this project was to assess the genetic and reproductive health of Minnesota blueberries and their relatives, and how these measures of health are impacted by land management. We have completed this goal by collecting reproductive and genetic data from populations of four species of Vaccinium with different land management histories.

This work confirmed that current land management practices like prescribed burns promote reproductive health in both low-bush and velvet-leaf blueberry. However, these land management techniques did not promote reproductive health in lingonberry or dwarf bilberry. In addition, we found no relationship between genetic health and reproductive health. Our results reinforce the current land management techniques for blueberry species, but also lead to questions about the factors that determine reproductive health in lingonberry and dwarf bilberry. We also identified generally low reproductive effort across all species, which would benefit from further investigation.

Genetic health was lowest in lingonberry and higher in the other three species, but all four species utilized at least some degree of clonal reproduction. Genetic health was not predicted by land management in any species, indicating that other factors are more important. Populations with very low genetic health should be monitored for survival impacts.

Activity 1
Data collection and analysis for Activity 1 is complete. We reached the goal of completing reproductive surveys for each of the four species for two years, with 12 populations of each species in at least one of the years. However, some of the populations were smaller than anticipated, so the data was not statistically useful in for analysis, as indicated in the final report. This mainly impacted velvet-leaf blueberry - sample sizes were robust for the other three species. Reproductive effort (the proportion of flowering individuals per population) was generally below 50% and often below 25%

Analysis of the impact of land management and genetic health on the reproductive health of the populations in the survey revealed that recent disturbance was predictive of reproductive health for the two blueberry species, in the expected direction (recent disturbance resulted in good reproductive health). However, disturbance was not predictive for dwarf bilberry or lingonberry. Genetic health did not predict reproductive health for any species in the study. Please see the attached technical report for a detailed analysis.
(This activity marked as complete as of this status update)

Activity 2
Genetic data collection and analysis for Activity 2 is complete. We reached our goal of sampling 11-14 populations per species with at least 24 samples per population for all the species except for velvet-leaf blueberry, where only a few populations yielded useful genetic information (again because of small, sparse populations). All species showed at least some reliance on clonal reproduction, with lingonberry showing the highest degree of clonality (lowest genetic health) compared to the other species.

Analysis of the impact of land management on genetic health did not conform to our expectations (i.e., disturbance was not correlated with good genetic health). This is in contrast to predictions from other partially clonal species, where disturbance generally results in lower levels of clonality. Our result indicate that this is either not a factor for Vaccinium or that the pattern was not evident a the scale of our study. We suggest that further study, especially of the impact of

fire on the clonal composition of low-bush blueberry, would be useful. Please see the attached technical report for a detailed analysis.
(This activity marked as complete as of this status update)

Dissemination
Since the last update, we have presented a talk at the international Botany conference, with acknowledgements of LCCMR funding (attached).

The technical report* (attached) has been shared with land managers, and we will incorporate their revisions and recommendations for additional analyses. We had initially planned on a virtual joint meeting of all the land managers, but we have instead been meeting with groups from different agencies and locations separately to gather their input and plan for the next steps. We have met with land managers from the US Forest Service (Chippewa and Superior National Forests) so far, and will arrange meetings with the land managers of the Leech Lake Band of Ojibwe and Bois Forte Reservations in the near future. *Please note that the attached technical report is a PDF with some formatting glitches; we have provided an HTML version with smoother formatting via email.

Now that the data has been summarized and we have completed the initial analysis, we will proceed to preparing a peer-reviewed publication, but this goal has not been completed within the timeline of the project. Upon submission of the publication, we will deposit all raw data in free, publicly accessible data bases.

Status Update Reporting

Status Update May 1, 2026

Date Submitted: May 1, 2026

Date Approved: May 13, 2026

Overall Update
Since our last status update in November 2025, we have finished generating genetic data for all four species of blueberries and blueberry relatives in Minnesota, and we are now analyzing this data to determine the genetic health for each population (Activity 2). We are continuing to analyze the reproductive health of each population using the data we have collected over the course of the project (Activity 1).

Activity 1
In our last status report, we detailed the number of populations we had successfully collected data from for each of the four species, and stated that "With data collection complete, we are now analyzing the data to test for the influence of land management and genetic health (clonality) on reproductive health. Data analysis will be complete by the June 30, 2026 deadline." Data analysis has been ongoing since that status report. We have analyzed all reproductive health data relative to land management histories for the four species, and are now comparing reproductive health to genetic health data as it is generated from Activity #2.

Activity 2
At the time of our last status report, all leaf tissue samples had been submitted to the University of Minnesota Genomics Center (UMGC), DNA extraction was completed successfully for all four species, and sequencing was either underway or pending. As of this status report, raw sequencing data has been generated for all four species. A preliminary analysis of genetic health has been conducted for for the two species of blueberry (lowbush and velvetleaf blueberries), and is in process for lingonberry.

A technical problem was encountered for the dwarf bilberry genetic dataset (difference in sequencing read depth between different sequencing runs causing errors in the SNP-calling). We have met with the staff at the UMGC to discuss potential multiple pathways to address this problem, and one solution is being tested now. Because we have developed multiple ways to address the technical problem, we anticipate that the data will still yield usable results and we are still on track for project completion by June 30, 2026.

Dissemination
There were no dissemination activities during this reporting period.

Additional Status Update Reporting

Additional Status Update February 14, 2026

Date Submitted: December 17, 2025

Date Approved: January 6, 2026

Overall Update
Per LCCMR staff guidance provided on 12/16/26, this additional status update is not required.

Activity 1
Per LCCMR staff guidance provided on 12/16/26, this additional status update is not required.

Activity 2
Per LCCMR staff guidance provided on 12/16/26, this additional status update is not required.

Dissemination
Per LCCMR staff guidance provided on 12/16/26, this additional status update is not required.

Status Update Reporting

Status Update November 1, 2025

Date Submitted: December 17, 2025

Date Approved: January 6, 2026

Overall Update
Since our status update in May 2025, we have finished collecting reproductive health data for all four species of blueberries and blueberry relatives in Minnesota, and we are now analyzing this data in relation to land management history (Aim 1). We have submitted leaf samples for all species for genetic analysis; DNA extraction is complete and sequencing is underway or will commence shortly (Aim 2). In the absence of any technical difficulties with sequencing, we anticipate genetic data will be returned in sufficient time for data analysis to be complete by the target date of June 30, 2026.

We note that there is still a substantial balance in the "services and subawards" category of the budget, which is assigned for DNA extraction and sequencing (Aim 2). We will work with the service provider (UMGC) to ensure that invoices for services that have been completed are submitted and paid in the next two months.

Activity 1
We have now collected reproductive health data for all four species in our study for at least two years. Our goal was to collect data for 12 populations per species, and we met this goal for every species except velvetleaf blueberry (Vaccinium myrtilloides), for which we have 11 populations.

With data collection complete, we are now analyzing the data to test for the influence of land management and genetic health (clonality) on reproductive health. Data analysis will be complete by the June 30, 2026 deadline.

Activity 2
We have incorporated a minor change to the sampling design of Activity 2 based on new findings in the field which indicate that a deeper sampling within populations is necessary for accurate clone detection. Instead of submitting samples from 24 individuals in 14 populations per species as we had originally proposed, we sampled more densely within populations (24-40 individuals) and included fewer populations (11-12 populations/species). This change will provide more powerful genetic anlysis and more accurate results overall while reducing the population number only slightly.

All leaf tissue samples have been submitted to the University of Minnesota Genomics Center (UMGC) for DNA extraction and sequencing. DNA extraction was completed successfully for all four species, and sequencing is either underway or will commence in November. Barring technical difficulties, we are optimistic that the sequence data will be returned in time for analysis by our original goal of June 30, 2026.

Dissemination
We interacted with land managers and stakeholders multiple times over the field season in informal settings and via email. No other official dissemination activities took place. We plan to present the results of the project after data analysis this fall, and will also deposit our data in public repositories when it is complete (as per our original dissemination plan).

Status Update Reporting

Status Update May 1, 2025

Date Submitted: July 8, 2025

Date Approved: July 10, 2025

Overall Update
Reproductive data collection is complete for dwarf bilberry, and is in progress for lingonberry and the two species of blueberry during the summer of 2025. Genetic data collection is complete for dwarf bilberry and lingonberry, and is in progress for the two species of blueberry during the summer of 2025. Meetings with land managers to discuss data collection and the current status of the project are planned for summer of 2025, as part of our dissemination plan. The project is on track to be completed by December of 2025.

Since our status updated in November 2024, we have focused on analytical techniques. These include 1) testing detailed measurements of reproductive success with an automated seed counting pipeline and 2) data processing of pairwise measurements of clonality within populations. Both of these will be leveraged during data collection and production in the summer of 2025.

Activity 1
Year 1 and Year 2 reproductive health data collection is complete for dwarf bilberry. Year 1 reproductive health data is complete for lingonberry and both blueberry species, and Year 2 data collection will take place in the summer of 2025.

We are currently recruiting field staff to collect reproductive health data for lingonberry and blueberry populations in the summer of 2025. We will revisit previously established populations this summer for final measurements of reproductive effort (flower number) and reproductive success (fruit). If time allows, we will integrate seed number as an additional measure of reproductive health.

Activity 2
Genetic data collection is mainly complete for dwarf bilberry and lingonberry, and we will collect additional samples to fill remaining gaps in the summer of 2025.

Summer and fall 2025 will focus on collecting and analyzing genetic data from blueberry populations using the data processing techniques we have developed for lingonberry and dwarf bilberry.

Our main objective for all species is the measurement of clonality, but we may also be able to generate overall measures of genetic diversity.

Dissemination
We will continue our meetings with land managers during the summer of 2025 to update them on the project progress. At the end of the project, we will share the technical report of the initial results (=the final LCCMR report) with land managers and meet with them for feedback.

Raw genetic data will be uploaded to public repositories in the fall of 2025.

We anticipate that peer-reviewed publications will occur after the conclusion of the project, and that they will be based on the initial results reported to the LCCMR.

We failed to include this in our previous report, but in June of 2024 we had two presentations related to this project.

Both took place a the national Botany meeting in Grand Rapids, MI (both attached as PDFs in the "Attachment" section):
1. “Drivers of reproductive effort and reproductive success in populations of Vaccinium cespitosum and Vaccinium vitis-idaea at the southern range edge.” Talk presented by David Hainlen, former MS student at UMD.
2. "Sexual reproductive success and land management in Vaccinium cespitosum." Poster presented by Ellie Horsnell, undergraduate student at UMD.

Status Update Reporting

Status Update November 1, 2024

Date Submitted: October 31, 2024

Date Approved: November 19, 2024

Overall Update
Since our status updated in May 2024, we have focused on collection of reproductive data (Activity 1) and leaf tissue for genetic analysis (Activity 2) from blueberry populations. We have also completed a analyses of reproductive and genetic health of dwarf bilberry. Our dissemination activities have been focused on communication with land managers hosting our work on blueberry populations.

Compared to the milestones originally proposed for this project, our work is behind schedule. Because we were ambitious in our original timeline, we still have room to achieve the milestones in the coming year, but will stay in contact with LCCMR staff about the possibility of an amendment if it appears necessary.

Activity 1
We have completed the Activity 1 goals for dwarf bilberry. The reproductive health of dwarf bilberry populations in Minnesota generally low in both 2022 and 2023. There was variation among populations, but this variation was not predicted by the land management history of the population. This was contrary to our original predictions based on research in blueberry populations, and suggests that other historical factors may be more important.

In the summer of 2024, we collected initial data on the reproductive health of blueberry populations. We also planned to collect reproductive data for lingonberry populations, but we did not accomplish this goal due to unexpected health problems among our field technicians. Thus, we are behind our originally proposed milestone schedule (fall of 2024) for data collection in lingonberry. We will focus field work in the summer of 2024 on reproductive health data for lingonberry and blueberry populations.

Activity 2
Genetic data has been generated for most populations of dwarf bilberry, and a preliminary analysis indicates that populations range from entirely clonal to genetically diverse. However, these differences in genetic health were not correlated with reproductive health.

In the summer of 2024, we collected tissue from blueberry populations to be used for genetic analysis. This tissue will be submitted for the generation of genetic data in the winter of 24/25.

Dissemination
Our dissemination work was focused on communication with land managers of populations located in the Chippewa National Forest/Leech Lake Band of Ojibwe Reservation, the Bois Forte Reservation, and the Superior National Forest.

Status Update Reporting

Status Update May 1, 2024

Date Submitted: May 1, 2024

Date Approved: July 10, 2024

Overall Update
Since our progress report in November 2023, our progress has been mainly in Activity 1. We have focused on detailed measurements of samples collected during the 2023 field season, as well as analysis of multiple years of data for the the dwarf bilberry populations in relation to land management histories. Activity 2 and our dissemination efforts are unchanged. We have begun preparations for the 2024 field season, where we will concentrate on collecting data from blueberry populations (Activity 1), generating genetic data (Activity 2), as well as maintaining communication with land managers (dissemination).

Activity 1
As noted in our last progress report, this winter was focused on collecting detailed data berries collected from lingonberry and dwarf bilberry populations. We also conducted a preliminary analysis of the reproductive health of these populations in relationship to land management. This will serve as a model for future analyses of the other species in our study. We have now completed two years of reproductive health surveys for dwarf bilberry. This summer, we will focus our reproductive health measures on blueberry (first year) and lingonberry (second year).

Activity 2
There is no change in the status of this activity since November 2023. We still intend to prioritize genetic sampling and data generation during the 2024 field season in order to complete this activity in the time frame of the project.

Dissemination
There is no change in the status of dissemination efforts since November 2023. We will reach out to state, federal, and tribal land managers this spring to arrange virtual or in-person meetings in advance of the 2024 field season.

Status Update Reporting

Status Update November 1, 2023

Date Submitted: October 31, 2023

Date Approved: December 20, 2023

Overall Update
Since our last progress report in May, we have collected reproductive health measures for both dwarf bilberry and lingonberry, and we have established sampling locations for lowbush and velvet leaf blueberry in cooperation with the Leech Lake Band of Ojibwe and the Bois Forte Band of Chippewa. We have collected tissue samples from our dwarf bilberry and lingonberry populations for genetic analysis, to be submitted this winter.

Overall, our progress in terms of identifying populations and conducting reproductive health surveys is on track. Our progress in terms of genetic sampling is behind our original schedule, so we will need to focus strongly on this aspect of the proposed work during the summer 2024 field season. Our communication with land managers and the community in terms of dissemination is keeping pace with our work and is on-pace for or exceeding our goals.

Activity 1
Since May, we have initiated reproductive health measures for 12 populations of dwarf bilberry and 8 populations of lingonberry. This is the second year of reproductive health measurements for dwarf bilberry and the first year for lingonberry. Over the winter, we will complete the data collection, which includes berry measurement and seed counts, and analyze the data. The order of data collection is slightly different compared to what we originally proposed in terms of the species we are prioritizing, but this will not impact the overall progress of the work. We do note that we have fewer dwarf bilberry and lingonberry populations in our study than we originally proposed (12 and 8 vs. 14 per species); this is because some of the populations became inaccessible due to flooding or trail/road blockages due to downed trees. We will scout for additional populations in summer 2024, but also feel confident that we have a good sampling of both of these species.

Activity 2
We have collected the bulk of our samples for genetic analysis from dwarf bilberry and lingonberry. We have not yet collected samples for genetic analysis from lowbush and velvetleaf blueberry. This puts us behind our original schedule to have complete genetic sampling by the end of summer 2023. Part of the delay in collecting genetic samples from the blueberry species is because we have taking time to reach out to and work with the Leech Lake Band of Ojibwe and the Bois Forte Band of Chippewa to ensure we are communicating with them, taking their advice on what populations to sample, meeting with them to ensure that they approve of the work. We think that this will ultimately help us build stronger relationships and make the study more valuable. We will prioritize moving this aspect of the work forward during the summer 2024 field season, and will assess at the end of that season whether we need to request a no-cost extension to finish the work.

Dissemination
In May 2023, Briana Gross attended a Local Indian Council meeting on the Leech Lake Reservation to present the project to local residents and answer questions. This meeting was kindly arranged through cooperation with the LLBO Division of Natural Resources Plant Resources Program manager Kate Hagsten. B. Gross received very useful feedback and questions about the project during the meeting.

In June 2023, Briana Gross and the research team spend the day with Cody Swanson, the forester for the Bois Forte Band of Chippewa, to visit lingonberry and blueberry populations on the reservation and learn about the management practices there. We now have several study sites on the Bois Forte Reservation.

In July 2023, MS student David Hainlen presented a talk at the international Botany Conference (https://2023.botanyconference.org/) entitled "Reproductive effort and reproductive success in dwarf bilberry (Vaccinium cespitosum) in the Superior National Forest", which described the findings on reproductive heath we had collected to-date, and also acknowledged the ENRTF as the funding source.

Status Update Reporting

Status Update May 1, 2023

Date Submitted: May 1, 2023

Date Approved: May 1, 2023

Overall Update
We have generated reproductive health measures for dwarf bilberry, and these measures indicate that managed populations have greater reproductive effort and greater reproductive success than unmanaged populations. We are using the lessons learned from the first field season to plan data collection fro the 2023 season.

We are working with the Leech Lake Band of Ojibwe to identify best practices for genetic data collection and storage that fit the needs of this indigenous nation. We hope this will serve as a model for our work with other tribes in Minnesota.

Our preliminary findings on the reproductive health of dwarf bilberry populations were presented at a regional meeting, and the project was featured as part of a larger article about the Environment and Natural Resources Trust Fund by the MinnPost in early April.

Activity 1
Since our last progress report in November, we have worked on data generation and data analysis for the 12 populations of dwarf bilberry that we were able to access in the summer of 2022. The data generation included processing berries collected during the summer of 2022 to generate detailed measures of reproductive health including berry wet and dry weight, berry diameter, and number of viable and inviable seeds per berry. We analyzed the measures of reproductive health and found that managed populations of dwarf bilberry showed greater reproductive effort (as measured by the number of flowering ramets per plot) and greater reproductive success (as measured by the number of viable seeds per berry) than unmanaged populations.

The data analysis for dwarf bilberry puts us ahead of our original schedule for measures of reproductive health, which were originally scheduled to begin in the summer of 2023. This was a useful test of how to implement these measures in the field and in the lab, and we are using lessons from this initial field season to plan the summer 2023 data collection efforts.

Activity 2
We have been in communication with the Leech Lake Band of Ojibwe to identify populations for potential genetic sampling, and we are working on how to store and share the genetic data in accordance with the preferences of this sovereign nation. We are still working to identify a stable database that fits the needs of the LLBO, which includes the option to withdraw data if necessary. Once this is identified, we will request an update to our dissemination plan to reflect these modified data sharing practices for the LLBO and any other tribes we cooperate with on this project.

Dissemination
We presented a poster with the reproductive health results for dwarf bilberry at the "Great Lakes Science for Parks Symposium 2023" meeting in Ashland, Wisconsin. The poster was titled "Reproductive effort and reproductive success in dwarf bilberry (Vaccinium cespitosum) in the Superior National Forest". The LCCMR was acknowledged as a funder of the research, although we regret that our attribution language did not match the standard recommended language recommended by the LCCMR. We apologize for the oversight and will correct this in the future.

This project was featured in an article about the ENRTF in the MinnPost by Walker Orenstein on April 13, 2023. Link:

https://www.minnpost.com/environment/2023/04/future-of-minnesota-environment-funding-state-lottery-could-be-on-your-ballot-in-2024/

Status Update Reporting

Status Update November 1, 2022

Date Submitted: November 8, 2022

Date Approved: November 11, 2022

Overall Update
We have begun the process of identifying suitable populations of Vaccinium in this project period. While site selection is going well, it is behind our optimal schedule because of some delays with receiving the Notice of Grant Award (NOGA) and being able to use grant funding for travel (all delays were within the UMN system, not the LCCMR). We anticipate 'making up' this time over the winter of 2022/23 and being ready to sample and measure reproduction in the summer of 2023. Our ability to access lingonberry populations was also somewhat limited due to flooding/wet conditions in 2022, so we hope to access several more known (but inaccessible) populations next year. We have good management records for the dwarf bilberry populations, and will prioritize this for the lowbush and velvet-leaf blueberry populations going forward.

Activity 1
We have identified and visited 12 populations of dwarf bilberry and 9 populations of lingonberry in Minnesota. We are in communication with partners to identify populations of lowbush and velvet-leaf blueberry. These populations will be used in Activity 1 and Activity 2.

Activity 2
We have identified and visited 12 populations of dwarf bilberry and 9 populations of lingonberry in Minnesota. We are in communication with partners to identify populations of lowbush and velvet-leaf blueberry. These populations will be used in Activity 1 and Activity 2.

Dissemination
No dissemination activities at this point.