Environment and Natural Resources Trust Fund

M.L. 2022 Approved Work Plan

General Information

ID Number: 2022-109

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: June 15, 2022

Project Title: Status of Minnesota Blueberries and Related Berry Species

Project Budget: $191,000

Project Manager Information

Name: Briana Gross

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Project Reporting

Date Work Plan Approved by LCCMR: June 27, 2022

Reporting Schedule: May 1 / November 1 of each year.

Project Completion: December 31, 2025

Final Report Due Date: February 14, 2026

Legal Information

Legal Citation: M.L. 2022, Chp. 94, Art. , 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
Personnel								
Masters Degree Graduate Student		Collect and analyze genetic data			40%	1.5		$57,617
Field Technician		Locate populations, collect samples, collect reproductive health data			24%	0.51		$19,035
Undergraduate Research Student		Assist in sample and data collection			0%	0.75		$21,481
Project Manager		Project design and data analysis, supervision and training of employees for sample and data collection			27%	0.06		$9,584
							Sub Total	**$107,717**
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
							Sub Total	**$61,558**
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.					$1,335
							Sub Total	**$1,335**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								

							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Milage/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.					$20,090
							Sub Total	**$20,090**
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
							Sub Total	**$300**
							Grand Total	**$191,000**

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
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
			State Sub Total	**$96,016**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**$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....

Optional Attachments

Support Letter or Other

Title	File
Submission Approval	23cfdfeb-84a.pdf
2022-109_ResearchAddendum	3354e79e-98d.pdf
Background Check	59f1a0cc-3a5.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 agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I agree to the UMN Policy.

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

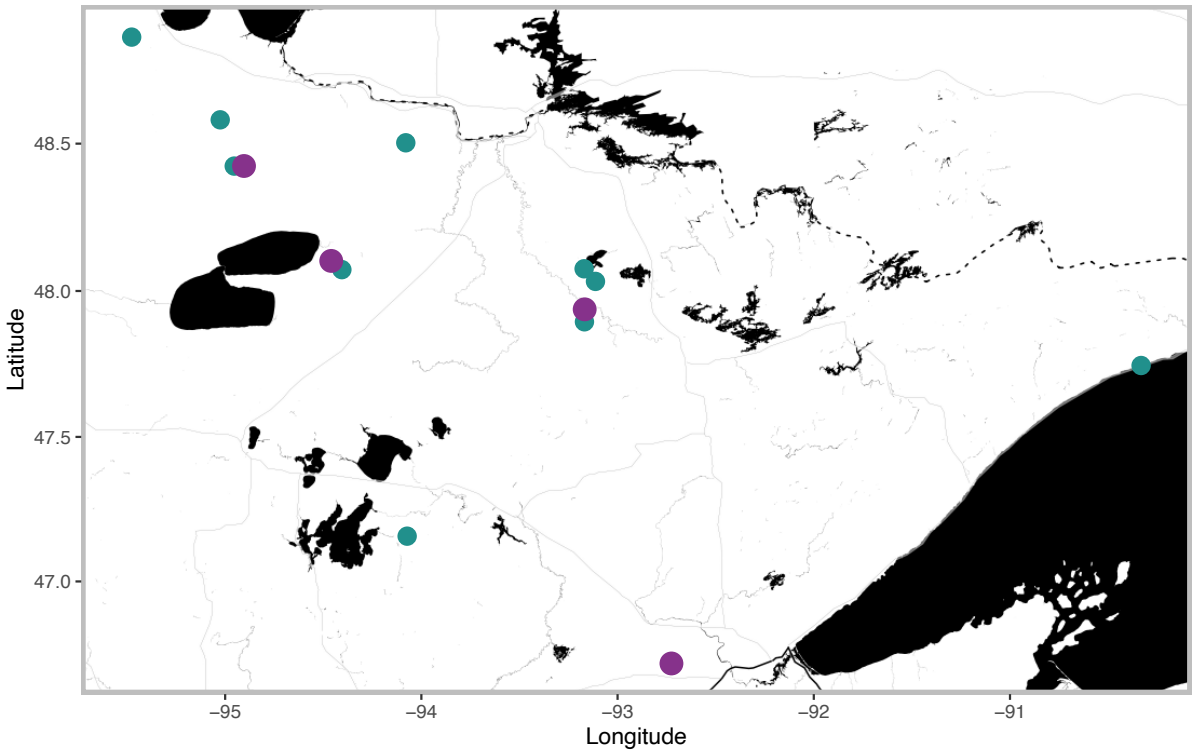
Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Lingonberry Genetic Health



Minnesota lingonberry populations that were genetically assessed in a previous study. At least ten plants were sampled from each population. Populations marked in purple contained no more than four genetically unique individuals, indicating high clonality and low genetic health.

Velvet-leaf blueberry

Lowbush blueberry

Wild blueberries: *Vaccinium myrtilloides* on left and *Vaccinium angustifolium* on right. Photos by Peter M. Dziuk.

Lingonberry

Dwarf bilberry

Blueberry relatives: *Vaccinium vitis-idaea* on left and *Vaccinium cespitosum* on right. Photos by Peter M. Dziuk.