



## Environment and Natural Resources Trust Fund

### 2022 Request for Proposal

#### General Information

**Proposal ID:** 2022-109

**Proposal Title:** Status of Minnesota Blueberries and Relatives

#### Project Manager Information

**Name:** Briana Gross

**Organization:** U of MN - Duluth

**Office Telephone:** (218) 726-7722

**Email:** blgross@d.umn.edu

#### Project Basic Information

**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.

**Funds Requested:** \$191,000

**Proposed Project Completion:** June 30 2025

**LCCMR Funding Category:** Small Projects (H)

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

#### Project Location

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

Region(s): NE

**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

## Narrative

**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? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and 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.

## Activities and Milestones

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

**Activity Budget:** \$79,500

**Activity Description:**

We will survey six populations of each of the four species (two species of wild blueberry, lingonberry, and dwarf bilberry) over two years in locations spread across northeastern Minnesota (6 populations x 4 species = 24 locations). 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 health.

**Activity Milestones:**

Description	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	June 30 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 15 populations of each of the three species, with at least 25 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	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



## 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

## Long-Term Implementation and Funding

**Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?**

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

## Project Manager and Organization Qualifications

**Project Manager Name:** Briana Gross

**Job Title:** Associate Professor

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

B. L. Gross has been working in the area of plant population biology and genetics since 2001. Gross has extensive experience with wild plant genetics and field work and has completed projects targeting a range of plant species in northeastern Minnesota, including lingonberry (funded by the UMN), red oak (funded by the MLSCP), and the arctic relict plants on the North Shore of Lake Superior (funded by the MLSCP). Gross's current work focuses on the monitoring and conservation of arctic relict plant communities (funded by the LCCMR) and a joint project with the US Forest Service focused on the effects of management practices on dwarf bilberry populations in the Superior National Forest (funded by the Great Lakes Restoration Initiative, GLRI, through the EPA). Gross is well positioned to supervise and train graduate students and technicians to apply genetic and field monitoring techniques to populations of wild blueberries and their relatives.

**Organization:** U of MN - Duluth

**Organization Description:**

The University of Minnesota Duluth houses the modern Swenson Science Building, where this work will be based in the laboratory of B. L. Gross. The location of the campus is ideal for research in northeastern Minnesota, and will allow easy

access to the plant populations targeted in this project. All genetic work will be conducted with in the UMN system at the University of Minnesota Genomics Center, where a discounted rate is available to Minnesota institutions.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
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
							<b>Sub Total</b>	<b>\$107,717</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	-
<b>Equipment, Tools, and Supplies</b>								
	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
							<b>Sub Total</b>	<b>\$1,335</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	-
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								

	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
							<b>Sub Total</b>	<b>\$20,090</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
							<b>Sub Total</b>	-
<b>Other Expenses</b>								
		RAD-seq genetic data generation at the University of Minnesota Genomics Center. Cost includes overnight shipping of frozen samples, DNA extraction, library preparation, and sequencing.	Genetic data for evaluation of genetic health of populations.					\$61,858
							<b>Sub Total</b>	<b>\$61,858</b>
							<b>Grand Total</b>	<b>\$191,000</b>



Classified Staff or Generally Ineligible Expenses

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

Category	Specific Source	Use	Status	Amount
<b>State</b>				
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
			<b>State Sub Total</b>	<b>\$96,016</b>
<b>Non-State</b>				
			<b>Non State Sub Total</b>	-
			<b>Funds Total</b>	<b>\$96,016</b>

## 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	<a href="#">23cfdfeb-84a.pdf</a>

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

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

No

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

N/A

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

N/A

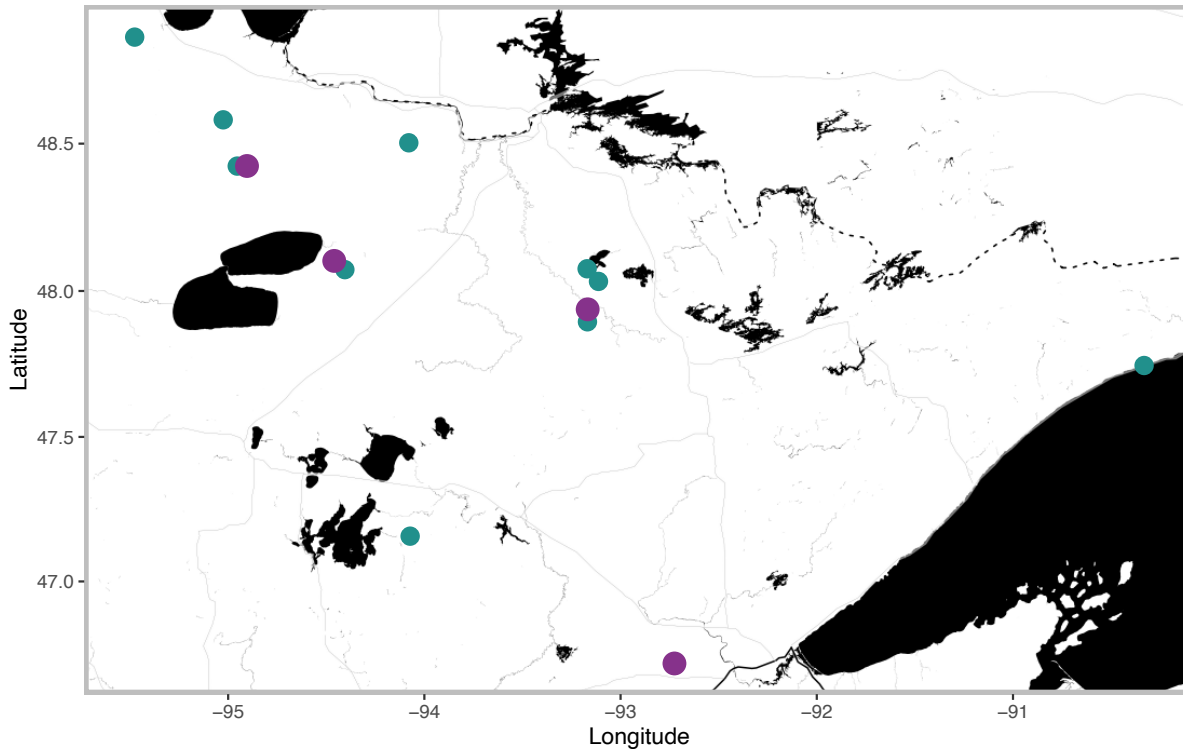
**Does your project include original, hypothesis-driven research?**

Yes

**Does the organization have a fiscal agent for this project?**

No

## 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.