Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-011

Proposal Title: Minnesota Flora: A New Generation of Discovery

Project Manager Information

Name: Timothy Whitfeld

Organization: U of MN - Bell Museum of Natural History

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Project Basic Information

Project Summary: A user-frindly, interactive online guide and companion book for the identification of all 2,200+ Minnesota plants. Includes detailed information on natural history and high quality photos and distribution maps.

Funds Requested: $1,527,000

Proposed Project Completion: 2026-06-30

LCCMR Funding Category: Foundational Natural Resource Data and Information (A)

Project Location

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

Statewide

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

Statewide

When will the work impact occur?

During the Project and In the Future

Narrative

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

Ensuring a sustainable future for all Minnesota's native plants is hindered by the lack of a comprehensive local source of relevant botanical information. This is important because with over 2,200 species, Minnesota has a wealth of plant diversity. Our state lies at the confluence of three major biomes (prairie, broadleaf forest, coniferous forest) and this unique geography puts us at the center of North American plant diversity. However, Minnesota's native plants face increasing threats from loss of habitats, invasive species, and changing temperature/precipitation patterns. Continent wide technical manuals do exist but with minimal local focus and existing local guides are incomplete in their coverage. Simply identifying all Minnesota's trees, grasses, ferns, and wildflowers is challenging because information is scattered and not customized for Minnesota ecosystems. As it stands, students and educators lack access to proper information on local plants. Policy makers must often make natural resource decisions with incomplete understanding of affected species. Foresters and land managers have no definitive source for assessing management decisions or evaluating habitat. Outdoor enthusiasts, researchers, and consultants must turn to information from other states. All these user groups, and more, require a one-stop resource to properly understand Minnesota plants.

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.

Minnesota Flora draws on a rich trove of botanical knowledge collected over the past 180 years by the Bell Museum, the DNR, colleges across the state, consultants, and citizen scientists. The project also builds on three important LCCMR investments: Bell Museum Biodiversity Atlas, Minnesota Biological Survey, and Minnesota Wildflowers, while adding significant amounts of new information in the form of species descriptions, images, new identification tools, and a printed field guide for offline use. Minnesota Flora will be a user-friendly, online encyclopedia with detailed morphological, ecological, and natural history descriptions (including phenology and pollinators) of all Minnesota plants. In addition, Anishinaabe and Dakota traditional plant uses, extensive images galleries and, crucially, new and innovative identification tools suitable for everyone. The companion hard-copy field guide will summarize the online encyclopedia and include additional identification tools for use offline in remote areas. Together, these products support a wide variety of stakeholders including wildlife managers, foresters, policy makers, governmental units, researchers, teachers, students, conservationists, landowners, citizen scientists, consultants, developers, outdoor enthusiasts, and anyone curious about our shared botanical heritage. Minnesota Flora puts the state's plant diversity at our fingertips and will be the go-to resource for anyone asking: "what is that plant?"

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?

The Minnesota Flora online encyclopedia is based entirely on data and observations from Minnesota. It is a one-stop clearing house for anyone needing to understand and preserve our state's plant diversity even as habitat loss, invasive species, and other changes exert pressure. All components are new or substantive additions to existing products:

(1) interactive identification tools for everyone

(2) Species descriptions

- image gallery
- distribution maps
- ecology and morphology descriptions
- pollinator/phenology information
- Anishinaabe and Dakota traditional uses
- Wildlife value

(3) Printed companion field guide

- identification tools for offline use
- brief species descriptions summarized from online encyclopedia, images, distribution maps

Activities and Milestones

Activity 1: Part 1 of the online Minnesota Flora encyclopedia: develop the first ever interactive identification key for recognizing all Minnesota plants.

Activity Budget: $527,065

Activity Description:
Develop an accessible plant identification tool for everyone in Minnesota. Users include: students learning about local plants, land managers differentiating rare and common plants, foresters classifying timber stands, citizen scientists monitoring invasives.

Task #1: Assemble a list of all 2,200+ wild plants in Minnesota
The list integrates and standardizes the Bell Museum's Plant Checklist (based on 190,000+ herbarium specimens and associated label data) and the DNR's MNTAXA (based on expert knowledge and field experience).
Outcomes: an authoritative list of Minnesota plants based on two centuries of accumulated knowledge.

Task #2: Based on expert knowledge and literature review, compile a list of 150-200 characteristics known to be valuable for differentiating plant species. Once each characteristic is coded for each Minnesota species, the resulting database will be the foundation of our new identification key. The characteristics (with illustrated glossary) will include species' distribution in Minnesota, habitat preference, growth form, morphology, and natural history. Many characteristics will come from published literature whereas specific details such as leaf dimensions, flower size, location, and habitat in Minnesota will come only from specimens in the Bell Museum Herbarium.
Outcomes: completely new framework for plant identification based on characteristics specific to Minnesota specimens

Activity Milestones:

Description	Completion Date
List of characteristics and associated data for completing a database supporting the interactive identification key	2021-10-31
A definitive list of all native and naturalized plant species in Minnesota	2021-10-31
Development of new interactive identification keys based on database of morphological and natural history characteristics	2023-12-31

Activity 2: Part 2 of the Minnesota Flora online encyclopedia: interpretation of Minnesota plants with descriptive text, maps, and extensive image gallery

Activity Budget: $527,065

Activity Description:
Comprehensive descriptions of all Minnesota plants summarizing natural history, habitat preferences, morphology, and Anishinaabe/Dakota traditional uses. Images of live plants and herbarium specimens with Minnesota distribution maps.

Task #1: Develop descriptions of each Minnesota plant species with associated high-resolution image gallery.
Descriptions pull directly from the database of characteristics, filling pre-formatted templates with linking phrases to form descriptive paragraphs for each species. Graphic icons indicate pollinators, wildlife value, phenology. Three-quarters of images come from Minnesota Wildflowers and the Bell Museum Biodiversity Atlas; the rest will be compiled under this project.
Outcomes: Comprehensive descriptions and associated image galleries for use by students learning about Minnesota

biodiversity, Lake Associations for planning shoreline planting, managers needing information about plants for wildlife or habitat restoration.

Task #3: Distribution maps for all plant species in Minnesota based on herbarium specimens and expert observations
Two thirds of specimens in the Bell Museum Herbarium have mapped coordinates and the rest will be plotted under this project, based on locality descriptions from specimen labels.
Specific outcomes: A map for each Minnesota plant species showing documented collection locations. More information about plant distribution in Minnesota helps create a statewide community of informed citizens, managers, and policy makers.

Activity Milestones:

Description	Completion Date
Distribution maps for each Minnesota species plotted from Bell Museum Herbarium specimens and expert observations	2024-03-31
High resolution pictures of all Minnesota plant species including images from the field and herbarium	2024-03-31
Descriptions of each Minnesota plant species based on expert knowledge and Bell Museum Herbarium specimens	2024-03-31

Activity 3: First ever printed field-guide covering all Minnesota plants. A portable, offline resource when connection to the online encyclopedia is limited

Activity Budget: $472,870

Activity Description:
The book provides a printed archive of Minnesota plant diversity, with brief species descriptions, selected images, and distribution maps. Plus, new identification keys that will be user-friendly and valuable to people with botanical experience, e.g., environmental consultants and ecologists documenting plant diversity in remote areas.

Task #1: preparation of text, maps, and advanced identification keys for all Minnesota plants.
Descriptive text summarizes the detailed online encyclopedia. Maps and a subset of species images also come from the encyclopedia. The advanced identification keys are an efficient way for experienced users to identify challenging groups (e.g., grasses). These technical “dichotomous” keys, generated using specialist software and thoroughly field tested by the core proposal team, make powerful companions to the interactive keys and provide options for a wide range of users.
Specific outcome: A companion to the online Minnesota Flora that expands the range of user groups.

Task #2: Format all material for submission to the publisher
The University of Minnesota Press has indicated strong interest in publishing this book. Professional editors will assist with editing and formatting in preparation for submission to the publisher.
Specific outcome: A print-ready manuscript for the first ever book covering all plants of Minnesota.

Activity Milestones:

Description	Completion Date
Expert eview of identification keys in the field and in the herbarium	2025-10-31
Preparation of descriptive text, maps, images and advanced identification key covering all Minnesota species	2025-10-31
Submit book manuscript to the publisher	2026-04-30

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Amanda Grusz	University of Minnesota, Duluth	Funds to support one graduate student at UMD. The graduate student will compile data for species characters, assign coordinates to specimens, assist with species descriptions and field work.	Yes
Jon Nichols	University of Minnesota Libraries	Management and coordination of data storage, backup, and archiving	Yes
Tom Prather	University of Minnesota Super Computing Institute	Provide technology support for building out the existing Minnesota Biodiversity Atlas to incorporate new content from the Minnesota Flora project. This includes linking data tables associated with plant images and the interactive identification tool and developing a user interface.	Yes
George Weiblen	Bell Museum, University of Minnesota	Collaboration, guidance, and expertise for linking data in the Minnesota Biodiversity Atlas to the Minnesota online encyclopedia. Expertise in herbarium specimen databases and specimen management. Local botanical and scientific expertise.	No
Katy Chayka	Minnesota Wildflowers	Minnesota Wildflowers will contribute their existing species descriptions and image gallery. Furthermore, they will continue to take more field photographs where needed and assist with the transition of their database to the new Minnesota Flora system. This proposal enables the completion of these two previously agreed upon tasks.	Yes
Minnesota Biological Survey	Minnesota Department of Natural Resources	With extensive statewide botanical expertise, a combined tally of nearly 50,000 herbarium specimens, and previous publications on aspects of Minnesota' s flora, Welby Smith, Michael Lee, and Courtney Millaway will lead the completion of species descriptions and development of identification keys. Also, additional specimen collection and photography where necessary.	Yes

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?

The project pulls together the Bell Museum Biodiversity Atlas, the Minnesota Biological Survey, and Minnesota Wildflowers and significantly expands the audience for these previous LCCMR investments. Implementation of the online encyclopedia and distribution of the companion field guide will be communicated to potential users through targeted marketing and programing at the Bell Museum. We plan implementation and training workshops for the Minnesota Science Teachers Association, Minnesota DNR, Nature Conservancy, Minnesota Forestry Association, Minnesota Master Naturalists, Minnesota Native Plant Society and other groups. If additional funding is needed we will coordinate with the Bell Museum development team to approach potential donors.

Project Manager and Organization Qualifications

Project Manager Name: Timothy Whitfeld

Job Title: Collections Manager

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

Tim Whitfeld has twenty years of botanical and ecological experience in Minnesota. He is currently Collections Manager of the Bell Museum Herbarium at the University of Minnesota leading the curation of over 900,000 dried and pressed specimens collected over the past two centuries in Minnesota, North America, and 150 countries around the world. Over 190,000 of these specimens are from Minnesota, dating back to Joseph Nicollet's 1839 Northwest Expedition. Tim

has contributed to this catalog of local plants with over 1,200 collections from across Minnesota. He also oversees a team of 12 undergraduate students working on two large-scale digitizing projects that will add over 50,000 images and database records to the Bell Museum Biodiversity Atlas. This work requires coordination with Bell Museum curators and ongoing reporting to the granting agency supporting this effort (National Science Foundation). Tim completed his PhD in the Plant Biological Sciences Program, working with Prof. George Weiblen, at the University of Minnesota with a focus on plant diversity in tropical forests. This involved fieldwork in Papua New Guinea, collecting specimens for the herbarium and documenting changes to tree diversity as forests undergo ecological succession. He also completed post-doctoral work with Prof. Peter Reich on an LCCMR-funded project focused on invasive plants in Minnesota's forests. Prior to graduate school, Tim worked for six years with the Minnesota Biological Survey as a field botanist and ecologist. This work involved vegetation surveys and documentation of rare plants in prairies and forests of west-central and northwest Minnesota. Tim was also an intern and naturalist at the Audubon Center of the Northwoods where his interest and appreciation for Minnesota's plant diversity was fostered under the guidance of then Executive Director, Mike Link.

Organization: U of MN - Bell Museum of Natural History

Organization Description:
We are Minnesota's official natural history museum, established by the legislature in 1872 and held in trust by the University of Minnesota. For over a century, the museum has preserved and interpreted our state's rich natural history and served learners of all ages. Additionally, our scientific collections contain over one million specimens, representing every county in Minnesota and various locales around the globe. As Minnesota's state natural history museum, our mission is to ignite curiosity and wonder, explore our connections to nature and the universe, and create a better future for our evolving world. Our vision is to energize a community that embraces the transformative nature of science.

We believe education is a journey and we delight in the process of hands-on discovery. We believe in authenticity to engage curiosity. We reflect and respect diversity. We seek to preserve knowledge and biodiversity for the future. We value our visitors and partners and seek collaboration to enrich learning. We strive for excellence in all that we do and we are principled in the way we take care of our people and the planet.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Bell Museum Herbarium, University of Minnesota, Project manager		Manage project logisitics and communication with all partners, oversee student workers, coordinates all aspects of project completion			36%	1.25		$162,500
University of Minnesota undergraduate student worker		Compile species characteristics from herbarium specimens and literature searches for interactive identification tools and species descriptions. Student employees do not receive fringe benefits. Student positions at the University of Minnesota provide important research experience and STEM employment opportunities.			0%	1.5		$38,400
University of Minnesota undergraduate summer student worker		Compile species characteristics from herbarium specimens and literature searches for interactive identification tools and species descriptions, collect specimens in the field as needed. Student positions at the University of Minnesota provide important research experience and STEM employment opportunities.			0%	0.75		$11,520
University of Minnesota Super Computing Institute, programmer		Provide technology support for building out the existing Minnesota Biodiversity Atlas to incorporate new content from this project. This includes linking data tables associated with plant images and the interactive identification tool and developing a user interface.			36%	0.5		$50,000
University of Minnesota, Duluth MSc student		Summer suport for compiling data for species characters, assigning coordinates to specimens			20%	0.4		$25,000
University of Minnesota Libraries, Data Manager		Management and coodination of data storage and archiving			36%	0.09		$11,500

University of Minnesota undergraduate student worker		Compile species characteristics from herbarium specimens and literature searches for interactive identification tools and species descriptions. Student employees do not receive fringe benefits. Student positions at the University of Minnesota provide important research experience and STEM employment opportunities.			0%	1.5		$38,400
University of Minnesota undergraduate student worker		Compile species characteristics from herbarium specimens and literature searches for interactive identification tools and species descriptions. Student employees do not receive fringe benefits. Student positions at the University of Minnesota provide important research experience and STEM employment opportunities.			0%	15		$38,400
University of Minnesota undergraduate student worker		Compile species characteristics from herbarium specimens and literature searches for interactive identification tools and species descriptions. Student employees do not receive fringe benefits. Student positions at the University of Minnesota provide important research experience and STEM employment opportunities.			0%	1.5		$38,400
University of Minnesota undergraduate student worker		Compile species characteristics from herbarium specimens and literature searches for interactive identification tools and species descriptions. Student employees do not receive fringe benefits. Student positions at the University of Minnesota provide important research experience and STEM employment opportunities.			0%	1.5		$38,400
University of Minnesota undergraduate summer student worker		Compile species characteristics from herbarium specimens and literature searches for interactive identification tools and species descriptions, collect specimens in the field as needed. Student positions at the University of Minnesota provide important research experience and STEM employment opportunities.			0%	0.75		$11,520
							Sub Total	**$464,040**
Contracts and Services								
Minnesota Wildflowers	Sub award	Collating species characteristics, natural history, and Native American plant uses for species descriptions.				0.75		$30,000

		Taking species images in the field. Database management and input into overall design of the online encyclopedia						
Minnesota Biological Survey	Sub award	Taxonomic determinations, develop plant identification tools, verify identification of herbarium specimens, test interactive identification keys, edit species descriptions, field surveys to address specific questions and fill information gaps necessary for product development. Personnel: $855,000 Travel: $25,000 Direct & Necessary: $55,635		X		7.5		$935,635
							Sub Total	**$965,635**
Equipment, Tools, and Supplies								
	Equipment	1 laptop	Needed for undergraduate student workers adding species characterstics to the project database	X				$1,000
	Equipment	1 laptop	Needed for undergraduate student workers adding species characterstics to the project database	X				$1,000
	Equipment	1 digital single lens reflex camera	For taking high resolution images of plants in the field					$1,600
	Equipment	Rugged tablet	For recording collection information in the field	X				$2,100
	Tools and Supplies	Collecting supplies	For collecting herbarium specimens in the field we will need two additional plant presses, cardboard ventilators, clippers, and trowels. For mounting and achiving specimens, we will need barcode stickers, acid free paper, glue, and tape plus folders for storing specimens in the herbarium cabinets					$1,625
							Sub Total	**$7,325**
Capital Expenditures								
							Sub Total	**-**

Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Expenses associated with project fieldwork	$10,000 per year for field expenses during the first three years of the project will cover project manager and all undergraduate student workers. The total covers all in-state mileage, meals, and lodging. Targeted fieldwork is required to fill in gaps on the distribution maps, locate suitable plants for high quality images, and collect additional specimens for species that are poorly represented in the Bell Museum herbarium					$30,000
							Sub Total	**$30,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Publication costs associated with production of 5000 printed copies of the companion field guide to the Minnesota Flora online encyclopedia. Costs cover layout, printing, and publishing of the printed field guide to the Minnesota Flora. This will nclude color images, distribution maps, and summary descriptions of all Minnesota plants.	The University of Minnesota Press has indicated a strong interest in publishing the printed Minnesota Flora. This printed field guide provides a permenant archive of our work. It will be useable in the field and the lab by users with advanced botanical knowledge but will also provide information and images of general interest.					$60,000
							Sub Total	**$60,000**
Other Expenses								

							Sub Total	**-**
							Grand Total	**$1,527,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Contracts and Services - Minnesota Biological Survey	Sub award	Taxonomic determinations, develop plant identification tools, verify identification of herbarium specimens, test interactive identification keys, edit species descriptions, field surveys to address specific questions and fill information gaps necessary for product development. Personnel: $855,000 Travel: $25,000 Direct & Necessary: $55,635	Any classified staff position paid for by ENRTF will either: 1) be backfilled with a new position OR 2) the work done by this position will be delayed, eliminated, or completed by the start of the project. Direct & Necessary costs cover DNR HR Support ($13,289), Safety Support ($2,468), Financial Support ($10,617), Communication Support (~$1,324), IT Support ($26,787), and Planning Support (~$1,149).
Equipment, Tools, and Supplies		1 laptop	To efficiently complete their work, undergraduate student workers will need to be able to add all measurements and other characteristics directly into the project database. Working with pen and paper would dramatically increase the amount of work needed to complete all necessary data entry. The Bell Herbarium does not have extra laptops that can be dedicated to this project.
Equipment, Tools, and Supplies		1 laptop	To efficiently complete their work, undergraduate student workers will need to be able to add all measurements and other characteristics directly into the project database. Working with pen and paper would dramatically increase the amount of work needed to complete all necessary data entry. The Bell Herbarium does not have extra laptops that can be dedicated to this project.
Equipment, Tools, and Supplies		Rugged tablet	Collecting additional specimens will make the Minnesota Flora project as comperhensive as possible. Each collection requires detailed information related to locality, habitat, and associated species. Recording this information with pen and paper means long hours transcribing notes into the database. Recording everything electronically in the field is a major time saver and dramatically increases efficiency.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	University of Minnesota cost share	Unrecovered indirect costs	Secured	$270,737
			Non State Sub Total	**$270,737**
			Funds Total	**$270,737**

Attachments

Required Attachments

Visual Component

File: 4d8432ff-3d5.pdf

Alternate Text for Visual Component

The visual summarizes the proposal with the following text:
"Transforms 180 years of botanical exploration in Minnesota. Builds upon existing resources to create an interactive and readily accessible encyclopedia (online and printed) for all of Minnesota's 2,200+ plants."

There is a list of the main user groups:
Education: students learning about nature and Minnesota ecosystems
Policy making: crafting well-informed natural resource decisions
Management & conservation: evaluating and assessing habitat quality
Research: studying Minnesota plant diversity in times of change
Citizen Scientists: documenting plant distribution, and recording invasive species
All Minnesotans: local information about local plants

And a list of the new products
Extensive image galleries
New data from the field
New distribution maps and species descriptions
New data from the lab

And a list of the existing LCCMR projects upon which this proposal builds:
Bell Museum Biodiversity Atlas
Minnesota Biological Survey (MN DNR)
Minnesota Wildflowers

Optional Attachments

Support Letter or Other

Title	File
Minnesota Flora: letters of support	b5d3bba4-55b.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

Does your project include research?

Yes

Does the organization have a fiscal agent for this project?

No

Minnesota Flora

a new generation of discovery!

The definitive guide to all Minnesota plants!

Transforms 180 years of botanical exploration in Minnesota. Builds upon existing resources to create an interactive and readily accessible encyclopedia (online and printed) for all of Minnesota's 2,200+ plants.

Essential for...

- ✓ **Education:** students learning about nature and Minnesota ecosystems
- ✓ **Policy making:** crafting well-informed natural resource decisions
- ✓ **Management & conservation:** evaluating and assessing habitat quality
- ✓ **Research:** studying Minnesota plant diversity in times of change
- ✓ **Citizen Scientists:** documenting plant distribution, and recording invasive species
- ✓ **All Minnesotans:** local information about local plants

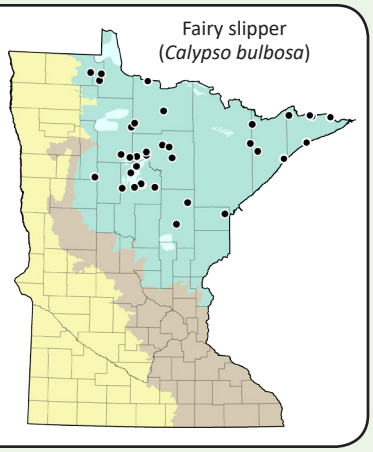
Minnesota Flora will feature...

Extensive image galleries

- 150,000+ pictures from the field
- 190,000+ digitized herbarium specimens

New distribution maps and species descriptions

- Based on 180 years of expert data collection
- Interactive
- Continuously updated

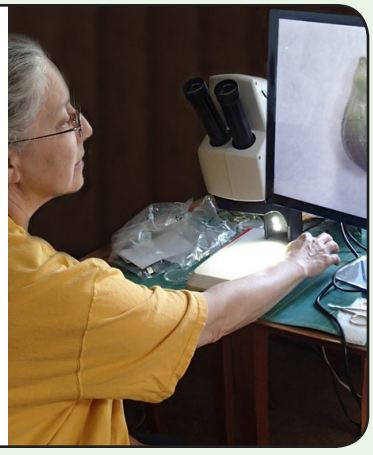


New data from the field

- Additional collections to fill knowledge gaps
- Focused surveys for poorly-documented species

New data from the lab

- Knowledge gleaned from herbarium specimens for identification keys
- Assigning accurate location coordinates to thousands of historic specimens



Minnesota Flora will build upon existing LCCMR investments...

bell museum
Minnesota Biodiversity Atlas

DEPARTMENT OF NATURAL RESOURCES
MINNESOTA BIOLOGICAL SURVEY

Minnesota Wildflowers