Final Abstract

Final Report Approved on October 20, 2025

M.L. 2021 Project Abstract

For the Period Ending June 30, 2025

Project Title: Protecting Minnesota's Beneficial Macroalgae: All Stoneworts Aren't Starry

Project Manager: Donna Perleberg

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Funding Source:

Fiscal Year:

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 03b and M.L. 2024, Chp. Sec. 2, Subd. 18

Appropriation Amount: $811,000

Amount Spent: $755,405

Amount Remaining: $55,595

Sound bite of Project Outcomes and Results

This first-ever statewide inventory identified and mapped more than 50 stonewort species, revealing potential rare species and biodiversity hotspots. The resulting baseline data enable long-term monitoring of floristic changes that may reflect shifting lake conditions, supporting efforts to protect native aquatic communities and conserve freshwater biodiversity statewide.

Overall Project Outcome and Results

Stoneworts are unique freshwater algae that play important roles in lake ecosystems, yet they are often overlooked in aquatic surveys. They are common in many Minnesota lakes, but identifying them accurately is difficult due to a lack of training and resources. The introduction of a non-native species, “starry stonewort,” in several Minnesota lakes, raises concerns about native aquatic community health and the need for better understanding of stonewort diversity.

To address this gap, Minnesota Department of Natural Resources partnered with Leech Lake Band of Ojibwe Division of Resource Management, Leech Lake Tribal College, the New York Botanical Garden, and the University of Minnesota Bell Museum to survey more than 650 lakes across the state with a focused survey of Leech Lake.

More than 1,300 stonewort collections were made, often with triplicate samples, resulting in around 3,900 specimens. Traditional field methods and DNA sequencing tools revealed more than 50 different species in Minnesota, increasing the known diversity fivefold. All specimens have been archived and made available online through Bell Museum's Biodiversity Atlas and NYBG's Virtual Herbarium.

To build expertise within Minnesota, we trained 150 natural resource professionals and students in stonewort sampling and identification. Ten students completed internships where they gained hands-on field and laboratory experience. A new identification guide including laminated reference sets was created to support ongoing work.

These data allow us to compare statewide species distribution patterns and water quality trends, highlighting species that are indicators of water quality or changing conditions. Stonewort information will be included in the next evaluation for State-listed rare species, updates to Lakes of Biological Significance, and Lake Health Assessments. In a follow-up, LCCMR recommended project (2026-074: Mapping Leech Lake Vegetation), recently trained stonewort surveyors will use this new knowledge to take an even closer look at Leech Lake's vegetation.

Project Results Use and Dissemination

We presented results at Aquatic Plant Identification Workshops, Tribal College classes, Leech Lake Association, Minnesota Native Plant Society (live-streamed to the public), and the North East Algal Society. Articles were published in the Leech Lake Association newsletter and Minnesota Conservation Volunteer magazine. All specimens are accessible online via the Bell Museum's Biodiversity Atlas and NYBG's Virtual Herbarium. Our team continues to meet regularly to analyze findings and prepare publications for peer-reviewed scientific journals. At a tour of Leech Lake, we shared a summary of our findings and presented hands-on examples of stonewort diversity to LCCMR committee members.

Environment and Natural Resources Trust Fund

M.L. 2021 Approved Final Report

General Information

Date: November 12, 2025

ID Number: 2021-055

Staff Lead: Mike Campana

Project Title: Protecting Minnesota's Beneficial Macroalgae: All Stoneworts Aren't Starry

Project Budget: $811,000

Project Manager Information

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Project Reporting

Final Report Approved: October 20, 2025

Reporting Status: Project Completed

Date of Last Action: October 20, 2025

Project Completion: June 30, 2025

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 03b and M.L. 2024, Chp. Sec. 2, Subd. 18

Appropriation Language: $811,000 the first year is from the trust fund to the commissioner of natural resources to conduct a statewide inventory to provide baseline data and build in-state knowledge of Minnesota's native stoneworts, a diverse group of aquatic plants that support clear lakes and healthy fish habitat.and (a) The availability of the appropriations for the following projects is extended to June 30, 2025: (11) Laws 2021, First Special Session chapter 6, article 6, section 2, subdivision 3, paragraph (b), Protecting Minnesota's Beneficial Macroalgae: All Stoneworts Aren't Starry;

Appropriation End Date: June 30, 2025

Narrative

Project Summary: This statewide inventory will provide baseline data and build in-state knowledge on Minnesota's stoneworts, a diverse group of aquatic plants that are critical for clear lakes and healthy fish habitat.

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

Hidden beneath the surface of most Minnesota lakes, native macroalgae, or "stoneworts", are keeping our waters clear and our fish habitats healthy. These plants occur statewide and represent at least 25% of Minnesota's lake plant diversity but resource managers ignore them because they don't have the technical knowledge to identify them. This would be analogous to bird surveyors not distinguishing the many different warbler species and simply calling them "songbirds". Stoneworts are unique lake plants that serve important ecological roles by stabilizing sediment, absorbing nutrients, purifying water, maintaining high clarity, and providing habitat for muskellunge and other fish and wildlife. The types of stoneworts present tell a lot about the water quality and habitat of each lake. Minnesotans are concerned about the non-native, "starry stonewort," and the potential negative impacts it may have in our lakes including potential competitive interactions with native aquatic plants. As we attempt to limit the spread of starry stonewort, it is essential to also understand the distribution, diversity, and changing patterns of our native stoneworts and how management actions may impact them. Otherwise, in our ignorance, we may be destroying these special plants that keep our lakes pristine.

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 challenge requires an investment in existing specialized knowledge that can be shared to grow expertise within Minnesota. Four years ago, DNR began ad hoc collaboration with Dr. Kenneth Karol, a world-renowned stonewort expert at the New York Botanical Garden (NYBG). Dr. Karol uses a combination of field surveys, microscopic analyses and genetic studies to identify and describe stoneworts. It was Dr. Karol who first identified the non-native starry stonewort in Minnesota and has used genetics to confirm all new locations and compare them with other North American and European populations to help understand its mode of spread. His lab has analyzed hundreds of Minnesota stonewort samples and from them, identified dozens of native stonewort species, all at no cost to the state. We now need to expand and fund this collaborative work so that 1) stonewort sampling becomes a routine component of lake surveys 2) Minnesota surveyors gain expertise in stonewort identification and ecology and 3) we build baseline data on stonewort communities across the state. These data can then be used to help prioritize lakes for protection and restoration, monitor changes in lake habitat, and improve lake health assessments statewide.

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?

1. Creation of in-state expertise in identifying and documenting stoneworts
2. Baseline, statewide, lake specific data on the identity, diversity and distribution of stoneworts
3. Mapping and identification of stoneworts in Leech Lake where they provide critical water quality benefits and muskie spawning habitat and may be threatened by changing lake conditions including non-native species
4. Addition of lake-specific stonewort diversity data in lake management planning

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

Activities and Milestones

Activity 1: Statewide Inventory and Collection of Stoneworts in Minnesota Lakes Including Focused Searches within Leech Lake Reservation

Activity Budget: $376,200

Activity Description:
In 500 waterbodies across Minnesota, surveyors will search for and collect stoneworts. In Leech Lake, we will also conduct lakewide searches. Searches will be made by wading shorelines and with watercraft. An underwater drone will facilitate deep-water searches; this will be less expensive, logistically easier, and faster than SCUBA surveys. Each unique stonewort observed in a lake will be collected along with geographic location and selected water quality and habitat data.

Field data will be entered electronically and uploaded daily to a central database. Suspected new locations of starry stonewort will be promptly reported. DNR equipment cleaning protocols will be followed to prevent unwanted spread of non-native species. We expect about 1,500 live collections (average of three species per lake, with fewer species in turbid southern lakes and more species in clear northern lakes.)

Three live samples of each stonewort collection will be shipped to New York Botanical Garden for morphological and genetic analysis and a fourth sample will be pressed and dried in Minnesota as a field voucher record. This study will also include about 100 historical Minnesota stonewort specimens currently housed at the Bell Museum.

Activity Milestones:

Description	Approximate Completion Date
Select survey sites, determine lake access points and train surveyors on field methods	June 30, 2022
Lakewide survey of Leech Lake	September 30, 2023
Statewide stonewort searching and collecting in 500 waterbodies	September 30, 2024

Activity 2: Morphological and Genetic Analyses to Identify Minnesota Stoneworts

Activity Budget: $337,000

Activity Description:
All stonewort collections (estimated 1,500 new plus 100 historical) will be shipped to the New York Botanical Garden (NYBG) for identification using a combination of expert examination and state-of-the-art genetic analysis and interpretation.

At NYBG, each stonewort collection will be cleaned, sorted, and inspected under magnification; tentative identifications will be based on morphology. Three museum quality pressed specimens will be created for each collection. Genomic DNA will be extracted and purified using the Nucleon Phytopure DNA Extraction Kit. Nested polymerase chain reaction (PCR) method will be used to amplify a universal DNA "barcode" for each collection. These barcodes will be sent to a DNA sequencing laboratory for sequencing and the resulting electropherograms will be returned to NYBG for assembling and editing. Edited barcodes from each Minnesota collection will be compared to existing data in NYBG's barcode library to confirm or modify initial identifications that were made based on morphology, and to reveal species that are new to science.

Activity Milestones:

Description	Approximate Completion Date
Sort, clean, and analyze live specimens and extract DNA	September 30, 2024
DNA sequencing	January 31, 2025
Interpret DNA sequencing results and match with morphological analyses	April 30, 2025
Labels all specimens and update databases	June 30, 2025

Activity 3: Educational Outreach and Technology Transfer for Minnesota Lake Managers

Activity Budget: $97,800

Activity Description:
In-state expertise on stonewort identification and ecology will be built through a multi-faceted educational approach that includes student mentorship, hands-on workshops, field identification guide, museum quality reference collections, and data acquisition into lake planning datasets.

In 2021, 2022, and 2023, we will hold stonewort identification workshops for public natural resource organizations. We anticipate 50 participants per workshop with attendance by tribal, federal, state, and county groups. Live specimens will be used to teach participants how to collect, identify and report common, rare and non-native stoneworts. Teaching aids will include a field guide and key to Minnesota stoneworts and laminated specimens of representative species.

An estimated 1,500 museum quality specimens with final identifications will be deposited at the Bell Museum with duplicates at NYBG. Additionally, about 100 specimens already housed at the Bell Museum will be updated with contemporary identifications. These specimens and species distribution maps will be an online resource for lake managers and researchers throughout the state and internationally.

Summarized final lake survey data will be added to Minnesota Geospatial Commons for use in lake planning.

Activity Milestones:

Description	Approximate Completion Date
Workshop 1 with draft field guide	August 31, 2022
Workshop 2 with revised field guide	August 31, 2023
Workshop 3 with revised field guide	August 31, 2024
Verified specimens imaged and accessioned into U of MN Bell Museum Herbarium	June 30, 2025
Educational materials including field guide to Minnesota stonewort species completed	June 30, 2025
Geo-referenced data from study lakes available in MN Geospatial Commons	June 30, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Kenneth G. Karol	New York Botanical Garden	Co-Principal Investigator. Lead research to collect, analyze, identify, describe and catalog Minnesota stonewort species. Develop, conduct and coordinate laboratory analysis to identify species using morphological and genetic techniques. Organize, interpret and present results. Develop and provide hands-on species identification training to project field teams and workshop participants.	Yes
Dr. Timothy J.S. Whitfield, Dr. George D. Weiblen	University of Minnesota, Bell Museum	Receive final, genetically verified, labeled specimens from NYBG and accession into the University of Minnesota Herbarium. Bell Museum will scan each specimen to create an image for the online virtual herbarium.	Yes
Ms. Katherine Hagsten	Leech Lake Band of Ojibwe Division of Resource Management	Coordinate field surveys conducted on Leech Lake and other lakes within Leech Lake Reservation, supervise Leech Lake Tribal College student interns, and manage electronic and specimen data from those surveys that will be incorporated with the statewide survey data.	Yes
Ms. Melinda Neville	Leech Lake Tribal College	Coordinate Leech Lake Tribal College student internships.	Yes

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.
We will provide results in specific audience-appropriate formats for the general Minnesota public, natural resource students, lake managers, scientists and other stakeholders. We will write articles for local and regional newsletters, such as the Leech Lake Association newsletter and the Minnesota Native Plant Society newsletter, to update and inform Minnesotans about the importance of stoneworts and new discoveries in the state. An estimated 1,500 herbarium voucher specimens will be deposited at the Bell Museum with duplicates at NYBG and will be made available to the public through searchable online databases. Any new discoveries of non-native stoneworts will be promptly reported to the public and lake groups through the existing DNR Invasive Species Program. We anticipate training 150 natural resources staff in stonewort identification and ecology through hands-on workshops. Permanent educational materials will include a new field guide to Minnesota's stoneworts that will be available in print and online and will be distributed throughout the state. Lake-specific, georeferenced, stonewort species data will be shared in MN Geospatial Commons. Results from this project will be published in peer-reviewed scientific journals.

All project communications and outreach will acknowledge ENRTF through the use of the ENRTF logo or attribute language.

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?
The results of this project can stand alone as the initial statewide inventory and assessment of stoneworts and will serve as baseline data for individual lake assessment and for long-term statewide monitoring. Following training, we expect surveyors to include stonewort collecting in their routine lake plant sampling and DNR is committed to providing ongoing technical assistance to surveyors. Museum quality specimens will be publicly available for review and study

through existing online virtual herbaria of Bell Museum and NYBG. Geo-referenced species location data will be added to DNR's existing databases for lake management planning.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Student Worker		assist with surveys			20%	0.5		$20,958	-	-
Natural Resource Specialist		lead field survey team			20%	1		$53,549	-	-
Student Worker		assist with field surveys			20%	0.25		$8,258	-	-
Natural Resource Specialist		lead field survey team and organize final field data			20%	0.75		$47,241	-	-
							Sub Total	**$130,006**	**$130,006**	-
Contracts and Services										
Leech Lake Band of Ojibwe (LLBO) Division of Resource Management (LLDRM)	Subaward	LLDRM will lead surveys on lakes within Leech Lake Reservation. Personnel: $65,500 (Plant Biologist and Field Technician, 30% fringe), travel: $9,500 (mileage and gas), shipping: $1,000 (justification below), field supplies: $4,500, equipment: $19,500 (microscope, water quality meter, underwater drone; justification below for outboard motor, iPad)		X		2.3		$86,493	$86,493	-
Leech Lake Tribal College (LLTC)	Professional or Technical Service Contract	Leech Lake Tribal College will direct and mentor two interns to assist Leech Lake Band DRM and DNR with field surveys. Personnel: $26,400 (Science Director 35% fringe; 2 interns 8% fringe). Travel: $3,000 (lodging/meals for students).		X		0.5		$29,400	$29,400	-
University of Minnesota Bell Museum	Professional or Technical Service Contract	Funding will expedite the acquisition of specimens into Bell herbarium and online website. Personnel: $16,409 (curator, 36% fringe and student intern, no fringe). Supplies and archival cabinet: $5,491. Specimen and supply				0.6		$25,000	$25,000	-

		costs $1,000. (Budget adjustments include personnel increase by $89 and separation of shipping costs from supplies).								
New York Botanical Garden (NYBG)	Subaward	Conduct genetic analysis, identify, make museum specimens for 1,500 stonewort collections, create field guide, train surveyors, develop/instruct workshops. Personnel: $269,700 (Researcher and Lab Technician, 42% fringe); DNA sequencing: $61,700; Supplies: $40,000; Shipping: $2,500; Workshops: $30,000 (includes travel to MN). Justification below		X		3.51		$403,900	$360,615	$43,285
							Sub Total	**$544,793**	**$501,508**	**$43,285**
Equipment, Tools, and Supplies										
	Equipment	1 underwater drone (shared by DNR field teams)	Underwater drones will be used to rapidly search deeper water of clear lakes. This is cheaper, faster, more efficient, and requires less training than SCUBA surveys.					$2,749	$2,749	-
	Equipment	2 iPads with waterproof cases and accessories	All field data will be entered electronically in the field to expedite data entry	X				$1,600	$1,600	-
	Tools and Supplies	field and lab supplies for 2 DNR teams (2 years) and a 3rd team (1 year) to collect water quality data, stoneworts (boots, PFDs, kayaks, GPS, bags, trays, coolers, plant press, archival pressing supplies, laminator)	supplies to sample water quality and to collect and preserve stoneworts in lakes					$29,974	$29,609	$365
							Sub Total	**$34,323**	**$33,958**	**$365**
Capital Expenditures										
							Sub Total	**-**	**-**	**-**

Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**
Travel In Minnesota										
	Miles/ Meals/ Lodging	In-state travel to conduct surveys. 3 Vehicles for 8 months, lodging and meals for estimated 180 travel days for 5 field staff in accordance with the Commissioner's Plan.	Surveys will be conducted throughout the state and about 50% of field work will require overnight stays. In 2023 travel costs include a 2nd field team and in-kind field support from DNR Research Biologists. In 2024, in-state travel is for in-kind field surveys by DNR Research Biologist.					$72,207	$67,991	$4,216
							Sub Total	**$72,207**	**$67,991**	**$4,216**
Travel Outside Minnesota										
							Sub Total	**-**	**-**	**-**
Printing and Publication										
	Printing	300 printed and bound copies of field identification guide to Minnesota stoneworts	Printed copies of field guide will be provided to training workshop participants, DNR Area offices and other Minnesota natural resource organizations.					$2,000	$225	$1,775
	Printing	100 sets of printed "flashcards" as teaching aids to compliment field guide	for distribution to natural resource agencies and for use at future training events					$3,000	$1,185	$1,815
							Sub Total	**$5,000**	**$1,410**	**$3,590**
Other Expenses										
		Shipping	Express shipping of live specimens through State of	X				$8,000	$3,904	$4,096

			MN Contract @ $30 per shipment. See justification for shipping below.							
		DNR Direct and Necessary Costs	Direct and necessary costs to cover HR support (~$3,322), Safety Support (~$617), Financial Support (~$2,862), Communication Support (~$1,324), IT Support (~$6,697), and Planning Support (~$1,149).					$15,971	$15,971	-
		2024 Statewide Workshop Meeting Rooms and Catering	Final workshop for natural resource professional. Costs include: 1/2 cost of auditorium and registration area rental $230, 1/2 cost facility use fees $220, stonewort lab/classroom $90, microscope rentals $160.					$700	$657	$43
							Sub Total	**$24,671**	**$20,532**	**$4,139**
							Grand Total	**$811,000**	**$755,405**	**$55,595**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Contracts and Services - Leech Lake Band of Ojibwe (LLBO) Division of Resource Management (LLDRM)	Subaward	LLDRM will lead surveys on lakes within Leech Lake Reservation. Personnel: $65,500 (Plant Biologist and Field Technician, 30% fringe), travel: $9,500 (mileage and gas), shipping: $1,000 (justification below), field supplies: $4,500, equipment: $19,500 (microscope, water quality meter, underwater drone; justification below for outboard motor, iPad)	LLBO will provide a motorboat as in-kind support but will need ENTRF funds to purchase a new outboard motor ($9,000) to safely operate that boat on Leech Lake. LLBO will continue to use this outboard motor (through its useful life) to conduct stonewort surveys on Leech Lake and other lakes within Leech Lake Reservation. If the outboard motor is sold, LLBO understands and acknowledges the requirement to pay back the Environment and Natural Resources Trust Fund an amount equal to either the cash value received or a residual value approved by the LCCMR director. An iPad with waterproof cover ($800) to electronically enter data in the field. When unique stoneworts are discovered, express shipping to NYBG is required. Up to $3,200 of travel budget will be used for LLBO to travel to NYBG to tour the library, greenhouse, herbarium and laboratories. This will provide a unique and critical opportunity for Leech Lake Band to learn about all components of this study, meet world experts in various botanical fields, and develop mentorship and research networks to further collaboration and shared learning.
Contracts and Services - Leech Lake Tribal College (LLTC)	Professional or Technical Service Contract	Leech Lake Tribal College will direct and mentor two interns to assist Leech Lake Band DRM and DNR with field surveys. Personnel: $26,400 (Science Director 35% fringe; 2 interns 8% fringe). Travel: $3,000 (lodging/meals for students).	Up to $3,000 of travel budget will be used for LLTC to travel to NYBG to tour the library, greenhouse, herbarium and laboratories. This will provide a unique and critical opportunity for Leech Lake Band to learn about all components of this study, meet world experts in various botanical fields, and develop mentorship and research networks to further collaboration and shared learning. LLTC will provide additional cost-share for this travel.
Contracts and Services - New York Botanical Garden (NYBG)	Subaward	Conduct genetic analysis, identify, make museum specimens for 1,500 stonewort collections, create field guide, train surveyors, develop/instruct workshops. Personnel: $269,700 (Researcher and Lab Technician, 42% fringe); DNA sequencing: $61,700; Supplies: $40,000; Shipping: $2,500; Workshops: $30,000 (includes travel to MN). Justification below	Dr. Kenneth G. Karol is the national expert on identification of stoneworts. He has over 30 years of specific research on this group and is uniquely qualified to conduct lab research, instruct workshops and develop field guide. His specific knowledge, existing specimen database and DNA barcode library at NYBG are required to conduct this research. This work requires DNA sequencing which was originally planned at U of MN Genomics Center (UMGC) but their lab can no longer conduct this work; $61,700 originally planned for UMGC for this specific portion of the genetic analyses will be added to NYBG contract and they will subcontract with a private lab where they have years of successful collaboration; costs include express shipping of samples to that lab (~$2,500). Costs include annual travel to MN for workshops and field surveys for Dr. Karol and 1-2 associates, travel costs within state, collecting supplies, and workshop materials; workshop participant registration fee will cover workshop facility and workshop meals.

Equipment, Tools, and Supplies		2 iPads with waterproof cases and accessories	Electronic data entry reduces costs by greatly reducing the need for post survey manual data entry. It also reduces paper use, minimizes data transcription errors and expedites data acquisition. Data are downloaded and backed up daily. DNR has successfully used iPads for this type of field survey for several years.
Other Expenses		Shipping	This study requires express shipment of live plant samples to NYBG for morphological and genetic analyses. DNR has an existing shipping contract with UPS that discounts express shipping by 70%.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount	$ Amount Spent	$ Amount Remaining
State						
In-Kind	Game and Fish (M.S. Ch. 97A.055)	DNR will provide two boats, 1 field iPad, GPS for use on this project and will utilize existing office and laboratory space, microscopes and office computers.	Secured	$25,000	$25,000	-
Cash	Game and Fish Fund (M.S. Ch. 97A.055)	Research Scientist (80% time for 3 years): project manager, field survey design, survey team lead and statewide coordination of field work.	Secured	$288,000	$288,000	-
In-Kind	University of Minnesota Bell Museum	University indirect costs not covered by grant.	Pending	$16,150	$16,150	-
			State Sub Total	**$329,150**	**$329,150**	**-**
Non-State						
In-Kind	Leech Lake Band of Ojibwe Division of Resource Management	Leech Lake Band will provide boat, GPS, office space and office computers in-kind.	Pending	$10,000	$10,000	-
In-Kind	Leech Lake Tribal College	25% cost share for 2 student internships at Leech Lake Tribal College and 50% cost share for Science Director (1 month per year for 2 years)	Pending	$13,250	$13,250	-
In-Kind	New York Botanical Garden	Laboratory space and equipment use are provided in-kind. NYBG will fund about 50% of Dr. Karol's time on this project for three years.	Pending	$100,000	$100,000	-
			Non State Sub Total	**$123,250**	**$123,250**	**-**
			Funds Total	**$452,400**	**$452,400**	**-**

Attachments

Required Attachments

Visual Component

File: 390faea0-4cd.pdf

Alternate Text for Visual Component

This visual emphasizes the importance of stoneworts in Minnesota lakes (image of boaters on clear lake, moose eating stoneworts, fish spawning in stoneworts). Photos summarizing how we can improve knowledge about these plants (surveyor searching for stoneworts, collecting, identifying with microscope, participants at workshop). A map shows 500 stonewort study lakes distributed across entire state with a focus on Leech Lake in north central Minnesota. Outcomes and Partners are listed....

Supplemental Attachments

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

Title	File
Leech Lake Association letter of support	4245e2b4-da2.pdf
Research Addendum 2021-055 Perleberg	98f199cc-2a1.pdf
Background Check form	bc54db83-468.pdf
Dec 2022 Update - Map 1	f69c4395-3e8.pdf
Dec 2022 Update - Map 2	44377c45-f41.pdf
Dec 2022 Update - Map 3	eefc85be-851.pdf
Project Summary Poster	7e014133-c86.pdf
Poster presented at NE Algal Society Conference	f238fc39-b45.pdf
Map of 650 Minnesota Stonewort Study Sites	8ae0b292-06b.pdf
example presentation	fb566947-cee.pdf
example workshop agenda and techniques	fc9f769e-564.pdf

Media Links

Title	Link
News release: Starry stonewort confirmed in Bowen Lake in Cass County, Turtle River Lake in Beltrami County	https://www.dnr.state.mn.us/news/2022/08/15/starry-stonewort-confirmed-bowen-lake-cass-county-turtle-river-lake-beltrami-county
News release: Starry stonewort confirmed in Lake Bemidji in Beltrami County	https://www.dnr.state.mn.us/news/2022/09/01/starry-stonewort-confirmed-lake-bemidji-beltrami-county
News release: Starry stonewort confirmed in Thunder Lake in Cass County	https://www.dnr.state.mn.us/news/2022/09/15/starry-stonewort-confirmed-thunder-lake-cass-county

News release: Starry stonewort confirmed in Long Lake in Kandiyohi County	https://www.dnr.state.mn.us/news/2023/06/29/starry-stonewort-confirmed-long-lake-kandiyohi-county#:~:text=The%20Minnesota%20Department%20of%20Natural,public%20access%20on%20Long%20Lake
News release: Starry stonewort confirmed in Blackduck Lake in Beltrami County	https://www.dnr.state.mn.us/news/2023/08/03/starry-stonewort-confirmed-blackduck-lake-beltrami-county
News release: Starry stonewort confirmed in Dora Lake, Itasca County	https://www.dnr.state.mn.us/news/2023/09/14/starry-stonewort-confirmed-dora-lake-itasca-county
Minnesota Conservation Volunteer article	https://www.dnr.state.mn.us/mcvmagazine/issues/2023/jul-aug/dispatch.html
Minnesota Biodiversity Atlas	https://bellatlas.umn.edu/
New York Botanical Garden Virtual Herbarium	https://sweetgum.nybg.org/science/vh/
Global Biodiversity Information Facility	https://www.gbif.org/
Minnesota Lake Plant Survey Manual	https://files.dnr.state.mn.us/eco/lake-habitat/lake-plant-survey-manual.pdf
NatureServe	https://www.natureserve.org/

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Changes reflect a 25% reduced budget as recommended by the LCCMR committee. The number of waterbodies to be surveyed was decreased from 650 to 500 (23% reduction) and we will focus the lakewide survey effort entirely on Leech Lake. DNR field teams were reduced from three to two and outreach efforts involving the creation of teaching specimens and field guide development have been shifted to the NYBG Lab Tech. DNR student intern positions were eliminated. Reduction in field surveys resulted in lower DNR travel and field supply costs. DNR staffing reductions resulted in lower DNR Direct and Necessary costs. We anticipate a reduction in sample number due to reduced field surveys and this led to a reduction in the contract costs for the U of MN Genomics Center and Bell Museum. We eliminated the contract for botanical line drawings but this remains a need for which we hope to find future funding.

NYBG was changed from "single source contractor" to "sub award" following advice from LCCMR staff.

LLBO was changed from "single source contractor" to "sub award" following advice from LCCMR staff. As explanation was added to describe how LLBO will continue to use outboard motor for stonewort surveys through the useful life of the motor. LLBO agrees that if they ever sell this motor, they understand and acknowledge the requirement to pay back the Environment and Natural Resources Trust Fund an amount equal to either the cash value received or a residual value approved by the LCCMR director.

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 Commissioner's Plan 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?

No

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Explanation & justification for Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	• Budget - Professional / Technical Contracts	$61,700 was originally budgeted for DNA sequencing by Univ. of MN Genomics Center (UMGC). That lab no longer provides this service. We are requesting these funds be added to the New York Botanical Garden (NYBG) contract and they can directly arrange for and pay for DNA sequencing from a secondary lab. This will allow NYBG to directly ship specimens, pay for analyses and promptly receive results they need for final species determinations.	October 27, 2022	Yes	October 28, 2022
2	Amendment Request	• Activities and Milestones • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Attachments	Out-of-state travel to NYBG for facility exploration and research knowledge exchange: LLBO ($3,200) and LLTC ($3,000); allows staff and students to participate in all aspects of this study and network with world-class scientists, facilitating our goal to build in-state expertise. LLTC providing cost-share funds. Transfer funds budgeted for second DNR underwater drone ($2,451) and chemistry probes ($5,000) to supply budget. Explained in December 2022 update: underestimated supply needs and cost increases.	December 5, 2022	Yes	December 8, 2022
3	Amendment Request	• Budget - Personnel • Budget - Travel and Conferences • Budget - Other	To complete statewide surveys on schedule, DNR added a second summer field crew and is providing additional in-kind field support from permanent DNR biologists. We are requesting $10,000 originally allotted for DNR summer staff be transferred to DNR travel to cover	October 2, 2023	Yes	October 3, 2023

			additional fleet and other in-state travel costs for DNR staff.			
4	Completion Date	Previous Completion Date: 06/30/2024 New Completion Date: 06/30/2025; Governor Approved on 04/15/2024	Covid-19 pandemic delayed our project subcontracts by nine to twelve months. We completed a statewide stonewort field inventory but because project activities are directly related and sequential, additional time is required to achieve outcomes. An extension will allow us to process 2023 samples and interpret data, apply learned field methods to Leech Lake Reservation lakes, and complete outreach projects to share this knowledge with natural resource stakeholders.	October 18, 2023	Yes	May 21, 2024
5	Amendment Request	• Activities and Milestones • Budget - Personnel • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Other	Because DNR is providing increased in-kind personnel support, we did not need full amount originally requested for Personnel. In 2024, DNR and NYBG are available to conduct additional field surveys to create outreach materials and document rare stoneworts; increased travel and supply costs are for DNR travel. Final workshop will piggyback with broader aquatic plant workshop and we request funds to stonewort classroom fee and microscope rental and half general meeting space fees.	July 7, 2024	Yes	July 8, 2024
6	Amendment Request	• Other • Budget - Capital, Equipment, Tools, and Supplies • Budget - Printing and Publication • Budget - Other	We originally budgeted $8,000 for shipping costs but we do not anticipate needing that full amount for shipping. We are requesting that $3,000 be moved to "supplies" for field supplies and materials needed to create additional teaching collection specimens. We are requesting that $1,000 be moved to "printing" for the production of Characeae flashcards to be distributed with the Field Guide.	February 21, 2025	Yes	March 13, 2025
7	Amendment Request	• Budget - Professional / Technical Contracts	Leech Lake Band completed contract but did not use $13,507. We may not use	April 30, 2025	Yes	May 19, 2025

		• Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Printing and Publication	$5,000 to $10,000 of these funds. We request funds be distributed as follows: $2,100 to Bell Museum (student to process 700 specimens in excess of original workload); $2,407 Travel (DNR trips to select lakes to collect Outreach materials); $7,000 Supplies (materials to process excess specimens and additional Outreach materials; $2,000 Printing (additional Outreach materials.)			
8	Completion Date	Previous Completion Date: 06/30/2025 New Completion Date: 12/31/2025	LCCMR administrative workaround for final update.	May 19, 2025	Yes	May 19, 2025
9	Completion Date	Previous Completion Date: 12/31/2025 New Completion Date: 06/30/2025	LCCMR administrative workaround for final update.	May 19, 2025	Yes	May 19, 2025

Status Update Reporting

Final Status Update August 14, 2025

Date Submitted: September 18, 2025

Date Approved: September 24, 2025

Overall Update
We have completed the first-ever, statewide inventory of Minnesota's stoneworts using a combination of traditional field-based botanical surveys and state-of-the-art genetic analyses. We intentionally built "shared-learning" into our study design so that local knowledge from natural resources staff and students and expertise from genetic researchers could be exchanged. This included hands-on workshops, shared field surveys, frequent communication between lab and field staff, and a unique opportunity to have field staff and students tour facilities at NYBG.

We believe our results are tremendous - with survey sites in every county and more than 50 species of stoneworts verified (most for the first time in Minnesota and some new to science!). These new data now reveal that stoneworts are the largest group of submerged aquatic plants in Minnesota. Distribution patterns suggest that many of these species will be important indicators of water quality and several species may be recommended for listing as rare.

While most Minnesotans are familiar with the non-native "starry stonewort", our study confirms that the present distribution of this species is relatively low (detected in <1% of sites). With continued outreach efforts, we aim to showcase the great value of native stoneworts and the need for their protection.

Activity 1
We more than doubled our proposed survey effort and searched for stoneworts at 1,300 lake and river sites throughout Minnesota, including a focused survey of 150 sites within Leech Lake Reservation. Native stoneworts were detected at over 50% of the sites with higher detection in clear, relatively undisturbed lakes of north-central Minnesota, including Leech Lake. Several species were found to be uncommon and/or with unique distribution patterns. The non-native, starry stonewort, was found at less than 1% of the waterbodies and often co-occurred with native stoneworts.

Field data have been compiled into a central database, quality checked, and ready to be used in lake management planning and protection efforts.

Outcomes: We now have baseline, statewide, lake specific data on the identity, diversity and distribution of nearly 60 species of stoneworts
We mapped and identified 12 species of stoneworts in Leech Lake. Stonewort species identified during this study have now been added to NatureServe, an international organization and data hub; MN DNR partners with Nature Serve on rare species issues and by adding stonewort data we have initiated the process for possible rare species designations for some stonewort species.
(This activity marked as complete as of this status update)

Activity 2
New York Botanical Garden identified over 3,900 stonewort specimens using morphology and DNA sequencing. More than 50 Characeae species were documented by our study, revealing that stoneworts (Family Characeae) are the largest group of submerged plants in Minnesota. All specimens have been labeled, barcoded, and accessioned into NYBG Herbarium with duplicates distributed to the Bell Museum and other herbaria. Associated electronic data for those specimens have also been imported into databases at NYBG and the Bell Museum.
(This activity marked as complete as of this status update)

Activity 3
Stonewort identification knowledge has been shared through student mentorships at Leech Lake Tribal College, DNR, and NYBG. With feedback from field staff and students, we have developed field identification aids including a key to Minnesota's stoneworts and related study cards and laminated teaching specimens; final processing (lamination) of these products will be completed this winter with distribution to natural resource professional and students for the 2026 field season.

Nearly 4,000 museum-quality voucher specimens have been deposited at the Bell Museum and the New York Botanical Garden. Georeferenced species data and images are now available on the MN Biodiversity Atlas, NYBG Virtual Herbarium, andGlobal Biodiversity Information Facility. Because these sites are curated and updated through accredited herbaria, they provide more appropriate and usable repositories for these taxonomic data than our original plan to store data on MN Geospatial Commons. Statewide and worldwide distribution maps for each Minnesota species are available at these sites; users do not need GIS programs or experience to view maps.

Outcome: We created in-state expertise in stonewort identification and documentation by training 150 natural resource professionals/students, creating study guides, and including stonewort collecting methodology in the Minnesota Lake Plant Survey Manual (Ch 11).
(This activity marked as complete as of this status update)

Dissemination
Stonewort specimen images, data, and maps are now available through the online searchable websites of NYBG and the Bell Museum (see Tab 7 for links).

We plan to submit at least one professional article to a peer reviewed journal by Spring 2026.

LCCMR Logo has been included on all powerpoint presentations, posters, and study cards. On each herbarium specimen label, the following language was included: "Funding for this project was provided by the Minnesota Environment and Natural Resources Trust
Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR)."

Additional Status Update Reporting

Additional Status Update August 14, 2025

Date Submitted: May 16, 2025

Date Approved: May 19, 2025

Overall Update
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Activity 1
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.
(This activity marked as complete as of this status update)

Activity 2
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.
(This activity marked as complete as of this status update)

Activity 3
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Dissemination
Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Status Update Reporting

Status Update June 1, 2025

Date Submitted: May 16, 2025

Date Approved: May 19, 2025

Overall Update
Over 1,300 sites were surveyed for stoneworts, including about 150 sites within Leech Lake Reservation. Stoneworts were detected at over 50% of the sites. Approximately 1,300 collections were made, most in triplicate, resulting in 3,900 voucher specimens identified using morphology and DNA sequence data. More than 50 Characeae species were documented, increasing known Minnesota diversity fivefold. Final field work will be completed by DNR in May and June, 2025 and will focus on recollecting at several lakes where very unique species were located. These additional collections will be used for outreach materials related to Activity 3.

Activity 1
Field data have now been quality checked and combined with genetic final determinations of species identity. Leech Lake Band completed their work but did not use $13,507 of the funds originally allocated to their contract. We are requesting those funds be redistributed towards outreach materials including specimen curation at the Bell Museum.
(This activity marked as complete as of this status update)

Activity 2
New York Botanical Garden has completed specimen identification using morphology and DNA sequencing. All specimens, over 3,900, have been labeled and barcoded and accessioned into NYBG Herbarium with duplicates distributed to the Bell Museum and other herbaria. Associated electronic data for those specimens have also been imported into NYBG database and sent to Bell Museum.
(This activity marked as complete as of this status update)

Activity 3
Three statewide workshops and focused workshops with Leech Lake Band have been completed. Museum quality specimens have been created and accessioned into herbaria and data are now available online through NYBG's and Bell Museum's websites. We are finalizing the Minnesota stonewort field guide for distribution and use by natural resource professionals and students.

Dissemination
We provided a summary update to the Leech Lake Association Spring newsletter. We presented updates on this project at the 2025 Northeast Algal Society Conference with the keynote address given by Raining White, Leech Lake Band, and a poster presented by Victoria Davis, New York Botanical Garden.

Additional Status Update Reporting

Additional Status Update February 21, 2025

Date Submitted: February 21, 2025

Date Approved: March 13, 2025

Overall Update
This additional update is to provide current spending status because I am submitting an amendment request to move some funding from "shipping" to "supplies".

Activity 1
This activity was previously marked complete. Surveys for Characeae throughout the state have been completed. In late April through early June, 2025, DNR staff will travel to selected sites where very unique Characeae were discovered in previous years to make multiple collections for teaching purposes. Spring-time collection for sites in southern Minnesota is critical because plants collected in mid to late summer in previous years were in poor condition due to algal growths in these lakes as water temperatures warm.
(This activity marked as complete as of this status update)

Activity 2
NYBG continues to progress on genetic analyses and plans to ship identified and labeled specimens to Bell Museum in the winter of 2025.

Activity 3
2024 in-person workshops were successful. In addition to the Field Guide of Minnesota Characeae, we would like to create "flashcards" for each species to be used as a companion to the field guide.

Dissemination
Our collaborative team is working on several publications and presentations focused on this study. We have received confirmation that the Journal "Diversity" is interested in publishing our first manuscript focused on the Leech Lake Characeae. We anticipate submitting a draft manuscript in May.

Status Update Reporting

Status Update December 1, 2024

Date Submitted: December 24, 2024

Date Approved: January 29, 2025

Overall Update
Field surveys for the first-ever systematic, statewide inventory of stoneworts in Minnesota have been completed. Our project serves as a model for how to logistically inventory other plant groups in the state. We exceeded our original goal of 500 sites and detected stoneworts in over 50% of sites. Additionally, we located the non-native, "starry stonewort" at six new lakes, leading to rapid response by lake managers.

Leech Lake Band of Ojibwe developed and completed a lakewide stonewort inventory method, using Leech Lake as a model. Stoneworts were detected at ca. 70% of 130 sites. The high quality of this lake is reflected in the high diversity of stoneworts discovered within it.

Morphological and DNA analyses of specimens collected to date are nearly completed and specimens collected in 2024 are being analyzed this winter.

We anticipate ca. 1,500 stonewort collections (many with duplicates) will be accessioned in the Bell Museum and other herbaria. DNR is creating framework to include final data in lake management processes. Leech Lake Band is specifically including stoneworts in several lake management research projects.

We have trained over 250 natural resource professionals and students in stonewort survey and identification methods.

Activity 1
Activity 1 is complete and includes stonewort surveys at over 900 sites throughout the state, including waterbodies in every county.

The statewide inventory included over 750 sites throughout the state, exceeding our original goal of 500 sites. Leech Lake Band completed 150 surveys within their Reservation, including the completion of the lakewide inventory of Leech Lake.

More than 1,500 stonewort collections were made and sent to New York Botanical Garden for final analyses and identification.
(This activity marked as complete as of this status update)

Activity 2
To date, NYBG has received more than 1,500 stonewort collections from this project. Each collection has been tentatively identified using morphology and has been vouchered in triplicate when possible. DNA-based species determinations and DNA barcoding are nearly complete.

Analysis of Minnesota's historical stonewort specimens is completed. About 85 specimens were reviewed and identified based on morphology; 58% were successfully DNA barcoded.

Analysis in progress includes 1) morphological and genetic analyses of the 2024 collections and 2) morphological and genetic analyses of approximately 100 Minnesota collections submitted by external partners we connected with through

outreach (Activity 3).

In addition to the high diversity of native stoneworts identified through this project, our surveys detected the non-native "starry stonewort" (Nitellopsis obtusa) in six new waterbodies. Identification was confirmed through DNA analyses and led to early detection for lake managers.

Activity 3
We completed a June 2024 workshop for Leech Lake Band and an August 2024 workshop for Tribal, state, federal, county, and local natural resource groups, educators, students, and other interested parties. About 75 workshop participants used and evaluated our draft Minnesota Stonewort Field Guide and we will make revisions based on those critiques.

Internships related to these stonewort surveys were completed by students at Leech Lake Tribal College, Sarah Lawrence College, and Fordham University.

Targeted 2024 fieldwork by DNR and NYBG collected material for workshops as well as for the creation of outreach materials such as laminated teaching specimens and high-quality photographs of species and habitats.

Completed museum quality specimens continue to be disseminated through our established pipeline with accredited herbaria including the Bell Museum (MIN), the New York Botanical Garden Herbarium (NY), and the Academy of Natural Sciences of Drexel University (PH) where they are available for public viewing on each institution's online website as well as Macroalgae Herbarium Consortium (macroalgae.org) and Global Biodiversity Information Facility (gbif.org).

Dissemination
The Dissemination Description is up to date.

Status Update Reporting

Status Update June 1, 2024

Date Submitted: May 30, 2024

Date Approved: July 8, 2024

Overall Update
Field surveys for the first-ever systematic, statewide inventory of stoneworts in Minnesota have been completed. Our project can serve as a model for how to logistically inventory other plant groups in the state. Survey sites occurred in every county and stoneworts were detected in over 50% of sites.

Leech Lake Band of Ojibwe (LLBO) developed a lakewide stonewort inventory method, using Leech Lake as a model. Good progress has been made with stoneworts detected at ca. 70% of 90 sites. The survey is scheduled for completion in 2024.

Morphological and DNA analyses of specimens collected to date are nearly completed and specimens collected in 2024 are scheduled for analyses this winter.

Upon project completion, we anticipate ca. 1,500 stonewort collections (many with duplicates) will be accessioned in the Bell Museum and other herbaria. DNR is creating framework to include final data in lake management processes. Leech Lake Band is specifically including stoneworts in several lake management research projects.

2024 statewide fieldwork will be to collect materials for educational outreach. Our efforts to build in-state stonewort expertise are showing early success with over 200 participants at outreach events and more than 100 additional collections submitted by these participants.

Activity 1
The statewide inventory component of Activity 1 is complete. We are conducting quality analysis / quality control of water quality and preliminary stonewort data to prioritize 2024 field surveys to collect species for outreach materials. Final analyses and reporting are dependent on final DNA determinations (Activity 2).

Leech Lake Band has successfully completed about one-third of the Leech Lake stonewort inventory and plans to complete this survey in 2024. Additionally, they surveyed several smaller lakes within the Reservation.

Activity 2
To date, NYBG has received more than 1,000 living stonewort collections from this project. Each collection has been tentatively identified using morphology and has been vouchered in triplicate when possible. DNA-based species determinations and DNA barcoding are nearly complete.

Analysis of Minnesota's historical stonewort specimens is completed. About 85 specimens were reviewed and identified based on morphology; 58% were successfully DNA barcoded.

Analysis for this year will include 1) completion of DNA barcoding for 2023 field season collections, 2) morphological and genetic analyses of Leech Lake Band's 2024 collections, and 3) morphological and genetic analyses of approximately 100 Minnesota collections submitted by external partners we connected with through outreach (Activity 3).

Activity 3
We have developed a June 2024 workshop for Leech Lake Band and an August 2024 workshop for Tribal, state, federal,

county, and local natural resource groups, educators, students, and other interested parties. Workshop participants will use and evaluate our draft Minnesota Stonewort Field Guide and we will make revisions based on those critiques.

Leech Lake Tribal College anticipates two internships focused on stonewort surveys this summer. Sarah Lawrence College undergraduate students, Gabrielle Krieger and Skyler Young, have completed internships for the academic year. Zainab Ali (undergraduate at Fordham University) anticipates completing her internship this summer.

Targeted 2024 fieldwork by DNR and NYBG will be to collect material for workshops as well as for the creation of outreach materials such as laminated teaching specimens and high-quality photographs of species and habitats.

Completed museum quality specimens continue to be disseminated through our established pipeline with accredited herbaria including the Bell Museum (MIN), the New York Botanical Garden Herbarium (NY), and the Academy of Natural Sciences of Drexel University (PH) where they are available for public viewing on each institution's online website as well as Macroalgae Herbarium Consortium (macroalgae.org) and Global Biodiversity Information Facility (gbif.org).

Dissemination

We have reached an estimated 300 people with our winter 2024 presentations.

January 2024 – presentation at MN DNR Annual Biodiversity Reporting Series (Donna Perleberg)
May 2024 – presentation at Minnesota Native Plant Society (Donna Perleberg, Kate Hagsten, Melinda Neville, Leanna Goose, Ken Karol)
March 2024 – presentation at NYBG’s weekly Science and Humanities Seminar Series (Ken Karol)

Status Update Reporting

Status Update December 1, 2023

Date Submitted: November 29, 2023

Date Approved: January 30, 2024

Overall Update
We have completed the first-ever Minnesota statewide stonewort field inventory. Searches have now been conducted in each of Minnesota's 87 counties with stoneworts detected in 68 counties (78%). Statewide, ca. 700 sites were sampled for stoneworts and water quality.

Morphological and DNA analyses of 2022 specimens is completed. Final, labeled specimens are available online for public view at sweetgum.nybg.org/science/vh/.

Our 2023 statewide Stonewort Identification Workshop was very successful with participants interested in a follow-up workshop and a waiting list of participants who are eager to attend a second workshop in 2024.

As described in our October 2023 update, Covid-19 restrictions delayed other project components and we have requested a one-year extension to process 2023 samples, interpret species distribution and habitat data, apply learned field methods to Leech Lake Reservation lakes, and complete outreach projects.

Activity 1
The statewide inventory component of Activity 1 is complete. Field water quality and preliminary stonewort collection data from 2022 and 2023 have been compiled in a draft GIS database.

Final analyses and reporting, including species descriptions, maps, and habitat characterization, are dependent on final DNA determinations (Activity 2).

Leech Lake Band of Ojibwe (LLBO) piloted the first-ever lakewide stonewort inventory on Leech Lake where they surveyed ca. 90 sites and located stoneworts at ca. 70% of the sites. They also surveyed several smaller lakes within the Reservation. An additional field season is needed to complete Activity 1 inventory work on Leech Lake and additional lakes within Leech Lake Reservation.

Activity 2
NYBG received nearly 700 living collections from the 2023 field season for a project two-year total of more than 1,000 live collections. Each collection has been identified using morphology and vouchered. Tissue from each has been isolated and DNA has been extracted and DNA barcoding is underway.

DNA sequencing of ca. 80 historical Minnesota stonewort specimens are currently being DNA barcoded. Approximately 50% are completed.

About 2,100 pressed specimens collected by DNR and NYBG during the 2023 field season, along with completed labels, have been shipped to and received by NYBG. In early December, an additional ca. 300 pressed specimens collected by LLBO during the 2023 field season are anticipated to be shipped to NYBG. These pressed specimens represent duplicates of the 700 living collections from the 2023 field season. Anticipated processing, analyses, barcoding and distribution of these specimens is estimated to take 12 to 18 months. This work will require a one-year extension and is critical to fully meet our project objectives.

Activity 3

Upon project completion, we anticipate ca. 1,500 stonewort collections (many with duplicates) will be accessioned in the Bell Museum (MIN), the New York Botanical Garden Herbarium (NY), and the Academy of Natural Sciences of Drexel University (PH) and available for public viewing on each institution's online website as well as Macroalgae Herbarium Consortium (macroalgae.org) and Global Biodiversity Information Facility (gbif.org).

Final species determinations and accession into herbaria is anticipated to take an additional 12 to 18 months and is a primary component of our extension request. These final determinations are also needed to complete the Minnesota Stonewort Field Guide and related outreach materials. NYBG has begun the process of making laminated specimens for outreach educational products.

Through our local training events with Leech Lake Band, Fond du Lac Band, Red Lake Nation, and other natural resource professionals, as well as our 2023 statewide stonewort identification workshop, we have reached about 200 stakeholders from Tribal, state, federal, county, and local natural resource groups, educators, students, and other interested parties. Pending our extension request, in 2024 we are hopeful to reach a similar number of stakeholders through additional outreach workshops.

Dissemination

See October 2023 update.

Additional Status Update Reporting

Additional Status Update October 3, 2023

Date Submitted: October 4, 2023

Date Approved: January 30, 2024

Overall Update
Covid-19 pandemic delayed project subcontracts by nine to twelve months, limited field surveys, and prevented statewide outreach workshops. By 2023, alleviated social distancing requirements allowed us to begin addressing delays by adding surveyors to escalate field surveys. NYBG also ramped up laboratory analyses by adding in-kind assistance from two student interns to help manage the influx of 2022 samples. We hosted our first of three planned statewide annual workshops where participants reviewed a draft stonewort field guide and learned preliminary study results.

We have completed a statewide stonewort field inventory but because project activities are directly related and sequential, additional time is required to achieve outcomes that cannot be completed out of order. We seek an extension to process 2023 samples and interpret data, apply learned field methods to Leech Lake Reservation lakes, and complete outreach projects. Without an extension, 50% of collected data will be unprocessed and unusable for science and conservation efforts, the area of Minnesota where we expect to find the highest stonewort diversity (Leech Lake Reservation) will be under sampled, our Field Guide will be incomplete and remain draft, and we will miss key opportunities to share this knowledge with resource stakeholders.

Activity 1
In 2023 we completed ca. 400 surveys for a two-year total of ca. 700 surveys across Minnesota, exceeding our original goal of 500. This was accomplished because: DNR added a second summer field team, DNR biologists provided additional in-kind field assistance, LLDRM and LLTC dedicated three student interns to the project, and NYBG researchers committed three weeks to intensive Minnesota field surveys.

LLDRM piloted the first-ever lakewide stonewort inventory on Leech Lake where they surveyed ca. 100 sites. Three LLTC student interns (Morgan Smith, Auralia Bellecourt and Seth Sisneros-Martinez) were trained in field botanical survey methods, water quality analyses, data entry, and stonewort identification.

Preliminary results suggest Minnesota is home to dozens of native stonewort species but final reporting is dependent on final DNA determinations. Stoneworts were found across the state, and as predicted, were most common in northern Minnesota with a great species diversity within Leech Lake Reservation.

Another study goal is to assist with early detection of the non-native starry stonewort (Nitellopsis obtusa). Between 2022 and 2023, starry stonewort was reported in nine new Minnesota lakes and our LCCMR project located 66% of these new discoveries (three in 2022 and three in 2023).

Activity 2
Two new unpaid interns joined the project. Skyler Young (undergraduate student at Sarah Lawrence college) and Zainab Ali (undergraduate student at Fordham University). Both interns are participating in all aspects of the project at NYBG.

NYBG received nearly 700 living collections thus far from the 2023 field season. Each collection has been identified using morphology and vouchered. Tissue from each has been isolated and prepared for DNA extraction and barcoding.

DNA sequencing of ca. 80 historical Minnesota stonewort specimens are currently being DNA barcoded. Approximately

25% are complete.

At least 2,000 pressed specimens collected during the 2023 field season are scheduled to be shipped to NYBG later this winter. Upon receiving these specimens, anticipated processing, analyses, barcoding and distribution is estimated to be 12 to 18 months.

Activity 3
Approximately 750 collections from the 2022 field season have been accessioned in the New York Botanical Garden Herbarium (NY). All specimens have been imaged and label data have been transcribed for public availability on the web. Duplicates of these have been shipped to the Bell Museum (MIN) and the Academy of Natural Sciences of Drexel University (PH). Both institutions are also committed to imaging and transcribing label data for availability on the web.

A statewide stonewort identification workshop was held in August 2023 and was attended by 50 participants from tribal, federal, state, and local natural resource stakeholders. Participants used living and laminated specimens to test and evaluate the draft Minnesota Stonewort Field Guide and they provided feedback for improvement. Workshops included laboratory and field experiences.

Additional outreach was accomplished through field site visits with a variety of natural resources professionals including Fond du Lac Band, Wolf Ridge Environmental Learning Center, DNR Minnesota Biological Survey, Carver County Watershed Organization, and volunteers.

Dissemination
Our project was highlighted in the July-August, 2023 edition of the Minnesota Conservation Volunteer.

Three press releases (links provided on Attachment page) highlighted our project's discovery of new sites of the non-native Starry Stonewort in 2023.

All dissemination acknowledged LCCMR through the use of ENRTF attribute language.

Status Update Reporting

Status Update June 1, 2023

Date Submitted: May 26, 2023

Date Approved: May 30, 2023

Overall Update
NYBG contract was amended and signed to include DNA sequencing budget costs. NYBG continued to successfully DNA barcode specimens relevant to the project and accessioned specimens into the NYBG physical herbarium with associated metadata and images available in the online NYBG virtual herbarium. Duplicates have been sorted for distribution. Throughout the academic year, NYBG mentored an undergraduate student intern from Sarah Lawrence College; she participated in all aspects of laboratory research and herbarium curation. NYBG has identified two additional undergraduate student interns for summer 2023. NYBG hosted a two-day education and outreach learning event for LLDRM staff and LLTC instructors.

LLDRM and LLTC were granted budget revision requests to travel to New York to participate in a two-day workshop at NYBG. DNR hosted a Spring 2023 workshop for LLDRM and LLTC. Logistical arrangements have been completed for an August 2023 statewide workshop for multiple tribal, state, and other natural resource stakeholders and the maximum of 50 participants has been reached.

DNR has doubled our field survey effort and hired two Seasonal Botanists and two Student Workers for the 2023 field season.

Project updates and interim invoices from subcontractors are anticipated by June 30, 2023.

Activity 1
In March 2023, DNR and LLDRM successfully used an underwater drone to search for stoneworts under the ice and to capture underwater habitat footage for education and outreach efforts.

DNR completed hiring of 2023 field survey crews and began field surveys of southeast waterbodies in May 2023. Surveys will continue statewide through mid-September and will focus on southeastern streams and Mississippi River backwaters, shallow western lakes, and lakes in the northern third of the state.

LLTC completed student intern hiring. LLDRM is prepared to lead surveys within the Leech Lake Reservation area beginning in June 2023.

Activity 2
About 100 historical Minnesota stonewort specimens housed at the Bell Museum were transferred to NYBG. They were reviewed for morphological identification, DNA was extracted, and PCR was amplified for DNA barcodes. Sequencing is nearly complete.

DNA extractions of 2022 collections have been completed. Approximately 80% of these have been successfully sequenced for the DNA barcode. Identifications based on DNA analyses have been updated in databases and annotation labels have been attached to specimens including duplicates. Duplicates are ready for distribution to the University of Minnesota - Bell Museum and The Academy of Natural Sciences of Philadelphia. All 2022 collections have been accessioned into the NYBG herbarium. This includes attaching a unique barcode, label data transcription, and specimen

image capture for each specimen. Traditional Ojibwe language has been included for lake names on labels when possible and efforts are continuing to research and include traditional place names.

Activity 3
A subaward contract with Bell Museum was completed and signed. Minnesota historic stonewort specimens have been sent from Bell to NYBG for morphological and genetic analyses.

In March 2023, NYBG hosted a learning event for LLDRM staff and LLTC instructors and students where they toured the laboratories, greenhouses, and herbarium, participated in imaging and cataloging Minnesota stonewort specimens, and learned DNA extraction techniques.
Karol drafted a Field Guide to Minnesota's Stoneworts, including a dichotomous key and associated line drawings, for education and outreach. Laminated specimens were created for teaching aids.

In May 2023, DNR and NYBG held a two-day workshop for 20 participants from LLDRM and LLTC. Perleberg (DNR) and Karol (NYBG) presented a review of the project goals and progress report updates. Participants received hands-on experience identifying and preserving specimens in the lab, and field/lake experience searching for stoneworts and collecting water quality data. Participants used living and laminated specimens to test and evaluate the draft Minnesota Stonewort Field Guide and they provided feedback for improvement.

Logistical arrangements have been completed for an August 2023 stonewort identification workshop. Fifty participants (maximum enrollment) have registered for the event and include tribal, state, and local natural resource stakeholders.

Dissemination
Perleberg (DNR) and Raining White (LLBO) presented a project update to the Leech Lake Association Board in May 2023 and provided a written summary for the Association's Spring newsletter.

Perleberg (DNR) and Karol (NYBG) were interviewed by the Minnesota Conservation Volunteer magazine for an article to be published in the July-August issue.

All 2022 stonewort collections are now available online at the NYBG C. V. Starr Virtual Herbarium.

All project communications and outreach acknowledged ENRTF through the use of the ENRTF logo or attribute language.

Status Update Reporting

Status Update December 1, 2022

Date Submitted: December 5, 2022

Date Approved: December 8, 2022

Overall Update
Covid-19 issues limited our workshop plans and delayed subaward contracts, but we have made excellent progress toward achieving outcomes. DNR contributed additional in-kind database and field support from a research scientist and NYBG conducted additional field surveys during their training visits.

Statewide, DNR and NYBG surveyors completed stonewort and water quality sampling at 300 lakes in 58 counties; stoneworts were detected at 165 sites (map 1).

We discovered three of the four new locations of non-native, Nitellopsis obtusa (starry stonewort) that occurred in 2022 (map 2). In the newly discovered area in Cass County, we searched public accesses at an additional 47 nearby lakes and did not locate any additional sites of the non-native (map 2 inset).

Within Leech Lake Reservation, LLBO and LLTC partners surveyed sites at 10 additional lakes (map 3). No new sites of Nitellopsis obtusa (starry stonewort) were discovered in this area. On Leech Lake, LLBO developed and tested a lake wide stonewort sampling strategy.

Field data have been proofed and uploaded to a central database. Specimens have been cataloged and shipped to NYBG where they have been processed and prepared for DNA sequencing.

Activity 1
We were able to complete 300 surveys in 2022 because DNR added in-kind field support, NYBG assisted with survey efforts, and most sites were easily accessed via lake public accesses. In 2023, survey time will increase as we move to northern lakes and southeastern stream sites with more remote access. As habitat diversity increases, we expect a reciprocal increase in stonewort diversity. A total of 500 survey sites remains our goal, but we have identified an additional 150 sites for survey as time and funding allow, increasing our potential to capture Minnesota's full stonewort diversity.

LLBO and LLTC are considering options to increase field surveys in 2023 including a possible additional survey team. LLBO has recently purchased an outboard motor and underwater drone that will facilitate Leech Lake offshore surveys.

Methodological changes: 1) less expensive field chemistry kits meet our needs instead of chemistry probes and 2) DNR will use only one underwater drone to search prioritized clear water sites. Equipment savings will cover field chemistry kits/refills, higher quality GPS unit, increased other supply costs (due to high freight price increases), and increased collecting and archival supply needs (due to higher than-expected sample numbers).

Activity 2
Co-principal investigator, Karol has directed all aspects of the project based at NYBG including training and managing of NYBG grant participants, identification and DNA extraction of project samples as well as preparing voucher specimens to be accessioned into NYBG and Bell herbaria. A lab technician has been hired and trained in charophyte identification, voucher preparation, tissue sample isolation, and DNA extraction.

NYBG has processed over 2,000 charophyte specimens for this study: more than 1,000 specimens representing duplicates of 381 collections from DNR and NYBG surveyors; 69 specimens representing duplicates of 24 collections from LLBO/LLTC surveyors; and 1,180 specimens representing duplicates of 13 charophyte species that will be teaching aids. Specimens were identified using morphology and tissue was isolated for DNA extraction. DNA extraction for all collections is now complete and sequencing will begin January, 2023.

Karol also provided independent verification of Nitellopsis obtusa (starry stonewort) for four new sites in Minnesota.

University of Minnesota Genomics Center (UMGC) no longer offers the service needed to meet project goals. As requested and approved through a workplan amendment, we are modifying the NYBG contract to reflect moving funds for DNA sequencing from UMGC to NYBG.

Activity 3

Covid-19 restrictions prevented our 2021 and 2022 statewide workshops but helped us think creatively about effective outreach options. In 2022, we used smaller group classroom settings and outdoor field events to effectively train project participants including LLBO and DNR staff, LLTC instructors and students.

In 2023, we will hold our scheduled stonewort identification workshops for public natural resource organizations. We anticipate up to 50 participants with attendance by Tribal, federal, state, county, and educational institutions. We have begun work on teaching aids including a field guide to Minnesota's stoneworts, a stonewort sampling manual, and laminated specimens.

DNR has drafted a subaward contract with the Bell Museum for work anticipated to begin in 2023 to image and catalog specimens.

LLBO and LLTC have expressed a strong interest in also learning about the laboratory and specimen curation aspects of this study. We are seeking an amendment to their subaward contracts to permit out of state travel to NYBG for facility exploration and research knowledge exchange.

Dissemination

We promptly reported our new discoveries of Nitellopsis obtusa (starry stonewort) locations to DNR Aquatic Invasive Species Program. For each of these three events, DNR distributed a statewide press release to inform the public of the new locations of this non-native stonewort and steps to take to reduce its spread. LCCMR funding was acknowledged in these announcements.

DNR and LLBO will coordinate an update to present to Leech Lake Association. At this meeting, we will propose a collaboration with Leech Lake resort owners to include resort access points in our Leech Lake surveys.

Status Update Reporting

Status Update June 1, 2022

Date Submitted: May 31, 2022

Date Approved: July 7, 2022

Overall Update
A GIS analysis was conducted to identify 500 survey sites throughout the state. Preliminary field surveys were conducted in August and September 2021 to refine and finalize survey methods and to assess equipment and supply needs. A field survey manual and electronic data entry form have been drafted. Selected species of stoneworts were collected in 2021 and used to create initial training materials. DNR field survey crew members have been hired.

Subawards contracts with New York Botanical Garden (NYBG), Leech Lake Band of Ojibwe (LLBO), and Leech Lake Tribal College (LLTC) were finalized in April 2022. Subawards with the University of Minnesota Bell Museum and the University of Minnesota Genomics Lab will be finalized in July because their work is not anticipated to begin until Fiscal Year 2023 (July 2022).

Activity 1
500 statewide sites have been selected in GIS and field access to 85% of these sites has been determined. Field survey methodologies for water chemistry and stonewort searching and collecting have been finalized and tested. An electronic data form for use on iPads has been drafted. DNR field survey crews have completed initial training. Field surveys began in mid-May and will continue through September 2022 followed by the second year of surveys in 2023.

For the lakewide survey of Leech Lake, Leech Lake Band of Ojibwe (LLBO) staff have conducted a GIS analysis of Leech Lake hydrology and aquatic plant community data and have discussed potential survey designs with DNR. A collaborative field survey event is planned for July with LLBO, Leech Lake Tribal College interns, NYBG, and DNR.

Activity 2
The subaward with New York Botanical Garden (NYBG) was finalized in April 2022. NYBG has conducted interviews for a Lab Technician and anticipates filling this position in the next few weeks.

Activity 3
The 2021 workshop was canceled due to Covid-19 restrictions. Also due to Covid-19 restrictions, the 2022 workshop was modified to focus directly with surveyors involved with this project. In May 2022, NYBG and DNR held a 2-day workshop for 17 participants from Leech Lake Band Division of Resource Management, Leech Lake Tribal College, and DNR. A presentation was given by Perleberg (DNR) that explained the goals of the project and discussed the importance of stoneworts in Minnesota's aquatic ecosystems. A second presentation was given by Karol (NYBG) that presented the diversity of stoneworts and the morphology used to identify them. Additional materials included a draft key to Minnesota's stoneworts and laminated specimens representing much of the stonewort diversity known for Minnesota to date. Participants received hands-on experience identifying and preserving specimens in the lab, and field/lake experience searching for stoneworts visually, with sampling hooks, and with an underwater drone.

Dissemination
In May 2022, we presented an overview of the project to instructors and students at Leech Lake Tribal College and Leech Lake Band of Ojibwe Division of Resource Management staff. At this workshop, we provided training in stonewort identification and ecology to 19 natural resources staff and students.