



Environment and Natural Resources Trust Fund

M.L. 2021 Approved Work Plan

General Information

ID Number: 2021-055

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: July 21, 2021

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

Project Budget: \$811,000

Project Manager Information

Name: Donna Perleberg

Organization: MN DNR - Ecological and Water Resources Division

Office Telephone: (218) 203-4363

Email: donna.perleberg@state.mn.us

Web Address: <https://www.dnr.state.mn.us/ewr/index.html>

Project Reporting

Date Work Plan Approved by LCCMR: July 20, 2021

Reporting Schedule: December 1 / June 1 of each year.

Project Completion: June 30, 2024

Final Report Due Date: August 14, 2024

Legal Information

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

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.

Appropriation End Date: June 30, 2024

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? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and 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	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, 2023

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. A step in the genetic analysis will utilize services provided at the University of Minnesota Genomics Center.

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 the University of Minnesota Genomics Center 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	Completion Date
Sort, clean, and analyze live specimens and extract DNA	September 30, 2023
DNA sequencing	January 31, 2024
Interpret DNA sequencing results and match with morphological analyses	April 30, 2024
Labels all specimens and update databases	June 30, 2024

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	Completion Date
Workshop 1 with draft field guide	August 31, 2021
Workshop 2 with revised field guide	August 31, 2022
Workshop 3 with revised field guide	August 31, 2023
Verified specimens imaged and accessioned into U of MN Bell Museum Herbarium	June 30, 2024
Educational materials including field guide to Minnesota stonewort species completed	June 30, 2024
Geo-referenced data from study lakes available in MN Geospatial Commons	June 30, 2024

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 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
Personnel								
Natural Resource Technician		assist with surveys			20%	1		\$54,000
Natural Resource Specialist Intermediate		lead field survey team			20%	1		\$100,000
							Sub Total	\$154,000
Contracts and Services								
University of Minnesota Genomics Lab	Professional or Technical Service Contract	University of Minnesota Genomics Laboratory will conduct DNA sequencing (9,000x reactions for Classic Sanger sequencing reactions, including PCR clean-up and quantification for 4,500 template DNA samples) and return data to NYBG for editing and interpretation.				0		\$61,700
Leech Lake Band of Ojibwe (LLBO) Division of Resource Management (LLDRM)	Sub award	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		\$100,000
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).				0.5		\$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: \$16,320 (curator, 36% fringe and student intern, no fringe) and Supplies and archival cabinet: \$6,580.				0.6		\$22,900

New York Botanical Garden (NYBG)	Sub award	NYBG will conduct genetic analysis, identify, and make museum specimens for 1,500 stonewort collections, create field guide, train surveyors, develop and instruct workshops. Personnel: \$270,000 (Researcher and Lab Technician, 42% fringe), supplies: \$40,000, 3 workshops: \$30,000 (includes annual travel to MN for 2-3 instructors). Justification below.		X		3.51		\$342,200
							Sub Total	\$556,200
Equipment, Tools, and Supplies								
	Equipment	2 underwater drones (one per DNR field team)	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.					\$5,200
	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
	Tools and Supplies	field and lab supplies for 2 DNR teams (2 years) to collect stoneworts (boots, PFDs, kayaks, GPS, bags, trays, coolers, plant press, archival pressing supplies, laminator)	supplies to collect and preserve stoneworts in lakes					\$11,029
	Equipment	2 water chemistry meters (one per DNR field team)	Each field team will collect water quality data at each collection site.					\$5,000
							Sub Total	\$22,829
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								

	Miles/ Meals/ Lodging	In-state travel to conduct surveys. 2 Vehicles for 8 months, lodging and meals for estimated 180 travel days for 3 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.					\$48,000
							Sub Total	\$48,000
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
							Sub Total	\$2,000
Other Expenses								
		Shipping	Express shipping of live specimens through State of MN Contract @ \$30 per shipment. See justification for shipping below.	X				\$12,000
		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
							Sub Total	\$27,971
							Grand Total	\$811,000

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)	Sub award	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.
Contracts and Services - New York Botanical Garden (NYBG)	Sub award	NYBG will conduct genetic analysis, identify, and make museum specimens for 1,500 stonewort collections, create field guide, train surveyors, develop and instruct workshops. Personnel: \$270,000 (Researcher and Lab Technician, 42% fringe), supplies: \$40,000, 3 workshops: \$30,000 (includes annual travel to MN for 2-3 instructors). 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 express shipping of samples to U of MN Genomics Lab (~\$2,500). Workshop require Dr. Karol and 1-2 associates to assist with workshop instruction; costs include annual travel to MN, travel costs within state, collecting supplies, and workshop materials; 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
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
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
In-Kind	University of Minnesota Bell Museum	University indirect costs not covered by grant.	Pending	\$16,150
			State Sub Total	\$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
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
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
			Non State Sub Total	\$123,250
			Funds Total	\$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....

Optional Attachments

Support Letter or 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

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 agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I agree to the Commissioner's Plan.

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

No

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

N/A

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

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

No

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

Stoneworts make up 25% of MN's underwater plant diversity and keep lakes healthy.

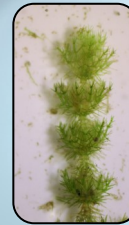
Clear Water

Wildlife Food

Fish Habitat

PROBLEM

Stonewort research focuses on the invasive Starry Stonewort and we've ignored native stoneworts because we lack technical expertise to identify species.



To protect these stoneworts and the ecological services they provide, we need baseline data on their identity and statewide distribution.

SOLUTION

Build expertise in Minnesota so that stonewort data are included in management decisions.



Surveying



Collecting

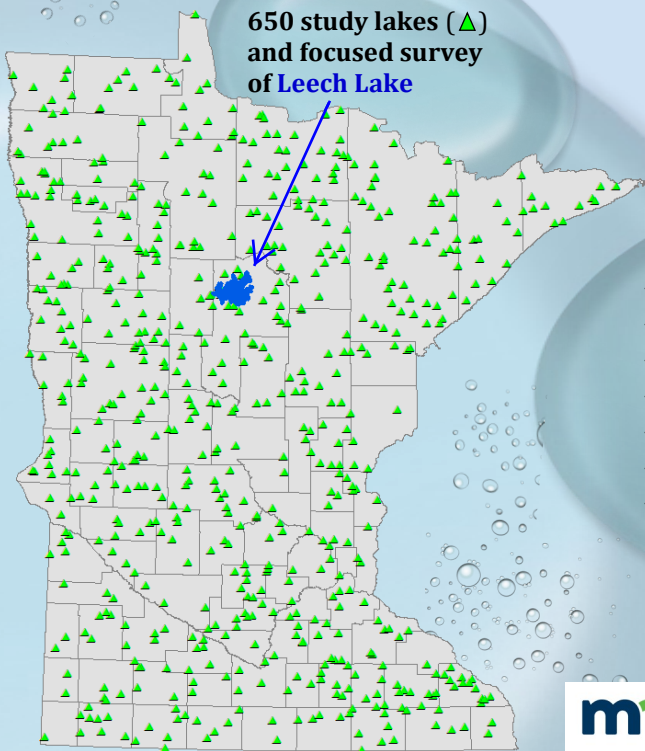


Identifying



Training

650 study lakes (▲) and focused survey of Leech Lake



OUTCOMES

- ◆ Baseline stonewort data for 650 lakes
- ◆ Report new starry stonewort lakes
- ◆ Newly trained surveyors (~150) with stonewort expertise
- ◆ New data on Leech Lake musky habitat
- ◆ New online museum reference collections (~2,100)
- ◆ New guide to Minnesota's stoneworts
- ◆ Discover species new to MN and science!

PARTNERS

Leech Lake Band of Ojibwe
Leech Lake Tribal College
New York Botanical Garden
U of MN Bell Museum
U of MN Genomics Center

