Environment and Natural Resources Trust Fund

M.L. 2020 Approved Work Plan

General Information

ID Number: 2020-070

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: August 13, 2021

Project Title: Unprecedented Change Threatens Minnesota's Pristine Lakes

Project Budget: $482,000

Project Manager Information

Name: Mark Edlund

Organization: Science Museum of Minnesota - St. Croix Watershed Research Station

Office Telephone: (612) 965-6946

Email: medlund@smm.org

Web Address: https://www.smm.org/scwrs

Project Reporting

Date Work Plan Approved by LCCMR: August 13, 2021

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: June 30, 2023

Final Report Due Date: August 14, 2023

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 20a1

Appropriation Language: The appropriation in Laws 2019, First Special Session chapter 4, article 2, section 2, subdivision 8, paragraph (c), Sauk River Dam Removal and Rock Rapids Replacement, in the amount of $2,768,000, no longer needed for its original purpose is transferred as follows:
(1) $482,000 is transferred to the Science Museum of Minnesota to determine how, when, and why lakes in pristine areas of the state without obvious nutrient loading are experiencing algal blooms;

(d) Transfers and Availability
The transfers under this subdivision are effective June 30, 2021, and the transferred amounts are available until June 30, 2023.

Appropriation End Date: June 30, 2023

Narrative

Project Summary: Why are Minnesota's nicest lakes turning green? We determine what's causing this change and which lakes are most at risk.

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

Minnesota's most pristine lakes are changing unexpectedly and we don't know why! Where we expect to find hundreds of our most beautiful and remote lakes—with little development or protected within state and national forests and parks—we instead often find green lakes, thick with noxious blooms of cyanobacteria. Lakes turn green when we add nutrients to them, but in protected or remote settings, typical sources of excess nutrients (land use change, erosion, sewage) are not obvious. Based on our work, we predict that climate change is working in concert with atmospheric deposition to drive the changes that have already begun to affect our pristine lakes. Importantly, it is possible that by missing climate and atmospheric effects on lakes we could be misattributing the causes of blooms and misdirecting resource-management efforts and dollars.

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.

We will determine why Minnesota's nicest lakes are unexpectedly turning green using:
1) first of their kind in-lake and atmospheric monitoring systems
2) sediment analysis showing how, when, and why pristine lakes are changing
3) lake simulations determining which lakes are most at risk
4) communication with managers and lake users on how and why nice lakes are changing.

Climate, weather, and atmospheric deposition change everything. Sediment cores from wilderness lakes show two causes of unprecedented noxious algae growth. Climate change results in longer ice-free seasons, stronger stratification, increased tannins, and correlates with alarming increased frequency of noxious algae blooms. In lakes with no watershed runoff we find large increases in mineral matter and greater growth of algae. If that mineral matter and its nutrients did not come from the watershed, it must be coming from dustfall or precipitation.

Nutrients in lakes have many sources—local, regional, global. Climate affects lakes by changing how nutrients are cycled in lakes and watersheds. Elsewhere, long-distance dustfall is linked to dramatic changes in remote lakes. We need to know if our lakes are imperiled by climate and dust-borne nutrients, rule out other causes of wilderness lake change, and not waste management dollars.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

The 8 lakes (deep vs shallow lakes, across watershed size, and along an E-W transect) selected for this study will be entirely within northern Minnesota's protected areas, so we can rule out local landuse inputs. Climate change and landuse changes well beyond Minnesota may be working in concert to change our pristine lakes. By linking modern and historical lake ecology, air deposition, and lake simulations, we will solve the unprecedented change question, and determine how to preserve and protect water quality in our pristine lakes. This project will fundamentally change lake management strategies everywhere in Minnesota.

Project Location

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

Region(s): Central, NE, NW,

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: Use water and air quality monitoring to assess the cause of changing water quality in our "pristine" lakes

Activity Budget: $228,637

Activity Description:
Water quality in remote lakes is rarely monitored and air quality monitoring in Minnesota does not measure dry deposition (dustfall). We will do high resolution monitoring of water quality for one year on 8 state and national forest and park lakes. We will simultaneously establish a state-of-the-art dustfall network with 4-5 sites in north and central Minnesota in partnership with National Atmospheric Deposition Program (NADP) to measure and map dustfall patterns and nutrient delivery.

Activity Milestones:

Description	Completion Date
Measure nutrients and algae for one year from 8 remote and wilderness lakes	December 31, 2022
Establish state-of-the-art dustfall monitoring network in north and central Minnesota	January 31, 2023

Activity 2: Use sediment cores to determine if our best lakes are imperiled

Activity Budget: $216,300

Activity Description:
Every lake accumulates sediments that record its history. We will collect sediment cores from 8 remote and protected lakes and determine when and how much they have changed—their biology, nutrient levels, dust inputs—using analysis of multiple biological and geochemical measures. We will reconstruct the influence of climate and dust-borne nutrients through time on each lake to understand why they changed, when they changed, and which lakes are most imperiled.

Activity Milestones:

Description	Completion Date
Collect, date, and analyze sediment cores from 8 remote lakes	May 31, 2023
Compare climate and dustfall records from cores with monitoring to determine why lakes are changing	May 31, 2023

Activity 3: Use lake simulations to determine which lakes are most at risk and how to protect them

Activity Budget: $37,063

Activity Description:
Computer simulations allow us to understand how lakes have changed in the past and how they might change in the future. MINLAKE is a simulation program that estimates lake thermal and oxygen dynamics. Importantly, input variables in the program let us test interactive effects of other forces that may be affecting our protected lakes such as changing weather patterns and ice-on/off. Model results will be paired with monitoring and sediment core histories to predict which protected lakes are most at risk.

We will spread our findings to help Minnesotans understand what threatens our favorite lakes and how to protect them.

Activity Milestones:

Description	Completion Date
Create a MINLAKE model for 8 study lakes to measure historical changes in lake function	May 31, 2023

Develop a framework for predicting which protected lakes are at risk	May 31, 2023
Develop reports, factsheets, and outreach to inform managers and Minnesotans on protecting their threatened lakes	June 30, 2023

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 develop scientific reports, informational factsheets, and engage social media to inform resource managers and lay-persons on the state and fate of Minnesota's most protected lakes. Edlund and project personnel are periodically invited to give presentations within their organizations, to agencies, at professional meetings, and to outside groups, and they will present this work upon invitation. We will communicate the findings of this study with the public through factsheets, blogs and social media (Twitter and Facebook) accounts associated with the St. Croix Watershed Research Station. We plan on publishing the results of this work as peer-reviewed publications in relevant scientific journals. All dissemination and outreach products will acknowledge ENRTF funding.

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?
This project establishes a new air-monitoring network, provides the first baseline data on dustfall in northern Minnesota, its effect on our best lakes, and determines which lakes are at risk. This project leverages collaborations with other research groups on dustfall and previous ENRTF and NPS funding on wilderness lakes across northern Minnesota, including the DNR Sentinel Lakes and the NPS Inventory & Monitoring programs. Through reporting, presentations, and outreach, we will spread our findings to help Minnesotans understand what really threatens our favorite lakes and fisheries.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Tracking and Preventing Harmful Algal Blooms	M.L. 2016, Chp. 186, Sec. 2, Subd. 04a	$500,000
Determining Risk of a Toxic Alga in Minnesota Lakes	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 06f	$200,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Edlund, Senior Scientist		Sediment Analysis			45.5%	0.72		$82,453
Heathcote, Senior Scientist		Water and Air Quality, DNA			45.5%	0.5		$51,464
Assistant Scientist		Lake Modeling			45.5%	0.3		$27,063
2 Field and Laboratory Technicians		2 Temporary Field and Laboratory Technicians			45.5%	0.66		$29,961
Science Communication Specialist		Outreach and Social Media			0%	0.24		$10,000
Postdoctoral Researcher		Fieldwork, Sediment and water quality analysis			45.5%	1.24		$90,210
							Sub Total	**$291,151**
Contracts and Services								
TBD	Professional or Technical Service Contract	Lab Analysis of Dust Samples: Dust chemistry (mass, P frac, N): 120 samples @ $100 ($12,000; Utah State University or competitive bid)				0		$12,000
TBD	Professional or Technical Service Contract	Lab Analysis of Pigments Samples: Algal pigment analysis: 80 samples @ $125 ($10,000; University of Regina or competitive bid)				0		$10,000
TBD	Professional or Technical Service Contract	Lab Analysis of Cyano DNA: 16S sediment DNA sequencing: 8 cores @ $1,250 ($10,000; University of Minnesota or competitive bid)				0		$10,000
							Sub Total	**$32,000**
Equipment, Tools, and Supplies								

	Tools and Supplies	Lab / Field Supplies	Bottles, reagents, preservatives, consumables					$6,556
	Tools and Supplies	Monitoring Buoy Supplies (Qty: 8)	Component sensors for constructing and installing monitoring buoys on lakes					$16,000
							Sub Total	**$22,556**
Capital Expenditures								
		Dust Monitoring, ADS/NTN Atmospheric Deposition Samplers (Qty: 5/$5,000 per)	Dust monitoring, ADS/NTN atmospheric deposition sampling					$25,000
		YSI EXO Water Quality sonde	measures water quality					$20,000
							Sub Total	**$45,000**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Atmospheric Monitoring and Network Setup ($2,459), 1 trip, 2 scientists, 6 days, 1,000 miles to north central Minnesota	Atmospheric monitoring and network setup					$2,459
	Miles/ Meals/ Lodging	Sediment Core Collection ($4,968), 1-2 coring trips, 2-3 field crew, 10 days and 850 miles/trip to northern Minnesota	Sediment core collection					$4,968
	Miles/ Meals/ Lodging	Water Quality Monitoring ($19,077), 5 water quality trips, 2-3 field crew, 12 days and 850 miles/trip to northern Minnesota	Water quality monitoring					$10,618
							Sub Total	**$18,045**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**

Other Expenses								
		Lab Analysis of Water Samples	Lab analysis of water samples: TN/TP, DIN/SRP, DOC, DIC: 80 samples at $112 per sample ($8960) (unit prices for analysis at SCWRS)					$8,960
		Lab Analysis of Sediment Samples	Lab analysis of sediment samples: 210-Pb (dating): 8 cores @ $2,400 ($19,200) (unit price for analysis at SCWRS); loss-on-ignition: 8 cores @ $800 ($6,400) (unit price for analysis at SCWRS); biogeochemistry (Sed P, diatoms, BSi): 8 cores @ $4,836 ($38,688) (unit prices for analysis at SCWRS)					$64,288
							Sub Total	**$73,248**
							Grand Total	**$482,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	All indirect project costs are provided in-kind by the Science Museum of Minnesota (federally negotiated indirect rate of 40.09% on all direct costs = $193,234)	In-kind contribution of indirect costs	Pending	$193,234
			Non State Sub Total	**$193,234**
			Funds Total	**$193,234**

Attachments

Required Attachments

Visual Component

File: c99dcd6a-50c.pdf

Alternate Text for Visual Component

Why are Minnesota's nicest lakes turning green? We determine what's causing this change and which lakes are most at risk....

Optional Attachments

Support Letter or Other

Title	File
Institutional Letter of Support, Science Museum of Minnesota	10cae6e3-70d.pdf
Form 990 - Institutional Tax Exempt Form, Science Museum of Minnesota	7177850c-867.pdf
Background Check Certification Form	029bed2a-f70.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Modifications include adjusting end date, milestone, and reporting dates to reflect start date in summer 2021 and project length of two years. Scope of project has been adjusted to reflect funding recommendation at $482,000 and two-year project timeline.

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?

Yes

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?

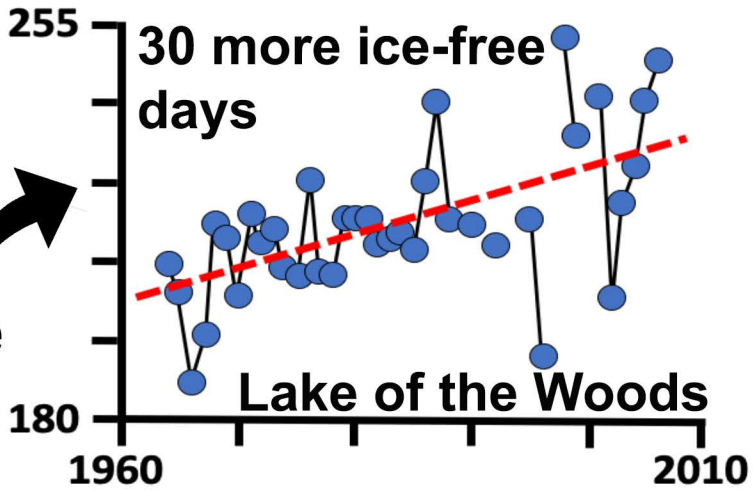
No

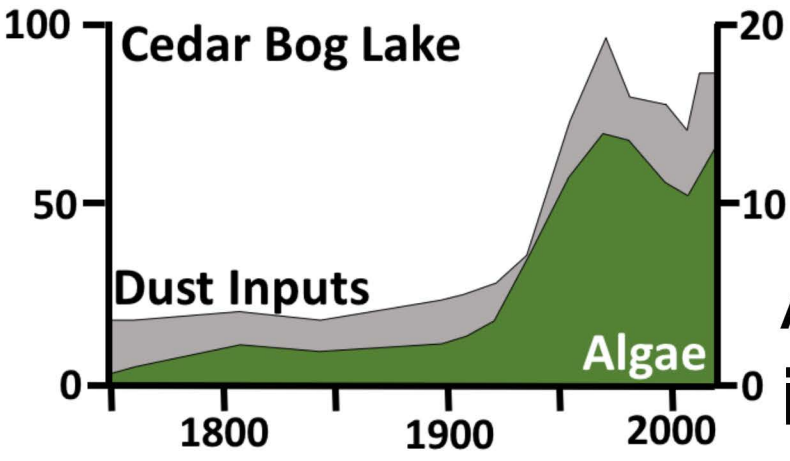
Unprecedented change threatens Minnesota's pristine lakes

Why are our ***pristine*** lakes turning green?

Possible Factors

Longer growing season with warmer temperature





Increased atmospheric inputs

Are some lakes more **imperiled** than others?