



Environment and Natural Resources Trust Fund

M.L. 2022 Approved Work Plan

General Information

ID Number: 2022-103

Staff Lead: LCCMR General Universal Staff User

Date this document submitted to LCCMR: June 20, 2022

Project Title: Changing Winters and Game Fish in Minnesota Lakes

Project Budget: \$238,000

Project Manager Information

Name: Ted Ozersky

Organization: U of MN - Duluth - Large Lakes Observatory

Office Telephone: (218) 726-7492

Email: tozersky@d.umn.edu

Web Address: <https://scse.d.umn.edu/large-lakes-observatory>

Project Reporting

Date Work Plan Approved by LCCMR: June 27, 2022

Reporting Schedule: March 1 / September 1 of each year.

Project Completion: June 30, 2025

Final Report Due Date: August 14, 2025

Legal Information

Legal Citation: M.L. 2022, Chp. 94, Art. , Sec. 2, Subd. 04d

Appropriation Language: \$238,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota for the Large Lakes Observatory in Duluth to determine how changing winter conditions such as ice cover, snowfall patterns, and water quality affect Minnesota's game fish populations.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: Winter is a critical period for game fish recruitment and survival, yet little is known about winter lake ecology. We will determine how changing winter conditions affect Minnesota's fish resources.

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

Winter is the main seasonal bottleneck for the survival and recruitment of Minnesota's game fish because of cold temperatures, oxygen depletion in productive lakes, decreased food availability, and predation. Winter is changing in Minnesota, but very little is known about the biology of Minnesota's lakes in winter and how changing environmental conditions affect the under-ice environment for fish. This knowledge gap represents a significant challenge to resource management.

Ongoing reductions in the duration of ice cover, changing snowfall patterns, and changes in water quality (e.g., eutrophication or its remediation) mean that winter conditions in lakes will continue to change statewide over the coming decades. These changes will impact under-ice abiotic and biotic conditions and the recruitment and survival of juvenile and adult gamefish such as walleye, yellow perch, and panfish. This will result in new patterns of competition, cannibalism, and predation among fish species and long-term change in fish communities.

Managing Minnesota's game fish resources into this uncertain future requires substantially improved understanding of winter in lakes. In collaboration with the Sentinel Lakes Program, this project will determine how winter conditions affect game fish in Minnesota lakes that vary in water quality and winter climate.

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.

Bottom-up (temperature, oxygen, food) and top-down (predation) forces control fish survival and recruitment. Researchers from UMD and the Sentinel Lakes Program (SLP) will work with citizen scientists to determine how these forces vary over winter in 5 sentinel lakes with different water quality and winter conditions.

UMD researchers will visit each lake 3 times during winter (and 2 times in summer), collecting data on abiotic and biotic conditions. The SLP will provide matching open-water season data for these lakes and continuous winter oxygen data collected on a subset of lakes. Studies of juvenile fish food habits and sizes (collected by SLP) and adult fish stomach contents (collected by researchers and community scientists) will determine how recruitment, feeding, and predation change during winter across lakes.

Findings will be shared with community members, scientists, and resource managers through a workshop in Year 3 of the project. Participants will produce recommendations for management and information needs given ongoing environmental change.

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?

Too little is known about the winter biology of seasonally frozen lakes to predict the response of Minnesota's aquatic resources to ongoing changes in winter conditions. This project will provide information about how abiotic and biotic conditions important for water quality and the survival and recruitment of game fish vary in Minnesota lakes of different trophic status and winter climate setting. This work will contribute to long term, science-based resource management, produce foundational winter data and establish methodologies for future winter work for the Sentinel Lakes Program.

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: Determine how abiotic and biotic winter conditions change across diverse Minnesota lakes.

Activity Budget: \$234,037

Activity Description:

Researchers from UMD will sample 5 diverse MN sentinel lakes in Years 1 and 2 of the project (3 visits per lake in winter, 2 visits in summer), collecting physical (light, temperature), chemical (oxygen, water quality), and biological (phytoplankton, zooplankton, benthic communities) metrics relevant to fish survival and recruitment. This information will be combined with available open water season data from the study lakes and year-round continuous oxygen and temperature records maintained by the Sentinel Lakes Program (SLP).

SLP researchers will collect juvenile game fish in a subset of study lakes during fall and spring. These samples will help determine how overwinter size, survival, body condition and feeding patterns of juvenile fish vary across water quality and winter climate gradients. UMD and SLP researchers will work with ice fishers (e.g., lake association members, fishing tournament participants) to collect samples of adult game fish from the study lakes for stomach content and isotopic diet analysis.

Combined, the assembled data will show how bottom-up and top-down forces interact to shape winter conditions for fish in different lakes. Results will provide a benchmark for comparing future conditions in Sentinel Lakes and enable forecasting how changing environmental conditions will affect Minnesota's resources.

Activity Milestones:

Description	Approximate Completion Date
Graduate students hired and preparation for first field season completed	December 31, 2022
UMD sampling of 2 of 5 study lakes completed	November 30, 2023
UMD sampling of all lakes completed	April 30, 2024
Sentinel Lakes Program (SLP) sampling of age-0 fish completed	May 31, 2024
UMD and SLP sample analysis complete	January 31, 2025
UMD and SLP data integrated	March 31, 2025

Activity 2: Communicate study results and management implications to citizens, scientists, resource managers, and other stakeholders.

Activity Budget: \$3,963

Activity Description:

We will communicate the results of our research through outreach to the media, a workshop/webinar, presentations at regional meetings (e.g., Minnesota Water Resources Conference), and the scientific literature.

In year 3 of the project, we will convene a 1-day workshop to communicate and discuss the results of our work with stakeholders. Participants will include academic and government scientists, resource managers, and interested members of the public (e.g., lake association members). During the first half of the day, UMD and Sentinel Lake Program (SLP) researchers will present the results of their work. During the second part of the day, participants will engage in a guided discussion of the results. The goal of the discussion will be to summarize the state of knowledge on winter ecology in Minnesota lakes, identify remaining priority questions regarding the role of winter conditions in shaping fish communities, and draft a set of management implications and recommendations based on results. The results of the

workshop will be summarized as a report and distributed to state agencies and LCCMR. The workshop will be held in person with an option to attend remotely to increase public accessibility and participation.

Activity Milestones:

Description	Approximate Completion Date
Presentations at Minnesota Water Resources Conference	October 31, 2024
Workshop with state stakeholders and report to stakeholders	April 30, 2025
Publications in scientific literature	June 30, 2025
Outreach to media	June 30, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Thomas Hrabik	University of Minnesota Duluth	Dr. Thomas Hrabik is a professor in the department of Biology (University of Minnesota Duluth). He has extensive experience studying freshwater fish and food webs. Dr. Hrabik will lead the fisheries portion of this work.	Yes
Marte Kitson	University of Minnesota Sea Grant Program	Marte Kitson is an Environmental Literacy Extension Educator at Minnesota Sea Grant. She has extensive experience with environmental education and extension activities, including work with the public, media and K-12 educators. She will help coordinate outreach and extension activities associated with this project.	Yes
Casey Schoenebeck	MN DNR Sentinel Lakes Program	The Sentinel Lakes Program will provide year-round dissolved oxygen and temperature data and sample for age-0 fish during fall and spring.	No

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.

Results generated through this project will be shared with researchers, resource managers, and other stakeholders through several mechanisms. The PIs and students working on the project will publish the results of their research in the scientific, peer-reviewed literature, disseminating their findings to the scientific and resource management community. We will also communicate the results of this work at the Minnesota Water Resources conference. In year 3 of the project, we plan a workshop with Minnesota natural resource managers and other interested stakeholders to share the results of our work and discuss management implications and remaining open questions and next steps for winter fisheries research in Minnesota. The discussions from the workshop will be summarized in a report. We will discuss our work with members of the public through our citizen-scientists efforts.

The data generated through this work will be shared through open-access data repositories such as DRUM (Data Repository of the University of Minnesota). Data will be made publicly available at the time of publication of manuscripts based on these data. Data generated through this work will be regularly backed up and stored on computers at the LLO as well as on the cloud storage service 'Google Drive' to ensure the longevity and integrity of the data.

Acknowledgement of ENRTF funding will be included in all project communication. Funding will be acknowledged in accordance with ENRTF Acknowledgement Requirements and Guidelines, through the inclusion of the ENRTF logo, ENRTF-specified attribution language, or by tagging the ENRTF on social media.

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?

Aquatic ecologists increasingly recognize that winter conditions play an important role in structuring lake ecosystems. However, too little is currently known about the links between water quality, winter climate, and fish biology to predict how ongoing environmental change will impact Minnesota's game fish. Our project will address this information gap for Minnesota lakes and produce results that will improve management of fish resources. We will use meetings, workshops, and reports to ensure our results are available to state scientists and resource managers and seek their feedback in identifying remaining open questions and management recommendations.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
PI - Ozersky		PI. 0.25 months summer salary for PI Ozersky in Years 1 and 2 of the project to coordinate project and participate in sampling			26.9%	0.04		\$6,095
Co-I Hrabik		Co-I. 0.35 months summer salary for PI Hrabik in Year 1 and 0.5 months in Year 2 2 of the project to coordinate project and participate in sampling			26.9%	0.06		\$10,574
Co-I Kitson		0.5 months salary in Years 1-3 to help coordinate citizen science component and workshop			26.9%	0.12		\$8,432
MS Grad Student		Full graduate research assistantship (academic + summer) in year 1 ; just summer in year 2. Student will conduct research of fish diets and survival.			44.2%	0.62		\$50,851
PhD Grad student GRA		Full graduate research assistantship (academic + summer) in 1 and 2 ; just summer in year 3. Student will conduct research on lower trophic levels and connections to fish.			45.1%	1.14		\$106,358
LLO Lab tech		1 months of lab technician that will assist with processing of water chemistry and bulk stable isotope sample analysis in year 2			24.2%	0.16		\$9,453
							Sub Total	\$191,763
Contracts and Services								
Large Lake Observatory	Internal services or fees (uncommon)	Water sample analysis: analysis of duplicate water chemistry samples characterize nutrients and phytoplankton biomass (TP, TN, Chl. a, DOC, POC/PON) in 5 study lakes, with 5 visits per lake and 3 sampling depths (90 samples for each analysis/year). Analyses will be performed at UMD-LLO.				0		\$6,300
Large Lakes Observatory	Internal services or fees (uncommon)	Foodweb C/N stable isotope analyses: stable isotope analysis (C and N) to determine feeding relationships and food web structure in study lakes throughout the year. Triplicate samples to be analyzed will include zooplankton, benthic invertebrates (3 groups) and fish (3 groups). Analyses will be performed at UMD-LLO.				0		\$10,830

							Sub Total	\$17,130
Equipment, Tools, and Supplies								
	Tools and Supplies	Winter field gear	Winter field sampling gear, including ice shelter, sleds, auger and ice chisels					\$1,500
	Tools and Supplies	Fish sampling gear	Gillnet for collection of adult fish for stomach content and stable isotope composition					\$1,000
	Tools and Supplies	Filters	Various filters for sample collection and processing					\$2,500
	Tools and Supplies	Containers	Containers (bottles, bags) for storage of samples					\$4,250
	Tools and Supplies	EtOH and other chemicals	Ethanol and other chemicals for sample preservation and processing					\$1,750
	Tools and Supplies	Misc. supplies	Misc. items for field and lab (tape, pens, gloves)					\$2,055
	Tools and Supplies	Citizen science kits	Packages, labels, fees to mail packages to lake associations					\$1,000
	Tools and Supplies	Ice fishing gear	Simple ice fishing gear for K-12 environmental education component of the project					\$250
							Sub Total	\$14,305
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Travel to field sites	Car travel to study lakes to perform sampling. Estimate is based on 5 visits to 5 lakes over the duration of the project.					\$4,150

	Miles/ Meals/ Lodging	Accommodations at field sites	Overnight stays during sampling. Assuming 2 rooms needed for each lake visit; 5 lakes x 5 times					\$4,000
	Miles/ Meals/ Lodging	Per diem for field work	Assuming per diem (\$30) for 4 people per sampling trip; 2.5 lakes x 5 times/yr					\$3,000
	Miles/ Meals/ Lodging	Travel to citizen-science lakes	Travel to collect samples from citizen scientists; assuming 1 visit to each of the 6 target lakes based on google maps distances, rounded to nearest \$1,000					\$1,000
	Conference Registration Miles/ Meals/ Lodging	MN Water Resources conference	Registration and travels expenses for two graduate students to present results of their work at MN Water Resources Conference.					\$1,152
							Sub Total	\$13,302
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
		Sensor calibration/ service	For the Sonde					\$1,500
							Sub Total	\$1,500
							Grand Total	\$238,000

Classified Staff or Generally Ineligible Expenses

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

Category	Specific Source	Use	Status	\$ Amount
State				
In-Kind	MN DNR	240 hours over two years from two staff to collect juvenile fish on 6 Sentinel lakes	Secured	\$10,400
In-Kind	UMN System	Foregone Indirect Costs at 55% Federally Negotiated rate	Secured	\$118,757
			State Sub Total	\$129,157
Non-State				
			Non State Sub Total	-
			Funds Total	\$129,157

Attachments

Required Attachments

Visual Component

File: [208de673-fca.pdf](#)

Alternate Text for Visual Component

Figure showing overview of project background, approach and outcomes.

- > Plots showing long-term decrease of ice cover duration on MN lakes and changing snowfall amounts along with a map showing proposed study sites (Sentinel Lakes) that vary in water quality.
- > Diagram summarizing how winter conditions can affect top-down and bottom-up factors affecting health and survival of game fish.
- > Summary of research, outreach and educational activities that will be undertaken to address problem...

Optional Attachments

Support Letter or Other

Title	File
MN DNR Letter of Support	dbfbbc29-412.pdf
Institutional Approval Letter	a2b507d1-047.pdf
Research addendum	b7322ea5-aae.pdf
Background check form	08c51310-e6a.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

The appropriation was \$29,000 lower than the amount requested. We therefore had to modify our workplan in two key ways:

1. We eliminated Activity 3 from the project. Activity 3 was an educational outreach component to middle school students. We planned to visit two rural Minnesota middle schools (one in each of Y1 and Y2 of the project), deliver classroom lessons on environmental science and take students into the field to participate in hands-on sampling of lakes. This change saves funds by reducing the salary of the outreach coordinator on this project (co-PI Kitson) and the budget for travel to the schools and bussing the students to field activities.
2. We reduced our proposed sampling effort. In the original proposal, we proposed to sample 6 lakes in different parts of Minnesota 5 times through the year (3 lakes in Y1 and 3 lakes in Y2). The allocated funds are insufficient to support this sampling effort. We therefore eliminated one lake from the study (Madison Lake). In the revised approach we will sample 2 lakes in Y1 and 3 lakes in Y2 of the project. This change saves funds by reducing the funds needed for travel to the field sites, supplies and analyses.

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 UMN Policy.

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

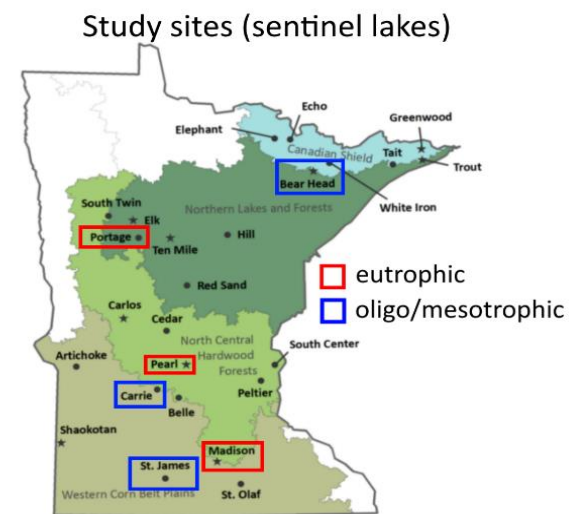
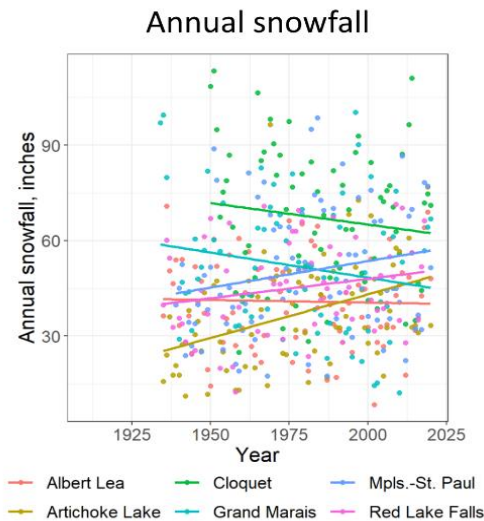
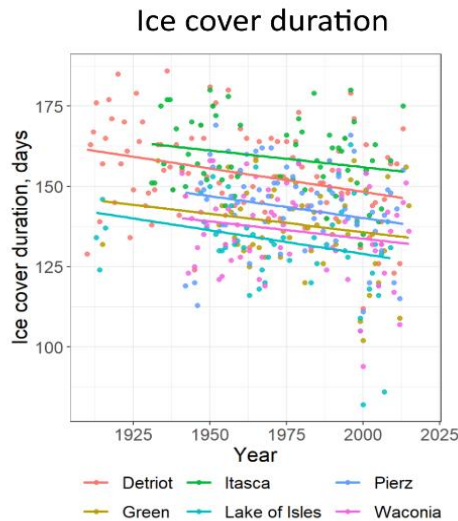
Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Changing Winters and Game Fish in Minnesota Lakes

Problem: Winter is a critical period for fish, but little is known about winter in Minnesota lakes. This knowledge gap is a challenge to resource management.

Solution: UMN-Duluth and Sentinel Lakes DNR researchers will determine how changing winter conditions affect Minnesota's fish and provide management recommendations.



environmental change: winter climate, water quality

overwinter feeding, body condition, growth, survival

cannibalism
competition
predation



food
light
oxygen
temperature

UMD & Sentinel Lakes researchers, citizen scientists:

- Effect of water quality and winter conditions on fish
- Implications for MN resource management

UMD researchers:

- Hands-on environmental education in MN schools
- Presentation of results to stakeholders, public, scientists

