Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-103

Proposal Title: Changing Winters and Game Fish in Minnesota Lakes

Project Manager Information

Name: Ted Ozersky

Organization: U of MN - Duluth - Large Lakes Observatory

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Project Basic Information

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.

Funds Requested: $267,000

Proposed Project Completion: June 30 2025

LCCMR Funding Category: Water Resources (B)

Project Location

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

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

When will the work impact occur?
During the Project and In the Future

Narrative

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

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? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and 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 6 sentinel lakes with different water quality and winter conditions.

UMD researchers will visit each lake 4 times during winter (and once 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.

We will leverage fieldwork to develop a winter environmental education program in 2 rural Minnesota schools. UMD researchers will collaborate with teachers to bring students in the field to participate in sampling and learn about lake biology and resources.

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, and pilot a novel winter environmental education program in rural Minnesota schools.

Activities and Milestones

Activity 1: Determine how abiotic and biotic winter conditions change across diverse Minnesota lakes.

Activity Budget: $258,000

Activity Description:

Researchers from UMD will sample 6 diverse MN sentinel lakes in Years 1 and 2 of the project (4 visits per lake in winter, one visit 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	Completion Date
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: $3,500

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	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

Activity 3: Design and implement winter lake ecology environmental education program for rural schools.

Activity Budget: $5,500

Activity Description:

Ice fishing is an integral element of Minnesota's culture and an activity that many rural K-12 students participate in with their families. Our research on frozen lakes represents an excellent opportunity to engage these students in learning about STEM, lake ecology, and the conservation of Minnesota's resources. In addition to linking environmental learning to an important element of cultural identity, winter sampling is more amenable to engaging large groups of students in fieldwork than summer sampling.

We will invite two classes (one in year 1 and one in year 2 of the project) from schools located near the study lakes to participate in a three-part education and research series. First, we will provide an overview of lake ecology, the importance of studying lakes in winter, and winter sampling methods. Second, UMD researchers will join teachers and students for a day of field sampling on a frozen lake. Students will collect samples of water and aquatic organisms, participate in ice fishing, and use a remotely operated vehicle to observe the under-ice environment. Third, members of the research team will help students analyze the data they collected and discuss topics related to water quality, climate change and resource conservation.

Activity Milestones:

Description	Completion Date
Field trip class prep - meeting with class 1 to discuss research and field work	March 31 2022
Class 1 sampling day on local lake	April 30 2022
Class 1 wrap-up - meeting to support student analysis, visualization, and/or interpretation of data	May 31 2022
Field trip class prep - meeting with class 2 to discuss research and field work	March 31 2023
Class 2 sampling day on local lake	April 30 2023
Class 2 wrap-up - meeting to support student analysis, visualization, and/or interpretation of data	May 31 2023

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

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?

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.

Project Manager and Organization Qualifications

Project Manager Name: Ted Ozersky

Job Title: Associate Professor

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

Dr. Ted Ozersky is an associate professor of biological limnology at the University of Minnesota Duluth where he is cross-appointed between the Large Lakes Observatory and the Biology Department. He has more than 15 years of research experience on the topics of water quality, food web structure, and winter ecology of diverse lakes in Minnesota and elsewhere. Dr. Ozersky has led several funded projects (~$790,000 total funding) and has experience with project management, supervision of graduate students and communications of scientific results to professional audiences and the broader public.

Organization: U of MN - Duluth - Large Lakes Observatory

Organization Description:

The laboratories of Drs. Ozersky and Hrabik are based at the University of Minnesota Duluth and the Large Lakes Observatory. Their laboratories have the sampling gear and know-how for collection of proposed water, plankton, benthos and fish samples. A wide range of laboratory and analytical equipment is available to the project researchers, including microscopes, balances, water chemistry, elemental and stable isotope analysis systems. The University of Minnesota Duluth has several graduate programs that can host graduate students working on this project.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
PI - Ozersky		PI. 0.5 months summer salary for PI Ozersky in Years 1 and 2 of the project to coordinate project and participate in sampling			26.7%	0.08		$12,530
Co-I Hrabik		Co-I. 0.5 months summer salary for PI Hrabik in Years 1 and 2 of the project to coordinate project and participate in sampling			26.7%	0.08		$16,468
Co-I Kitson		1.5 months salary in Years 1 and 2 to coordinate citizen science component, 0.5 month in year 3 to help with workshop			26.7%	0.3		$20,051
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.			43.9%	0.88		$50,194
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.			42.7%	1.38		$105,022
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			24.1%	0.16		$9,722
							Sub Total	**$213,987**
Contracts and Services								
							Sub Total	-
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					$3,000

	Tools and Supplies	Containers	Containers (bottles, bags) for storage of samples					$5,000
	Tools and Supplies	EtOH and other chemicals	Ethanol and other chemicals for sample preservation and processing					$2,000
	Tools and Supplies	Misc. supplies	Misc. items for field and lab (tape, pens, gloves)					$2,097
	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	**$15,847**
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 6 lakes over the duration of the project.					$4,984
	Miles/ Meals/ Lodging	Accommodations at field sites	Overnight stays during sampling. Assuming 2 rooms needed for each lake visit; 6 lakes x 5 times					$5,000
	Miles/ Meals/ Lodging	Per diem for field work	Assuming per diem ($30) for 4 people per sampling trip; 3 lakes x 5 times/yr					$3,600
	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
	Miles/ Meals/ Lodging	Travel for educational outreach	Travel to schools to participate in educational activities; 3 trips per year: 1 one trip to prepare for sampling, 1					$1,000

			sampling trip, 1 post-sampling trip (150 miles/one way), rounded down to nearest $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	**$16,736**
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
		Water chemistry analyses	Analysis of duplicate water chemistry samples characterize nutrients and phytoplankton biomass (TP, TN. Chl. a, DOC, POC/PON) in 6 study lakes, with 5 visits per lake and 3 sampling depths (90 samples for each analysis/year). Analyses will be performed at UMD-LLO.					$6,300
		Foodweb C/N stable isotope analyses	Stable isotope analysis (C and N) to determine feeding realtionships and food web strucutre 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.					$10,830
		Sensor calibration/ service	For the Sonde					$1,500
		Bussing	Bus rental to transport K-12 students from school to lake for environmental education component in Years 1 and 2 of project					$1,800

							Sub Total	$20,430
							Grand Total	$267,000

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				
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

Administrative Use

Does your project include restoration or acquisition of land rights?
> No

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

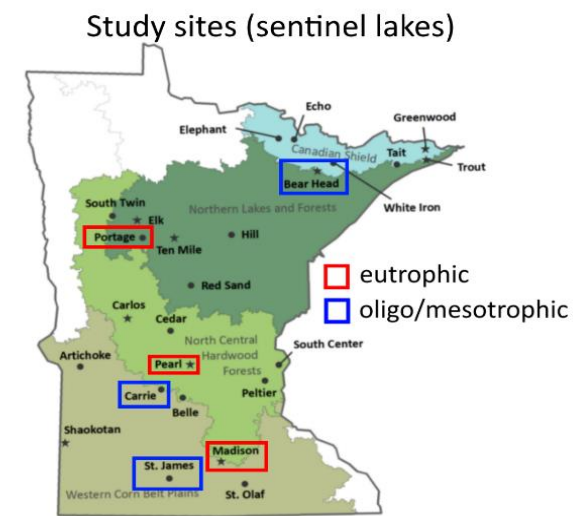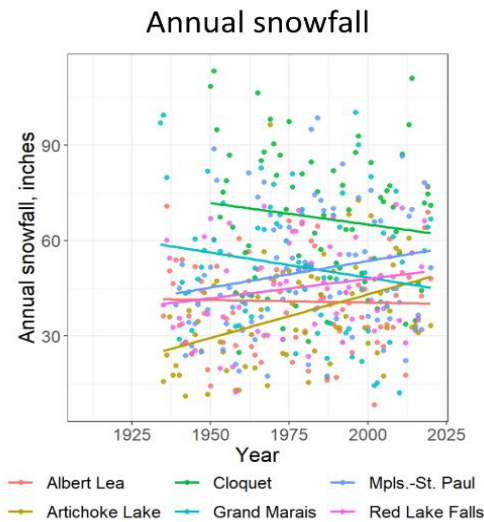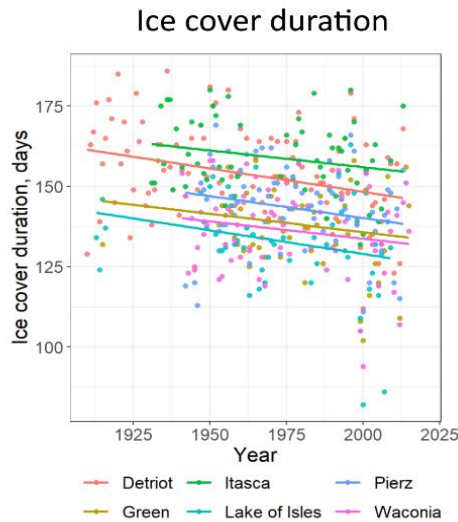**Does your project include original, hypothesis-driven research?**
> Yes

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.

Ice cover duration

Detroit — Itasca — Pierz — Green — Lake of Isles — Waconia

Annual snowfall

Albert Lea — Cloquet — Mpls.-St. Paul — Artichoke Lake — Grand Marais — Red Lake Falls

Study sites (sentinel lakes)

□ eutrophic
□ oligo/mesotrophic

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