



# Environment and Natural Resources Trust Fund

2022 Request for Proposal

## General Information

**Proposal ID:** 2022-108

**Proposal Title:** Walleye or water clarity? Evaluating alternative lake futures

## Project Manager Information

**Name:** ▼ Ryan Noe

**Organization:** U of MN - Humphrey School of Public Affairs

**Office Telephone:** ( ) -

**Email:** rrnoe@umn.edu

## Project Basic Information

**Project Summary:** Scenarios, models, and stakeholder workshops to assess tradeoffs between water quality, fisheries, recreation, and other lake values. Recommendations for more efficient and equitable targeting of lake restoration and protection activities.

**Funds Requested:** \$207,000

**Proposed Project Completion:** June 30 2024

**LCCMR Funding Category:** Foundational Natural Resource Data and Information (A)

## 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.**

Minnesota lakes face numerous and interacting threats. Water clarity is declining, zebra mussels threaten recreation, algal blooms reduce property values, and changes in fish composition are impacting tribal and recreational fisheries. Climate change is expected to exacerbate these dynamics but impacts will be variable among lakes. At the same time, a growing population will place additional demands on lake ecosystems and increase conflicts around how lakes should be used and managed.

Despite the urgency of these challenges our approach to lake management remains siloed. There is little integration across studies of limnology, fisheries, invasive species, land use, and socioeconomic factors. Studies of the economic value of Minnesota lakes are outdated and do not differentiate between types of lakes. Past research has shown that people value clean lakes and healthy fisheries, but we don't understand how residents may respond to tradeoffs across these dimensions. For example, do people prefer clear lakes with abundant panfish or turbid lakes with abundant walleye? These gaps limit our ability to manage a portfolio of lake ecosystems, weigh competing objectives from diverse stakeholders, and develop engagement and outreach strategies to inform the public about future challenges facing Minnesota lakes.

### **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.**

Minnesota has abundant lakes - but should they all be managed the same way? We explore scenarios for lake management that consider lakes as part of a diversified investment portfolio designed to provide multiple benefits in the face of uncertain threats from climate change, invasives, and nutrient pollution. We will develop typologies of Minnesota lakes, identify plausible future portfolios of these lake types, assess tradeoffs across competing lake objectives, and identify management strategies that are most likely to lead to a diverse and resilient investment portfolio.

First, we will apply state-of-the-art fish models to assess how water clarity, climate change, and invasive species will affect the distribution and abundance of fish species in Minnesota lakes. Second, we will use economic modeling and interactive stakeholder workshops to quantify preferences for lake attributes, such as fish species, vegetation, and clarity. Third, we will identify management strategies that will lead to alternative lake portfolios and evaluate how these strategies align with the preferences of different stakeholders. We will communicate findings through a web-based portfolio analysis tool, data on the economic value of different lake types, and a report for LCCMR and lake managers and opportunities for more strategic and equitable lake management.

### **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 outcomes of the project include: 1) lake-specific predictions of fish community composition under a range of water clarity and climate scenarios, 2) assessments of the economic value of lakes via changes in property values, 3) preferences for competing lake management objectives expressed by different lake stakeholders, 4) visualizations of benefits and tradeoffs associated with alternative lake conservation portfolios, and 5) report that summarizes findings and provides recommendations for lake protection strategies. Taken together these products will allow conservation managers to visualize multiple benefits and threats when planning for lake protection or other conservation activities.

## Activities and Milestones

### Activity 1: Fish community predictions for lakes throughout Minnesota under current and hypothetical scenarios of climate and water clarity change

**Activity Budget:** \$90,750

**Activity Description:**

Minnesota lakes support numerous economically and ecologically important fish species. A lake’s fish community depends in part on its water clarity and temperature, as well as inherent characteristics such as lake size and depth. Fish communities are variable across the landscape of lakes, creating a diverse “portfolio” of lakes at both local and statewide scales. The distribution of lake types and the composition of a region’s lake portfolio will be affected by climate change and potential trends in water clarity. Quantifying potential future lake fish communities can focus management efforts on maintaining diverse ecosystem services associated with variable lake types.

We will leverage federally funded research predicting the abundance of key fish species in Minnesota lakes (including walleye, yellow perch, northern pike, largemouth bass, and cisco). Ongoing work has demonstrated that climate change and water clarity affect fish community composition, but that lake responses to these stressors vary. We will predict fish community composition under scenarios of climate change and clarity changes associated with zebra mussel invasion, reduced nutrient loading, and precipitation patterns. We will develop classification of lake types and evaluate the diversity of lake portfolios in Minnesota. These predictions will inform stakeholder valuation workshops in Activity

**Activity Milestones:**

Description	Completion Date
Predicted fish community for 1,000 individual lakes across Minnesota	December 31 2022
Classify lakes into 4-8 types related to water clarity and fish community composition	December 31 2022
Visualization tools for examining the distribution of lake types at county and state levels	December 31 2022
Development of realistic scenarios of climate and clarity change	December 31 2022
Prediction and visualization of lake type portfolio under scenarios to be used in choice experiments	June 30 2023

### Activity 2: Economic valuation and stakeholder workshops to assess preferences for competing lake objectives

**Activity Budget:** \$63,170

**Activity Description:**

Estimates of the economic values provided by Minnesota lakes are outdated (mid-1990s) and do not differentiate between different lake types or fish species composition. Research on changing Minnesota lakes suggests that there may be tradeoffs between managing lakes for clarity vs. preferred fish species, such as walleye. However, we do not know how lake stakeholders perceive these tradeoffs or the ideal portfolio of lake types that will meet the demands of future lake users.

We will build on recent advances in economic valuation methods to update estimates of the value of 1000 Minnesota lakes. The resulting data can be used to evaluate the potential return on investment in lake management for individual lakes. We will complement this with participatory workshops statewide to understand the values and preferences for different lake types and benefits. Using traditional and participatory value elicitation methods, we will improve understanding of how lake users weigh tradeoffs among competing investments.

**Activity Milestones:**

Description	Completion Date
Apply updated revealed preference models to 1,000 Minnesota lakes	February 28 2023
Develop materials to communicate alternative lake futures integrating social, economic, and biological data	March 31 2023
Present findings to stakeholders via a series of participatory workshops	June 30 2023

### Activity 3: Recommendations and reporting for improved lake management

**Activity Budget:** \$53,080

**Activity Description:**

Description: Lake management is done by a patchwork of organizations that struggle to account for the interaction of multiple stressors facing individual lakes, much less a portfolio of thousands of lakes. Prior research points to potential tradeoffs in managing lakes for multiple objectives. We expect to find that warm-water and cold-water anglers, lakeshore property owners, recreationists, tribal communities, and wildlife enthusiasts will value different lake attributes. Activity 2 will document these preferences and Activity 3 will translate insights into management recommendations and publicly available datasets.

We will create a suite of plausible future scenarios of lakes and their fish species composition. Combined with insights from workshops, we will develop interactive visualizations of lake benefits that allow users to explore alternative portfolios of lakes. We will analyze how current priorities for lake management are aligned with stakeholder preferences and economic values of lakes. We will present findings to stakeholders and produce a final report and online datasets to communicate our results and suggest strategies for more diversified and proactive lake management.

**Activity Milestones:**

Description	Completion Date
Develop and present alternative scenarios for lake futures	October 31 2023
Assessment of lake management strategies and desired lake benefits elicited in Activity 2	December 31 2023
Create and promote an interactive website enabling exploration of findings through maps and visualizations	April 30 2024
Delivery of final project report to LCCMR and agency partners	May 31 2024

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Gretchen Hansen	University of Minnesota	Co-Principle Investigator, fish species composition modeling.	Yes
Jordan Read	United States Geological Surveys	Support for running lake temperature and clarity models	No
Bonnie Keeler	University of Minnesota	Principle Investigator, economic and social valuation methods.	Yes

## 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?**

All data and code will be open-source and distributed via a website and repository hosted by the University of Minnesota. We will co-develop lake typologies and relevant management scenarios with agency staff and scientists and share our maps, lake models, and projections with residents across Minnesota. All participants will gain access to all project materials, including data, maps, and final reports. Investments in co-development and workshops will raise awareness of the project and enhance future uptake in decisions. We will seek funding to continue the work through partnerships with agencies, fish and wildlife organizations, and federal funding sources.

## Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Understanding Water Scarcity, Threats, and Values to Improve Management	M.L. 2015, Chp. 76, Sec. 2, Subd. 04a	\$234,000
Conservation Easement Assessment and Valuation System Development	M.L. 2015, Chp. 76, Sec. 2, Subd. 09k	\$250,000
Assessment of Public Benefits of Protecting Source Water	M.L. 2017, Chp. 96, Sec. 2, Subd. 03b	\$320,000
MAISRC Subproject 16.2: AIS Impacts on Walleye Populations and Mercury Concentrations	M.L. 2017, Chp. 96, Sec. 2, Subd. 06a	\$0

## Project Manager and Organization Qualifications

**Project Manager Name:** ▼ Ryan Noe

**Job Title:** Senior Scientist

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

Ryan Noe is a senior scientist in the Science, Technology, and Environmental Policy area of the Humphrey School at the University of Minnesota. He manages projects on water and land use, with a focus on co-developing actionable research with state agencies, conservation organizations, and policymakers in Minnesota. Ryan holds an M.S. in natural resource science and management, with a focus on geospatial analysis. His work seeks to improve the usability of spatial data on environmental benefits such as clean drinking water, game species habitat, or lake recreation. He also seeks to improve the integration of data on threats such as climate change or land use conversion into environmental decision-making.

**Organization:** U of MN - Humphrey School of Public Affairs

**Organization Description:**

The mission of the Humphrey School of Public Affairs is to inspire, educate, and support innovative leaders to advance the common good in a diverse world. Within the Humphrey School, the Center for Science, Technology, and Environmental Policy fosters interdisciplinary and community-engaged research on human well-being, environmental sustainability, and social justice in a complex and diverse world. The Center conducts public engagement with external partners, develops environmental leadership, and facilitates solutions-oriented projects at the nexus of science, technology, and environmental policy.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Bonnie Keeler		Principal Investigator/Project Lead			36.5%	0.08		\$14,197
Ryan Noe		Project Manager			36.5%	0.5		\$47,393
Gretchen Hansen		Co-Investigator			36.5%	0.04		\$6,882
Researcher, TBN		Researcher 4			31.8%	0.4		\$27,156
HHH Grad Research Assistant, Academic Year		GRA #1, AY			126%	0.38		\$36,768
HHH Grad Research Assistant, Summer Session		GRA #1, SS			19.9%	0.13		\$7,803
CFANS, Grad Research Assistant, Academic Year		GRA #2, AY			109.66%	0.38		\$40,320
CFANS, Grad Research Assistant, Summer Session		GRA #2, SS			19.9%	0.28		\$16,392
							<b>Sub Total</b>	<b>\$196,911</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	<b>-</b>

<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Workshop Supplies	General Supplies for 6 half day workshops. Folders, pens, name badges					\$202
							<b>Sub Total</b>	<b>\$202</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	-
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	Trip costs for 3 days/2 nights: lodging \$125/night, meals \$36/day plus mileage for 2 vehicals	Travel for 5 members of research team to attend consecutive workshops at Marshall and Mankato, MN					\$2,018
	Miles/ Meals/ Lodging	Trip costs for 4 days/3 nights: Lodging \$125/night, Meals \$36/day plus mileage for 2 vehicals	Travel for 5 members of the research team to attend consecutive workshops in Brainard, Grand Rapids, and Bemidji, MN					\$3,017
	Miles/ Meals/ Lodging	Trip Costs for 2 days/1 night: Lodging \$150/night, Meals \$36/day plus mileage for one vehical	Travel for 2 members of the research team to attend an in-state conference to present results					\$952
							<b>Sub Total</b>	<b>\$5,987</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
							<b>Sub Total</b>	-



Other Expenses								
		Workshop Expenses	Food, lunch and bottled water for 6 half day workshops. Estimated number of participants at each workshop = 20, \$20/participant					\$2,400
		Workshop Expenses	Room rental for 6 half day workshops. Cost estimated at \$225/workshop x 6 workshops					\$1,350
		Workshop Expenses	Printing of materials for workshop participants at 6 half day workshops. Cost estimated at \$25/workshop x 6 workshops					\$150
							<b>Sub Total</b>	<b>\$3,900</b>
							<b>Grand Total</b>	<b>\$207,000</b>

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
<b>State</b>				
			<b>State Sub Total</b>	-
<b>Non-State</b>				
Cash	Department of Interior USGS Midwest Climate Adaptation Center	Support for developing fish species modeling methods.	Secured	\$162,175
			<b>Non State Sub Total</b>	<b>\$162,175</b>
			<b>Funds Total</b>	<b>\$162,175</b>

## Attachments

### Required Attachments

#### *Visual Component*

File: [1cda1294-091.pdf](#)

#### *Alternate Text for Visual Component*

Our project will:

Model fish species changes for 1,000 lakes under scenarios of changing lake temperature, watershed development, and invasive species.

Estimate the return on investment in lake restoration or protection for 1,000 lakes.

Conduct statewide workshops to understand stakeholder preferences for competing lake benefits.

Combine insights from workshops and ecosystem valuation methods to make recommendations for balancing tradeoffs among lake typologies in Minnesota's portfolio.

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### Optional Attachments

#### *Support Letter or Other*

Title	File
UMN Financial capacity: Most recent certified financial audit report.	<a href="#">71442418-f27.pdf</a>
UMN sponsored projects administration letter of intent	<a href="#">11f17499-d15.docx</a>
DOI USGS Letter of Support	<a href="#">128fb195-ce5.pdf</a>

## 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

# Walleye or Water Clarity? Evaluating Alternative Lake Futures

We will:

- Model fish species changes for 1,000 lakes under scenarios of changing lake temperature, watershed development, and aquatic invasive species spread.
- Estimate the return on investment in lake restoration or protection for 1,000 lakes.
- Conduct statewide workshops to understand stakeholder preferences for competing lake management objectives.
- Combine insights from workshops and ecosystem valuation methods to make recommendations for balancing tradeoffs among lake typologies in Minnesota's portfolio (Figures 1-2).

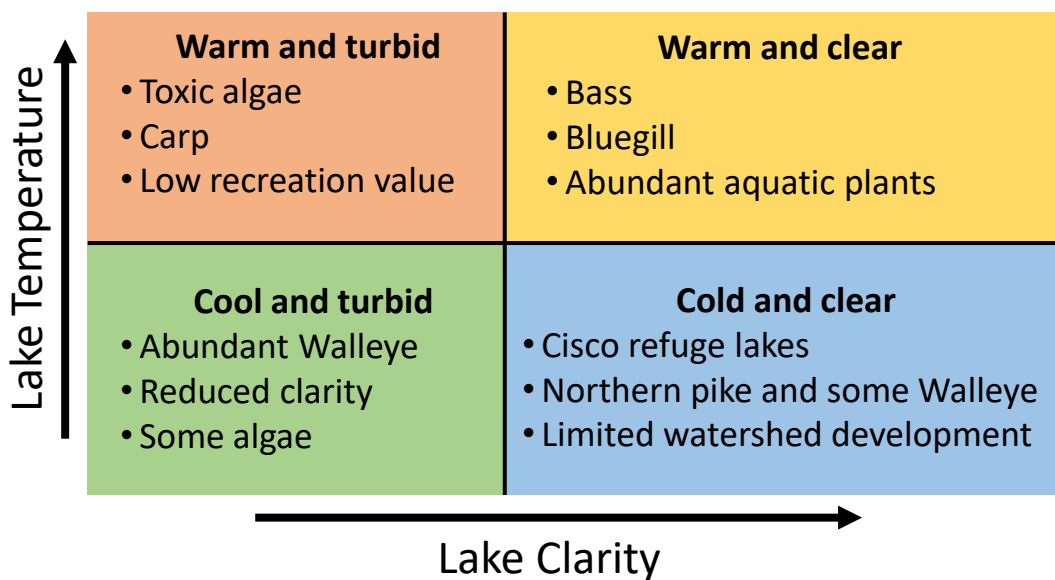
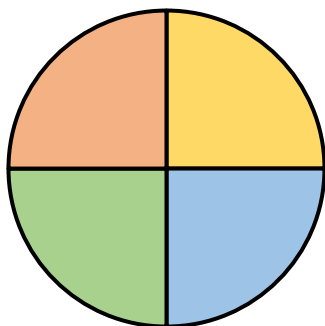


Figure 1. Example lake typologies based on combinations of lake temperature and clarity. Activity 1 will build on these typologies and apply them to a current portfolio of 1,000 Minnesota lakes.

Hypothetical Current Portfolio



Potential Future Scenario Portfolios

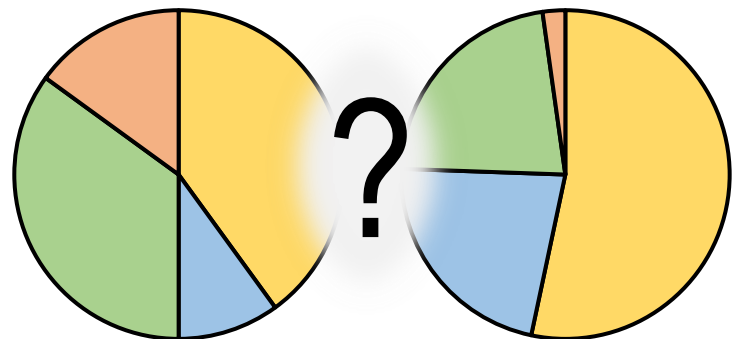


Figure 2. We will first develop and apply 4-8 typologies of lakes (e.g., warm and clear) and calculate what is currently represented in Minnesota's portfolio. We will then create scenarios of likely change and assess how stakeholders weigh the unavoidable tradeoffs. We will develop recommendations for a lake portfolio that equitably represents diverse stakeholder values, is more robust to external shocks, and is more likely to deliver value over time.

