

**Environment and Natural Resources Trust Fund
2019 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 029-AH

Protecting Minnesota's Cold-Water Fish into the Future

Category: H. Proposals seeking \$200,000 or less in funding

Sub-Category: A. Foundational Natural Resource Data and Information

Total Project Budget: \$ 168,760

Proposed Project Time Period for the Funding Requested: June 30, 2022 (3 yrs)

Summary:

Cold-water fish are threatened by low oxygen and warming waters across Minnesota lakes. Warming cannot be stopped, but nutrient runoff that contributes to oxygen depletion can be improved.

Name: Erik Smith

Sponsoring Organization: USGS

Title: Hydrologist

Department: Minnesota Water Science Center

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Mounds View MN 55112

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Web Address _____

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Discover how cold-water fish in one Minnesota lake are "squeezed" when warming and land use change shrink suitable habitat.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity	_____ Readiness	_____ Leverage	_____ TOTAL _____%
_____ If under \$200,000, waive presentation?			



PROJECT TITLE: Protecting Minnesota's cold-water fish into the future

I. PROJECT STATEMENT

THREAT: *Nutrient runoff and warming lake temperatures are a threat to Minnesota's fisheries due to loss of suitable habitat.*

In a future Minnesota summer, lakes will be warmer and land use changes may increase nutrient runoff, bottom waters will be trapped longer and more algae will settle and decompose. Cold-water fish (cisco, lake trout) will be trapped between surface waters that are too warm and bottom waters that do not have enough oxygen to survive; lakes can become a "dead zone".

KNOWLEDGE GAP: *To protect cold-water fish, we can't stop lake warming, but we can improve nutrient runoff and oxygen conditions. Which lakes will respond to watershed protection?*

Minnesota lakes are diverse -- one size *does not* fit all in predicting the impact of warming and nutrient runoff on fish habitat. Groups such as MPCA and DNR who have the responsibility to protect and improve water quality need to know which lakes will respond positively to nutrient management to prioritize resources across the vast number of Minnesota lakes.

SOLUTION: *Identify which Minnesota lakes are most likely to support cold-water fish with nutrient management efforts under the reality of warming waters, now and into the future.*

We will use existing data to estimate past and future daily fish habitat across Minnesota lakes that span a gradient of lake temperatures and land use.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Create a database of key fish habitat metrics for ~3000 target lakes.*

We will identify "target" lakes for the project, which are lakes susceptible to low oxygen. We propose no new data collection; instead, for the estimated ~3000 target lakes, we will bring together existing key data (temperature, oxygen, lake characteristics) that are scattered across several datasets, which currently hinders statewide assessment of cold-water fish habitat. We will leverage existing state and federal databases, including monitoring data from DNR and MPCA, modeled daily lake temperature data, and a nutrient database that includes data for thousands of lakes in Minnesota.

ENRTF BUDGET: \$49,825

Outcome	Completion Date
1. Assembled oxygen and temperature records from MN DNR and MPCA	December 2019
2. Assembled supporting data (nutrients, depth, etc.) from multiple sources	December 2019
3. Identification of "target lakes" that will be modeled.	December 2019

Activity 2: *Estimate daily cold-water fish habitat for target lakes.*

Hindcasted (1980-2018) and forecasted (to 2100) estimates of fish habitat for target lakes will be created using our assembled data and equations that describe oxygen production and consumption at the daily timestep. Individual fish species have unique temperature and oxygen requirements, and our daily temperature and oxygen data can be combined to find the volume of suitable fish habitat for every target lake at the daily timestep.



**Environment and Natural Resources Trust Fund (ENRTF)
2019 Main Proposal**

ENRTF BUDGET: \$78,210

Outcome	Completion Date
1. A free and publicly available model of oxygen for individual lakes throughout Minnesota	May, 2021
2. Publicly available data: Modeled oxygen data for all target lakes with supporting information	May, 2021
3. USGS data series: cold-water fish relevant summary metrics of temperature and oxygen	July, 2021

Activity 3 *Assess and communicate the future of cold-water fish in Minnesota lakes.*

Fish-relevant habitat metrics will be used to evaluate how warming and runoff will threaten cold-water fish. We will identify nutrient-sensitive lakes that could support cold-water fish with watershed protections or improvements under a warmer future. Our results will be communicated through publicly available outlets to reach the appropriate audiences, including peer-reviewed publications in scientific journals, state-level reports, and interactive web-based visualizations where users can see the probability of dead zones in individual lakes under various warming and land use scenarios.

ENRTF BUDGET: \$40,725

Outcome	Completion Date
1. Peer-reviewed publication: The impacts of warming and nutrient runoff on oxygen in MN lakes	May 2022
2. Report: Prioritized lakes across Minnesota for improving fish habitat through land conservation	May 2022
3. Web-based visual: key findings and implications for MN lakes for broad audience + links to reports/publications/data. Users can see data for all lakes or individual lakes, download data of interest.	June 2022

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Erik Smith	Hydrologist	USGS	PI & Project Manager
Samantha Oliver	Hydrologist	USGS	Co-PI, lead for data collection, analysis, modeling

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Jordan Read	Data Science Branch Chief	USGS	Data science, modeling, lake physics expert
Gretchen Hansen	Fisheries systems ecologist	MN DNR	Fisheries domain expert
Peter Jacobson	Habitat group supervisor	MN DNR	Oxygen dynamics expert, modeling

IV. LONG-TERM- IMPLEMENTATION AND FUNDING: The proposed project would prioritize lakes that will respond best to nutrient runoff management, which will inform best management practices of cold-water fishes into the future. Additionally, the database of fish habitat metrics will continue to be a resource for fisheries habitat information on individual lakes across the state.

V. TIME LINE REQUIREMENTS: The project is proposed as a 3-year project, July 2019 – June 2022. All data assembly and modeling will be completed by July 2021, with the final reports, publications, and web visualization completed by June 2022.

2019 Proposal Budget Spreadsheet

Project Title:

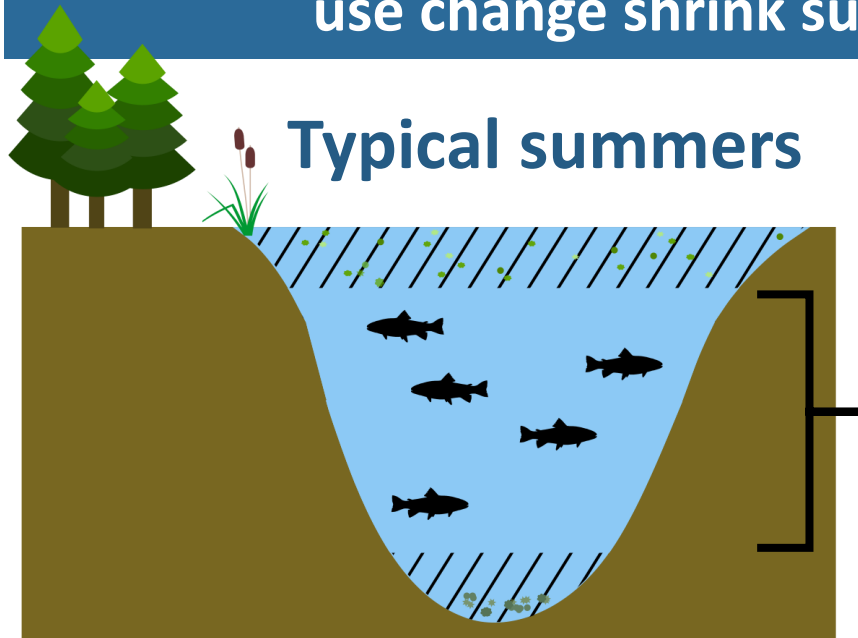
IV. TOTAL ENRTF REQUEST BUDGET *[Insert # of years for project]* 3 years

BUDGET ITEM (See "Guidance on Allowable Expenses")	AMOUNT
Personnel (USGS Hydrologist): 3 hydrologists, including: project manager with assisting role for modeling and dissemination [0.07 FTE x 3 years = 0.21 FTE (73% salary, 27% benefits)], a primary scientist to lead data assembly, modeling, publishing, and support web visualization [0.3 FTE x 3 years = 0.9 FTE (76% salary, 24% benefits)], and an additional hydrologist for high-performance computing and model support [0.03 FTE x 3 years = 0.09 FTE (72% salary, 28% benefits)]	\$ 104,894
Personnel (USGS Data Scientist): Data Scientist, provide assistance with data cleaning, publishing data, and will lead web visualization. 0.25 FTE x 3 years = 0.75 FTE (76% salary, 24% benefits)	\$ 53,659
Personnel (USGS Administration): Administrative support for funding agreements, cost accounting, and billing [0.03 FTE x 3 years = 0.09 FTE (72% salary, 28% benefits)].	\$ 7,207
Professional/Technical/Service Contracts: Publication expenses	\$ 3,000
Equipment/Tools/Supplies:	\$ -
Acquisition (Fee Title or Permanent Easements):	\$ -
Travel:	
Additional Budget Items:	\$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 168,760

V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period: USGS Cooperative Matching Fund.	\$ 55,000	secured
Other State \$ To Be Applied To Project During Project Period:	NA	
In-kind Services To Be Applied To Project During Project Period: MN DNR hours for Pete Jacobson and Gretchen Hanson (100 hr x 2 people x 2 years = \$20,950). USGS hours for Jordan Read (100 hr x 3 years = \$18,000)	\$ 38,950	secured
Past and Current ENRTF Appropriation:	NA	
Other Funding History:	NA	

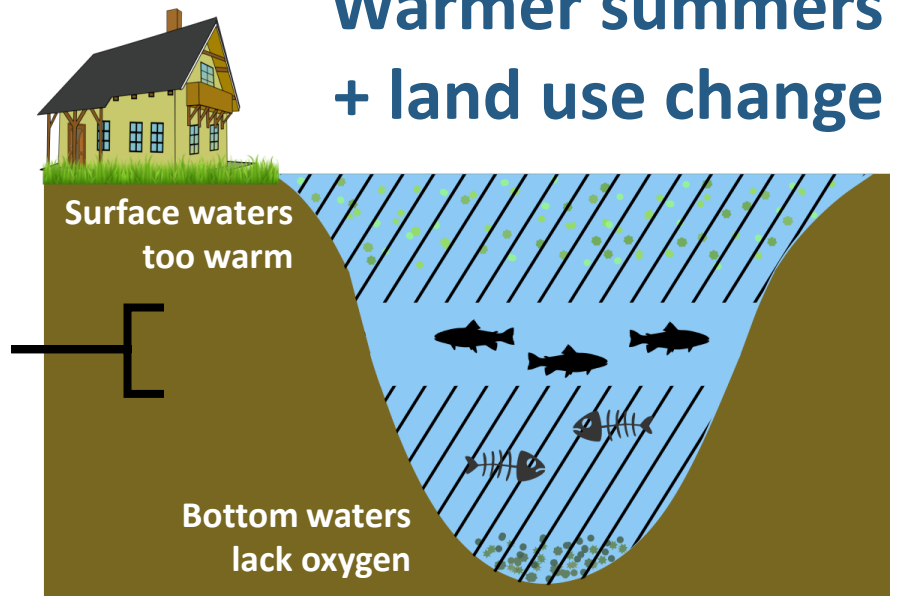
LAKE DEAD ZONES: Discover how cold-water fish in one Minnesota lake are “squeezed” when warming and land use change shrink suitable habitat.



Typical summers

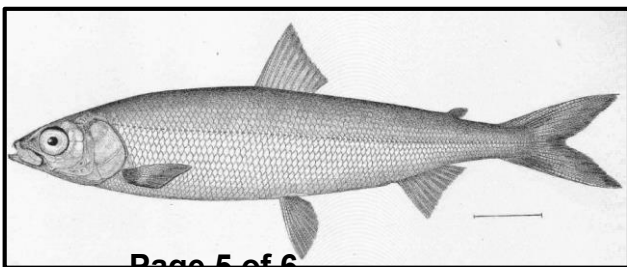
IN THE PAST -- PLENTY OF SUITABLE HABITAT: Summer is short and few nutrients enter the lake, limiting algal growth, decomposition, and oxygen depletion. Cold-water fish have plenty of habitat that is both cold and oxygen-rich.

IN THE FUTURE -- SHRINKING HABITAT: Summers are longer, lakes are warmer, and land use change may increase nutrient runoff. More algae grows, increasing decomposition and oxygen depletion in bottom waters. Cold-water fish are squeezed into smaller and smaller spaces.



Warmer summers + land use change

Who loses when lakes lose oxygen?



Fish kills of cisco have been reported in Minnesota lakes when suitable oxygen habitat disappears. *But oxygen depletion doesn't just affect cold-water fish.* Cisco and other cold-water fish are key prey species for sport fish such as walleye. Additionally, low oxygen in lakes can create chemical reactions that release nutrients, fueling algal blooms and perpetuating poor water quality.

Project Manager Qualifications

Erik Smith will assume the role of project manager, with an assisting role in modeling efforts and dissemination. Erik has been a hydrogeologist with the U.S. Geological Survey (USGS) since 2004. Erik received a Master's degree in Geology (2005), specializing in geochemistry, from the University of Minnesota-Twin Cities. In 2005, Erik transferred to the USGS in Iowa City, IA, to work as a supporting scientist and full-time hydrologist on the NAWQA program's Agricultural Chemicals Transport (ACT) team. In 2008, Erik transferred back to Minnesota to complete work on a PhD tied into the Iowa ACT project. After graduating from the University of Minnesota-Twin Cities (PhD, 2011, Water Resources Science), Erik has been a full-time hydrologist with the Upper Midwest Water Science Center-Minnesota. His current research focuses on limnological research of harmful algal blooms (HABs) and changes in fish habitat dynamics related to land-use changes. Erik has also been the lead author on several peer-reviewed publications related to his limnological research, including two comprehensive publications detailing Sentinel Lakes limnological modeling funded by the LCCMR.

Organization Description

The USGS Minnesota Water Science Center collects high-quality hydrologic data and conducts unbiased, scientifically sound research on the water resources of Minnesota. We strive to meet the changing needs of those who use our information—from the distribution, availability, and quality of our water resources to topic-oriented research that addresses current hydrological issues.