Environment and Natural Resources Trust Fund
2020 Request for Proposals (RFP)

Project Title: **ENRTF ID: 170-E**

Increasing Resilience of Lakes to Extreme Precipitation Events

Category: E. Air Quality, Climate Change, and Renewable Energy

Sub-Category:

Total Project Budget: $ 323,780

Proposed Project Time Period for the Funding Requested: June 30, 2024 (4 yrs)

Summary:

We will identify and communicate watershed best management practices for increasing resilience of coldwater fish habitat in lakes to warming and increased frequency of extreme storm events.

Name: Gretchen Hansen

Sponsoring Organization: U of MN

Job Title: Dr.

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Location:

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Extreme rain events are occurring more frequently. Coldwater fish can die from lack of oxygen, but lakes respond differently. We will assess how and why lakes respond to extreme rain.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

PROJECT TITLE: Increasing resilience of lakes to extreme precipitation events

I. PROJECT STATEMENT

Coldwater fish habitat in Minnesota's inland lakes is threatened by both climate and land use change. **As extreme precipitation events become more common in Minnesota, there is an urgent need to understand the drivers of coldwater fish habitat loss in order to design effective protection and conservation strategies.** Extreme rain events can reduce coldwater fish habitat because large influxes of sediments and nutrients enter lakes and deplete oxygen, causing fish kills. However, not all lakes respond in the same way, and lake and watershed characteristics can influence how dissolved oxygen responds following extreme precipitation events. Robust populations of coldwater fish such as cisco are vital for sustaining economically important fisheries such as walleye, northern pike, muskellunge, and lake trout. Watershed protections and best management practices can maintain coldwater fish habitat even as lakes warm and extreme rain events increase in frequency. Millions of dollars are being spent in Minnesota to protect watersheds of coldwater refuge lakes, but conservation targets are based on historical precipitation levels, and do not account for the impacts of extreme rain events as they increase in frequency and intensity. Indeed, in recent years, some of these refuge lakes have experienced fish kills following extreme precipitation events. As extreme precipitation events become more common under climate change, it is imperative that conservation funding decisions are based on comprehensive science. Watershed characteristics that increase the resilience of coldwater fish habitat to extreme storm events must be identified and used to prioritize protection and restoration actions to maximize their probability of success.

The overall goal of this project is to identify watershed best management practices for increasing resilience of coldwater fish habitat in lakes to warming and extreme storm events. This information will directly guide prioritization and protection efforts designed to conserve coldwater fish habitat throughout Minnesota. To support effective conservation of coldwater fish habitat and efficient use of public resources, we will 1. Assess oxygen and thermal conditions at high temporal resolution (i.e., minute- to hour-scale measurements) in lakes spanning a gradient of climate, watershed, and geomorphological conditions to quantify how extreme storm events influence coldwater fish habitat; 2. Identify watershed and lake characteristics that increase resilience of fish habitat to extreme precipitation events; and 3. Design and communicate watershed protection targets and best management practices that can reduce the vulnerability of lakes to loss of coldwater fish habitat, given predicted future frequency of extreme storm events.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1 Title: Continuous monitoring of oxygen and temperature conditions across a range of lakes

Description: We will assess oxygen and temperature dynamics in 10 Minnesota lakes spanning a gradient of watershed and climate conditions. We will deploy vertically distributed oxygen and temperature sensors to assess hourly, daily, seasonal, and annual patterns of oxygen and temperature limits for fish habitat. The Minnesota DNR and the US Fish and Wildlife Service already maintain similar sensors in 16 additional lakes, and we will partner with both agencies to share data in order to increase the number of lakes included in this research. In order to assess lake-specific drivers of low dissolved oxygen, we will measure dissolved and particulate nutrients (C, N and P) and calculate biological oxygen demand seasonally for each lake. Several years of assessment across a gradient of lake conditions and locations will increase the probability that we will observe extreme precipitation events and capture the range of lake responses.

ENRTF BUDGET: $145,138

Outcome	Completion Date
1. Collect hourly oxygen and temperature data from 10 Minnesota lakes	*10/30/2022*
2. Collect nutrient and water quality data from each lake in each year	*10/30/2022*

3. Develop database for continuous dissolved oxygen data from Minnesota lakes	*10/30/2022*

Activity 2 Title: Identify characteristics that increase resilience of fish habitat following extreme rain events

Description: Using data obtained from activity 1, we will link dissolved oxygen and temperature (oxythermal habitat) responses in each lake to precipitation events. We will use statistical models to quantify relationships between oxythermal habitat and watershed land use, temperature, precipitation, and other lake characteristics. We will use data collected in activity 1 to develop landscape-scale models of current and future oxygen conditions that account for increased frequency of extreme precipitation events for hundreds of Minnesota lakes in which continuous monitoring is not feasible. We will quantify the resilience of oxythermal habtitat in individual lakes to watershed development and climate change in order to identify lake-specific watershed development thresholds above which coldwater fish habitat is expected to disappear.

ENRTF BUDGET: $111,944

Outcome	Completion Date
1. Collate data on watershed landuse, shoreline disturbance, and lake morphometry	*6/30/2021*
2. Quantify relationships between watershed land use, climate (including temperature and precipitation), lake morphometry, and oxythermal habitat.	*12/31/2023*
3. Estimate lake-specific watershed protection targets for sustaining coldwater fish habitat under climate change	*12/31/2023*

Activity 3 Title: Design and communicate management strategies for resilient coldwater fish habitat

Description: The primary output of this work will be an online communication tool to guide watershed protection efforts designed to sustain coldwater fish habitat in lakes throughout Minnesota. This tool will allow stakeholders to assess the resilience of oxythermal habitat in individual lakes to climate change and watershed development in order to support protection and restoration efforts at multiple scales. For example, the tool could be used by lake associations to identify watershed protection targets designed to maintain coldwater fish habitat specific to their lake. It could also be used more broadly at a regional scale to prioritize protection and restoration efforts on lakes that would benefit most in terms of watershed management actions designed to sustain coldwater fish habitat. This tool will be designed and developed in partnership with stakeholders to maximize the value of our key findings for a wide range of potential users.

ENRTF BUDGET: $66,698

Outcome	Completion Date
1. Data visualization tool	*6/30/2024*
2. Peer reviewed manuscript in scientific journal	*6/30/2024*
3. Present results and data visualization tool to stakeholders	*6/30/2024*

III. PROJECT PARTNERS AND COLLABORATORS: Peter Jacobson and Casey Schoenebeck, MN DNR; Jared Myers, US Fish and Wildlife Service. Lesley Knoll, Itasca Biological Station, U of MN; James Cotner, U of MN.

IV. LONG-TERM IMPLEMENTATION AND FUNDING:

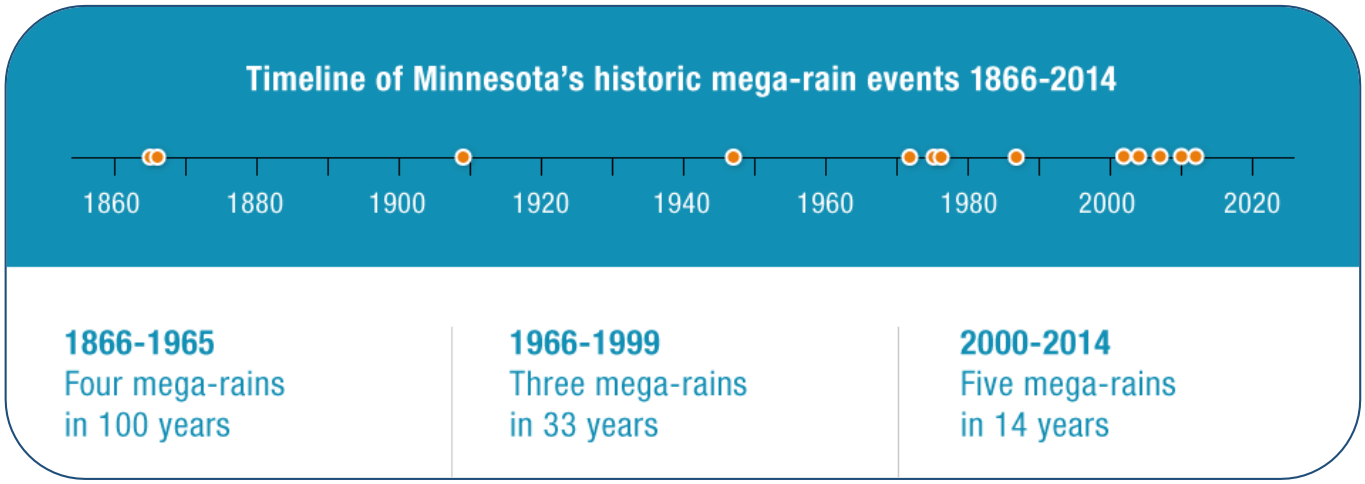
This project is a partnership between state (MN DNR and MN PCA, federal (USFWS), and University investigators and is a high priority for each of these groups. To date, the MN DNR and USFWS have committed over $100,000 for the purchase and maintenance of continuous monitoring of dissolved oxygen in Minnesota lakes and we will leverage those funds in this work. We will support implementation of efficient and effective management of coldwater fish habitat through our data visualization tool and will publicize this tool widely through presentations to stakeholder groups, social media, and the press. We will also make dissolved oxygen data publicly available for future collaborations, and plan to maintain data collection from at least a subset of these sensors in the long-term through the sentinel lakes program and USFWS monitoring activities.

Attachment A: Project Budget Spreadsheet
Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet
Legal Citation:
Project Manager: Gretchen Hansen
Project Title: Increasing resilience of lakes to extreme precipitation events
Organization: University of Minnesota
Project Budget: $323780
Project Length and Completion Date: 4 years (6/30/2024)
Today's Date: 4/10/2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 240,369	$ -	$ 240,369
UMN graduate assistant in Conservation Sciences; 50% RA for four years; $187,090 ($101,795 salary, $68,906 tuition, and $16,389 benefits at 16.1%)			
G. Hansen, project manager and lead PI, Assistant professor; $42,719 ($31,411 salary, $11,308 fringe at 36.0%); 5.8% FTE for years 1-4			
UMN undergraduate student worker; $10,560 (0% fringe); 1 student at 11.5% FTE for years 1 and 3 and 19.2% for year 2.			
Professional/Technical/Service Contracts			
Contract with data visualization and decision support tool professional service provider ($10,000). For development and implementation of online decision support tool. We will seek a provider with expertise in data visualization, science communication, and environmental issues via competitive bid	$ 10,000	$ -	$ 10,000
Equipment/Tools/Supplies			
Dissolved oxygen continuous loggers, 22 loggers @ $900.	$ 19,800	$ -	$ 19,800
Supplies for deploying loggers (e.g., rope [$400], buoys [$400], clamps and ties [$150], cinder blocks [$50], depth finder with GPS unit [$1000], Replacement batteries for loggers ($40)	$ 2,040	$ -	$ 2,040
Water chemistry analysis for 10 lakes at 5 sites per lake in years 1 and 2. Costs calculated based on per sample cost for soluble reactive phosphorus ($8), dissolved organic phosphorus ($15), Nitrate/Nitrite ($15), Total dissolved nitrogen ($10), Dissolved organic carbon ($15), Total phosphorus ($15), chlorophyll-A ($8), and particulate carbon ($15), plus annual instrument calibration and maintenence of $1950	$ 14,000	$ -	$ 14,000
Laptop computer for student (pending LCCMR approval) for downloading continuous data in the field and conducting large scale data analysis that is not possible with existing equipment.	$ 2,500	$ -	$ 2,500
Capital Expenditures Over $5,000			
	$ -	$ -	$ -
Fee Title Acquisition			
	$ -	$ -	$ -
Easement Acquisition			
	$ -	$ -	$ -
Professional Services for Acquisition			
	$ -	$ -	$ -
Printing			
	$ -	$ -	$ -
Travel expenses in Minnesota - in accordance with UMN Travel Policy			
Fieldwork to deploy, maintain, and download data from oxygen loggers from each of 10 lakes. Costs estimated for 2 ppl* 3 travel weeks for year 1, 4 travel weeks for year 2, and 3 travel weeks for year 3. Total based off 800 miles@$0.7/mi + 4 lodging nights@$150/night + 5 days of meals @$55/day for 2 people (meal estimate based on state per diem rate; actual costs will be reimbursed) + $200 for boat gas per week of field work travel = $2,510 per travel week or [$27,610].	$ 27,610	$ -	$ 27,610
Travel for UMN personnel to 1 project team meeting at Itasca Biological Station in years 1-4 [$2,745]. Cost estimated as mileage (442 miles RT @ $0.58/mile), 2 nights lodging for two people at Itasca cabins @$50/night, and meals (2 people for 3 days @ $55/day) in years 1 -4. Actual costs will be reimbursed	$ 2,745	$ -	$ 2,745
Travel to in-state professional conference (e.g., Minnesota AFS, Midwest Invasive Species Conference) in each of years 2,3 and 4. Cost estimated as registration ($200), mileage (400 miles RT @ $0.58/mile), 2 nights lodging (2 nights @$150/night), and meals (3 days @ $55/day). Actual costs will be reimbursed	$ 2,691	$ -	$ 2,691
Other - in accordance with UMN Travel Policy			
Travel - domestic. Travel for one team member to present results at a national conference (e.g., the American Fisheries Society meeting in Spokane WA in 2022). Costs calculated as $500 airfare, $450 conference registration, 4 nights lodging @$200/night, and 5 days of meals at $55/day (costs are estimated, actual expenses will be reimbursed pending LCCMR approval).	$ 2,025	$ -	$ 2,025
COLUMN TOTAL	$ 323,780	$ -	$ 323,780

SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State: N/A	N/A	$ -	$ -	$ -
State: Unrecovered IDC 54% MTDC	pending	$ 174,841	$ -	$ 174,841
In kind: MN DNR Fisheries Research Supervisor Peter Jacobson will provide 100 hours of in-kind support, for a value of $18,000	secured	$ 18,000	$ -	$ 18,000
In kind: MN DNR Sentienel Lakes Coordinator Casey Schoenebeck will provide 40 hours of in-kind support, for a value of $5,200	secured	$ 5,200	$ -	$ 5,200
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS	**Amount legally obligated but not yet spent**	**Budget**	**Spent**	**Balance**
N/A	N/A	$ -	$ -	$ -

Extreme rain events are occurring more frequently in Minnesota



Graphic created by Jaime Chismar for MPR news, data from MN DNR State Climatology office

Extreme rain events reduce oxygen in lakes and threaten coldwater fish habitat, but not all lakes respond in the same way

Loss of oxygen can result in fish kills

Oxygen loss can be sudden or gradual depending on lake characteristics.

Photos courtesy of MN PCA

Management can increase resilience of lakes to extreme rain events

Activity 1:
Continuous monitoring of oxygen and temperature conditions across a range of lakes

→ **How** do lakes respond to extreme rain events?

Activity 2:
Identify characteristics that increase resilience of fish habitat following extreme rain events

→ **Why** do lakes respond differently?

Activity 3:
Design and communicate management strategies for resilient coldwater fish habitat

→ **What** management strategies can protect and restore coldwater fish habitat, and **where** will they be most effective?

Project manager qualifications and organization description:

Dr. Gretchen Hansen will serve as the project manager and lead PI of the proposed work. Dr. Hansen is an assistant professor in the University of Minnesota Department of Fisheries, Wildlife, and Conservation Biology and will serve as the primary advisor to the graduate student working on this project. Dr. Hansen has a Ph.D. in limnology and marine science and M.Sc. in Fisheries and Wildlife. She has spent the past decade working at the interface of science and policy in understanding ecosystem changes affecting Midwestern lakes. As a leading researcher working to understand drivers of trends in Midwestern fish habitat and populations, Dr. Hansen has worked on the effects of climate change, watershed land use, and water clarity on water quality and fish. She currently serves as project manager for a collaborative multi-agency team on a MAISRC project studying the impacts of zebra mussels and spiny water flea on the food webs of Minnesota's largest walleye lakes. Many of her research projects bring together experts in fisheries management, ecosystem dynamics, and computer science to address real-world management problems with cutting-edge science solutions. Dr. Hansen has a strong publication track record and a commitment to communicating effectively with stakeholders using multiple media, including online, interactive data visualization tools.

The University of Minnesota Twin Cities is the state's land-grant university and one of the most prestigious public research universities in the nation. The research mission of the University is to seek new knowledge that can change how we all work and live. We apply our research and expertise to meet the needs of Minnesota, our nation, and the world through partnerships in addressing society's most pressing issues.

Within the University of Minnesota, faculty, staff, and students of Department of Fisheries, Wildlife, and Conservation Biology work on applied and fundamental problems related natural resource management and conservation. The mission of FWCB is to foster a high-quality natural environment by contributing to the management, protection, and sustainable use of fisheries and wildlife resources through teaching, research, and outreach. Our goals are to respond to societal needs for information and education pertaining to the conservation of our natural resources and to ensure excellent teaching, research, and outreach programs.