

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

Project Title:

ENRTF ID: 034-A

Winter Dynamics of Vulnerable Trout Streams: Central Minnesota

Category: A. Foundational Natural Resource Data and Information

Sub-Category:

Total Project Budget: \$ 767,060

Proposed Project Time Period for the Funding Requested: June 30, 2023 (3 yrs)

Summary:

We will intensively evaluate brook trout streams that are vulnerable to climate warming, will develop quantitative models to predict most vulnerable streams, assess winter food, movement and refugia for fish.

Name: Leonard Ferrington

Sponsoring Organization: U of MN

Job Title: _____

Department: CFANS

Address: 306 Hodson Hall, 1980 Folwell Avenue
St. Paul MN 55108

Telephone Number: (651) 226-8519

Email ferri016@umn.edu

Web Address: <http://midge.cfans.umn.edu/current-fellows/ferrington>

Location:

Region: Central

County Name: Benton, Meeker, Mille Lacs, Morrison, Sherburne, Stearns, Todd

City / Township:

Alternate Text for Visual:

The map shows locations of trout streams in central Minnesota and is adapted from on-line maps developed by MN DNR.

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



PROJECT TITLE: Winter Dynamics of Vulnerable Trout Streams: Central Minnesota

I. PROJECT STATEMENT: For almost a decade, Ferrington (PI) has studied the winter dynamics of trout streams in the Driftless Region (DR) of Minnesota. The DR was not glaciated during the most recent glaciation of MN and presently is relatively devoid of lakes. However, the geology consists of extensive karst landscape conducive to groundwater flows that re-surface at well-developed spring or seepages and buffer temperature regimes of streams. These point sources of groundwater keep streams cold in summer (but warm in winter!), contributing to high quality habitat for trout. More than 170 streams of the DR are managed in Minnesota for trout sport fishing, with considerable impact on local economies, estimated in 2008 by Trout Unlimited to be valued at 1.1 billion dollars. In contrast to the DR, glaciated regions of central MN have differing surficial landscapes and underlying geology, resulting in short stretches of stream that often receive flow from lakes and larger, more diffuse lateral wetlands, that feed streams as more diffuse groundwater discharge directly to stream courses, resulting in less buffered stream temperatures and warmer summer water temperatures. With this project, we are proposing to investigate and model winter dynamics of stream temperature buffering, trout movement and roles of lakes and/or wetlands as refugia in winter, so that management efforts can be targeted to marginal trout streams intended to reduce the impact of increasing thermal regimes predicted by global warming models.

II. PROJECT ACTIVITIES AND OUTCOMES: We will intensively map and sample eight streams/year that span a wide range of groundwater input intensities, and differ in geologic setting (compared to streams of the DR) to generate results leading to improved habitat management guidance. Our specific objectives are to:

- identify how groundwater, air temperature, and geology of central MN differ from conditions of the DR, and interact to determine habitat and fish movement patterns in this contrasting geologic landscape;
• understand how the changes in geology & groundwater input affect stream temperatures and therefore influence food availability during winter, and ultimately trout growth, movement and abundance;
• create quantitative models relating winter thermal regimes to food availability for trout consumption;
• quantify and model trout movements in winter in relation to groundwater inputs/thermal regimes;
• recommend ways that our quantitative models can guide efforts to enhance trout productivity via habitat modifications to protect or improve stream temperature or refugia, with a focus on the winter period;
• Trout in Minnesota's streams have great economic, sport and aesthetic importance. Trout depend on cold, clean stream water, a resource threatened by gradual groundwater warming. Minnesota's environmental managers and landowners need to understand what actions can reduce impacts of warming and by how much. Consequently, we will develop a web-based program that educates and utilizes citizen volunteers to assist monitoring the dynamics of winter-emerging populations of aquatic insects in a large number of trout streams in central Minnesota.

Activity 1: Thermal Modeling and Winter Insect Abundances and Genetics

We will build on past research findings to model how groundwater inputs interact with geology and streambed conditions to buffer trout streams, and will determine how genetic patterns differ among abundant winter active insects, and how genetic variability aligns with abundances as a function of water temperatures across streams.

Description: Activity 1 will allow us to predict ranges of thermal suitability for brook trout, and how they vary among streams, which will enable managers to position and tune restoration efforts with greatest impact in extending the moderating influence of groundwater on stream temperature. We will use historical and newly measured air and water temperatures (8 streams/yr.) to map groundwater influences at fine spatial scales. Models we develop will relate local geological conditions to a statistical model for prioritizing management actions. We anticipate the models will contrast with results of our previous/current LCCMR-funded projects based in the DR. We will determine the genetic patterns of winter-active insects, and how their genetic variability aligns with abundances and water temperatures across streams. ENRTF BUDGET: \$ 261,653

Table with 2 columns: Outcomes Activity 1: The following outcomes will be accomplished in 8 streams/year, Completion Date. Rows include: 1. Yr 1: Develop thermal models (TM) 8 streams; determine insect genetic patterns (June 2021), 2. Yr 2: Develop TM for 8 more streams; collect/determine genetic patterns of insects (June 2022), 3. Yr 3: Develop TM for 8 more streams; collect/determine genetic patterns of insects (June 2023)



Activity 2: Assess brook trout (BKT) movement in relative to groundwater, invertebrate emergence, and winter habitat.

Description: Though much is known about summer movement of BKT, winter movement is less well understood, especially as it relates to water temperature and insect emergence. It is important to understand whether BKT overwinter in streams, or leave streams to enter deeper water lake habitats (that may act as winter refugia) and how this movement choice is related to water temperature and, consequently, groundwater input. The goal of this activity is to assess winter trout movement in relationship to stream groundwater inputs, winter insect emergence patterns, and winter refugial habitat in central Minnesota streams. Fish sampling will be coordinated with insect and water temperature sampling from Activity 1. BKT will be implanted with passive integrated transponder (PIT) tags and tracked by 1) two fixed antennae stations which will record BKT passage remotely and 2) manually using a hand held locator. Finally, BKT movement patterns will be related to winter water temperature and insect emergence data from Activity 1

ENRTF BUDGET: \$ 295,222

Outcomes: Brook Trout (BKT) Movements	Completion Date
1. Yr 1: Install two fixed stations (November) to remotely monitor brook trout movement to potential winter refuges and measure in-stream habitat variables for modeling	June 2021
2. Yr 2: Supplement brook trout movement via fixed station with tracking using handheld antennae, continue measuring in-stream habitat variables in additional streams	June 2022
3. Yr 3: Correlate brook trout movement patterns with both water temperature data and insect emergence data from Activity 1, refine and finalize modeling activities	June 2023

Activity 3: Develop a communication and educational research and outreach program

Description: The goal of the communication and outreach program is to improve public engagement with science and to increase understanding of how specific actions impact trout stream conditions. The engagement of community volunteers or “citizen scientists” will be a key to the success of this communication program and research project. The study will focus on discovering how to best reach, engage and motivate citizen volunteers as they become aware of the project and actively participate. Roles that citizen science plays can have great impact on local communities, as well as influence economic factors for other Minnesota areas relying upon tourism revenue. Other audiences include landowners in NW MN, stakeholders, and conservation organizations, especially as we must gain access to both public and privately owned land to collect data. Research based upon our communications plan will determine the perceived benefits and motivations for participating in a citizen natural resource monitoring program and will evaluate the engagement needs of these citizen scientists. Focus groups and survey research will be conducted to gain insight into the participants’ experiences, attitudes and behaviors in regards to this project. Based on this study, outreach materials (e.g., training videos, online media groups, websites) will be developed to recruit, engage and retain Minnesotans as active citizen monitors, especially during winter. Stakeholders include outdoor recreationalists, 4-H clubs, nature centers, K - 12 educators, Trout Unlimited, and Minnesota Master Naturalists.

ENRTF BUDGET: \$ 210,185

Outcomes: Develop communication, educational research & and outreach programs	Completion Date
1. Yr 1: Determine benefits, motivations, and engagement needs of key stakeholders	August 2021
2. Yr 2: Develop and refine outreach materials and platforms for engaging stakeholders	August 2022
3. Yr 3: Implement and evaluate effectiveness of outreach products for key stakeholders	June 2023

III. PROJECT PARTNERS AND COLLABORATORS: We have coordinated with personnel at regional DNR fisheries offices in the central region, and have already obtained access to some historical water temperature data. We will coordinate with managers & staff to involve them in our planning and execution of our project. We will coordinate with Drs. Jim Perry and Bruce Vondracek (who have been part of our previous research teams).

IV. LONG-TERM IMPLEMENTATION AND FUNDING: We will continue to work with fisheries biologists and coordinate with Trout Unlimited to keep them informed of our findings. We will continue to seek funding from other sources during the execution of this project to leverage LCCMR-funded efforts, and use University-based internships, work-study and Undergraduate Research Opportunities as resources to extend our student staff.

Attachment A: Project Budget Spreadsheet
 Environment and Natural Resources Trust Fund
 M.L. 2020 Budget Spreadsheet

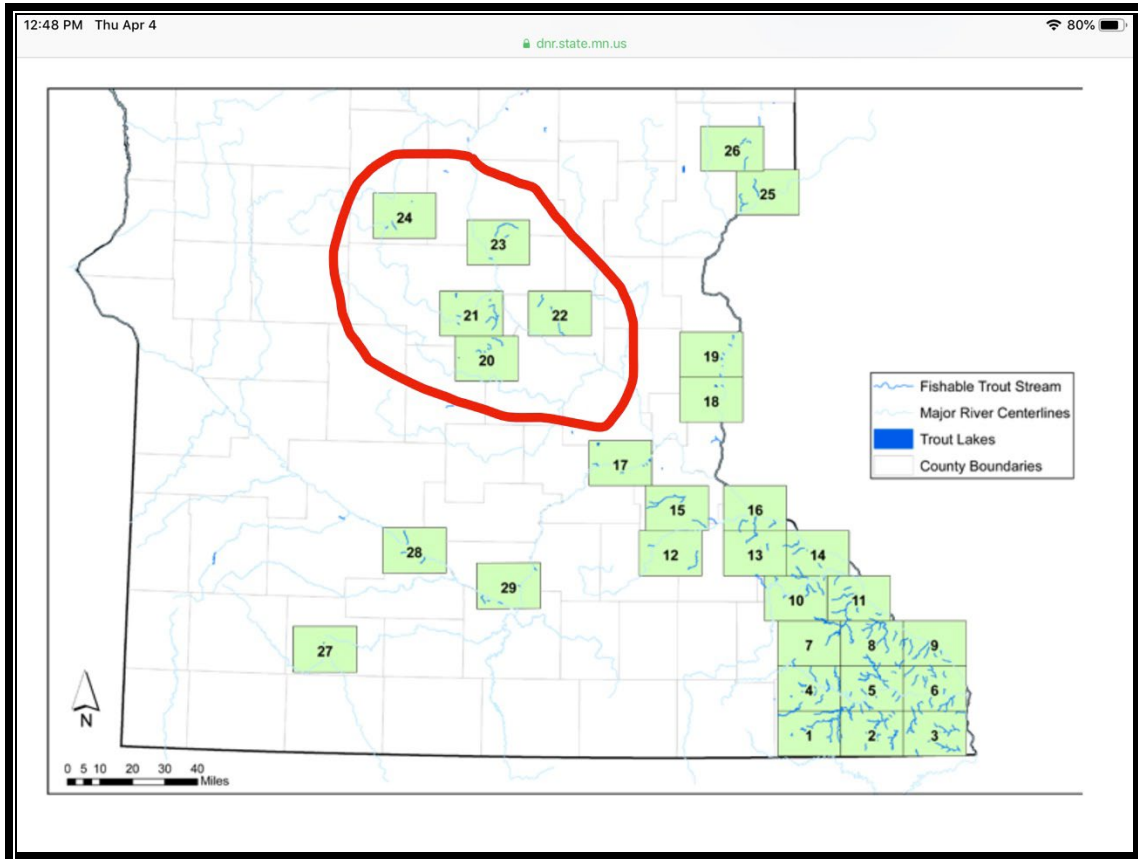


Legal Citation:
 Project Manager: **Leonard C. Ferrington Jr.**
 Project Title: **Winter Dynamics of Vulnerable Trout Streams: Central Minnesota**
 Organization: **University of Minnesota**
 Project Budget: **\$ 767,060**
 Project Length and Completion Date: **1 July 2020-30 June 2023**
 Today's Date: **9 April 2019**

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET		Budget	Amount Spent	Balance
BUDGET ITEM				
Personnel (Wages and Benefits)		\$ 630,962	\$ -	\$ 630,962
ACTIVITY 1: Ferrington, PI; manage grant and Activity 1. 9.1% effort all 3 years. Salary \$ 33267 (74%) Fringe benefits \$ 11977 (26%). (FTE = 0.091/year for all three years). / Graduate Research Assistant , one for Activity 1 , 12 mo/yr., 50% appointment, all 3 yrs. Salary \$ 73693 (86%) FB \$ 11865 (14%). (FTE = 0.50/year for all three years). / Undergraduate hourly technician , one for Activity 1 . (15 hrs/wk, 36 weeks/yr, all three years) @ \$11.25/hr. Salary = \$ 18777 (100%) FB \$ 0 (0%). (FTE = 265/year for all three years) / Tuition stipend for Graduate Student Research Assistant: One for Activity 1 . Total amount for all 3 years = \$ 50788.				
ACTIVITY 2: Schrank, Co-PI; manage Activity 2 , 2 months effort all 3 yrs. Salary \$ 45869 (74%) FB \$ 16513 (26%). (FTE = .20/year for all three years). / Graduate Research Assistant , one for Activity 2, 12 mo/yr., 50% appointment, all 3 yrs. Salary \$ 75213 (86%) FB \$ 12109 (14%). (FTE = .50/year for all three years). / Undergraduate hourly technician , one for Activity 2. (40 hrs/wk, 20 weeks/yr, all three years) @ \$11.25/hr. Salary = \$ 27818 (100%) FB \$ 0 (0%). (FTE = 0.385/year for all three years) / Tuition stipend for Graduate Student Research Assistant: One for Activity 2 . Total amount for all three years = \$ 50788.				
ACTIVITY 3: Swenson, Co-PI; manage Activity 3 , 1 month effort all 3 yrs, Salary \$ 31359 (74%) FB \$ 11289 (26%). (FTE = 0.10/year for all three years) / McKay , cooperating investigator Activity 3 @ one mo/yr. Salary \$ 25867 (74%) FB \$ 9312 (26%). (FTE = 0.10/year for all three years). / Steede , cooperating investigator Activity 3 @ one mo/yr. Salary \$ 22633 (74%) FB \$ 8148 (26%). (FTE = 0.10/year for all three years) / Graduate Research Assistant , one for Activity 3 , 12 mo/yr., 25% appointment, all 3 yrs. Salary \$ 37792 (86%) FB \$ 6085 (14%). (FTE = 0.25/year for all three years). / Undergraduate hourly technician , two for Activity 3 . (10 hrs/wk, 35 weeks/yr, all three years) @ \$11.25/hr. Salary = \$ 24341 (100%) FB \$ 0 (0%). (FTE = 0.343/year for all three years) / Tuition stipend for Graduate Student Research Assistant: One/half for Activity 3 . Total amount for all three years = \$ 25460.				
Equipment/Tools/Supplies: Activity 1 ---MtDNA Analyses (\$8/sample, 600 samples/yr., all 3 yrs)= \$14763; Temperature recording devices (40/year, for two years @ \$ 125.00/device)= \$ 10125; Misc consummable field and laboratory supplies total fro all 3 yrs = \$ 8000; Licenses and state park entry fees, all 3 years = \$ 692.		\$ 33,580		\$ 33,580
Equipment/Tools/Supplies: Activity 2 --- Tagging equipment, PIT tags and injectors: \$7000; Miscellaneous field equipment: Rite in the Rain paper, buckets, sharpies, label tape, thermometers, batteries, field preservatives and solutions, Whirl-pacs, sample jars, forceps. buckets: \$5000.		\$ 12,000	\$ -	\$ 12,000
Capital Expenditures Over \$5,000				
Activity 2: Two in-stream remote fish passage data collection arrays: (\$ 6552 x 2)= \$13,104		\$ 13,104	\$ -	\$ 13,104
Printing				
Publication of reports and research results of Activity 1 = \$ 2000., Activity 3 Communication Campaign material development & printing costs = \$ 5000		\$ 7,000	\$ -	\$ 7,000
Travel expenses in Minnesota				
Vehicle Rental: Vehicle rental for use in all Activities (5 months/yr @ \$ 912/mo. For all 3 years) = \$ 13680 (NOTE-The full amount of vehicle rental is part of budget for Activity 2 and Co-PI Schrank will keep track of rental fee): Activity 1: 400 miles/yr for 3 years = \$ 6581; lodging (21 nights @ \$ 94.00/night X 2 people for all 3 years) = \$ 12143; Per diem (\$ 55/day, 21 days, X 2 people for all 3 years) = \$ 7105. Activity 2: Mileage (2,500/yr @ \$0.23/mile) = \$ 1725; Lodging (2 people: \$94 per night for 60 nights for all 3 years) = \$ 16380; Per diem (2 people: \$55 per day 60 days for all three years) = \$ 9900. / Activity 3: Mileage (travel for interviews/focus groups with landowners and stakeholders) = \$ 1000.		\$ 68,514	\$ -	\$ 68,514
Other: Expenses for Activity 3 (Interviews, focus group meeting participant costs) Participant incentive for focus groups = \$1200; Participant incentives for surveys \$200; Food, building rental, printing for focus group activities = \$ 500.		\$ 1,900	\$ -	\$ 1,900
COLUMN TOTAL		\$ 767,060	\$ -	\$ 767,060
SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT				
	Status (secured or pending)	Budget	Spent	Balance
Non-State:		\$ -	\$ -	\$ -
State:		\$ -	\$ -	\$ -
In kind:		\$ -	\$ -	\$ -
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS		Amount legally obligated but not yet spent	Budget	Spent
Improve Trout-Stream Management by Understanding Variable Winter Thermal Conditions Subd 031 \$ 400,000 TF Leonard C. Ferrington PI.		\$ 98,936	\$ 400,000	\$ 29,806
				\$ 370,194

B. Visual Component or Map

Map (below) showing locations of streams that will form the basis for this study. Actual streams will be selected after consultation with Fisheries Biologists at regional offices of the Minnesota DNR, but will include at least one stream from each of the maps that are circled (maps 20, 21, 22, 23, 24). (Map included below was modified from the map publically available on-line @ dnr.state.mn.us)



PROJECT TITLE: Winter Dynamics of Vulnerable Trout Streams: Central Minnesota

Project Manager and Collaborator Qualifications

Leonard C. Ferrington Jr. has maintained an active research program dealing with responses of aquatic invertebrates to water quality conditions for 38 years, and is a specialist in the ecology, taxonomy and systematics of aquatic insects, with a focus on cold-adapted aquatic insects active in winter. He is a professor in the Department of Entomology at the University of Minnesota (2000-2019) and served for six years as co-director of the Environmental Sciences, Policy & Management undergraduate degree program in the College of Foods, Agricultural and Natural Resources Sciences. He presently is a track coordinator for this same degree program. He has been PI or Co-PI on more than 5.1 million dollars of grant-funded research projects, with funding from the NSF, USGS, National Park Service, US EPA, US Department of Energy, Minnesota SeaGrants, MN LCCMR, and various private contract labs involved in environmental monitoring and assessment. He has published 107 peer-reviewed journal articles and 40 technical articles. He has contributed chapters to three editions of the Aquatic Insects of North America (the primary identification text for aquatic insects in North America) and wrote two sections in “*Freshwater Animal Diversity Assessment*” (Hydrobiology 198, 2008), which was a collective effort of 163 experts commissioned by the European Union International Convention on Biological Diversity and funded by DIVERSITAS. Len will serve as project PI and be responsible for overall project management, and will supervise day-to-day duties of personnel related to Activity 1.

<http://midge.cfans.umn.edu/current-fellows/ferrington>

Rebecca Swenson is an Assistant Professor in the Agricultural Education, Communication & Marketing program within the Department of Applied Economics. Her research is related to education, outreach, assessment and communication, and she specializes in public and social media as platforms for science education and communication. She has published numerous articles in research and trade journals, and will interact with stake holder groups related to the topic of trout stream management and recreational use, including public attitudes and morés. Rebecca will participate as a Co-PI and supervise day-to-day duties of our new research team members, co-operating investigators Troy McKay and Garrett Steede, and other personnel related to Activity 3.

<https://ag-ed.cfans.umn.edu/about/people/rebecca-swenson>

Amy Schrank is an Adjunct Assistant Professor in the Department of Fisheries, Wildlife and Conservation Biology. Her formal graduate training is as aquatic ecologist. Her research skills and active projects are related to 1) fish movement patterns and community dynamics, 2) aquatic terrestrial links, and 3) the effects of human impacts on aquatic systems. She has previously focused on movement patterns in inland cutthroat trout (*Oncorhynchus clarki utah*), and contributed to formulating management and conservation recommendations. Amy will participate as a Co-PI and supervise day-to-day duties of personnel related to Activity 2.

<https://fwcb.cfans.umn.edu/personnel/amy-schrank>

ORGANIZATION DESCRIPTION: All Co-PI's and collaborators are members of the College of Foods, Agricultural and Natural Resources Sciences (CFANS) at the University of Minnesota, and have sufficient office and lab space to successfully complete the tasks and objectives proposed for this research project. In addition, they have all necessary field and laboratory equipment for field collection and lab-processing of field samples.