



Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-274

Proposal Title: Winter Dynamics of Vulnerable Trout Streams: Central Minnesota

Project Manager Information

Name: Leonard Ferrington

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Basic Information

Project Summary: Warming temperatures resulting from global warming will affect trout populations in Minnesota. Streams of central Minnesota are particularly vulnerable. We will model winter dynamics to identify the most vulnerable streams.

Funds Requested: \$520,000

Proposed Project Completion: 2024-06-30

LCCMR Funding Category: Methods to Protect, Restore, and Enhance Land, Water, and Habitat (F)

Project Location

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

Region(s): Central

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

Region(s): Central

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.

Populations of trout in streams of central Minnesota are vulnerable to increasing warming with changing climate. Ferrington (PI) has studied winter dynamics of trout streams in the Driftless Region (DR) of Minnesota. The DR was not glaciated during recent glaciation of MN and the geology includes extensive karst landscape conducive to groundwater flows that re-surface at springs or seepages and buffer temperature regimes of streams. Resurfacing groundwater keeps streams cold in summer (but warm in winter!), creating quality habitat for trout. More than 185 streams managed in Minnesota for trout sport fishing provide economic impact to local communities which, estimated by Trout Unlimited (2008), was valued at 1.1 billion dollars. In contrast to the DR, glaciated regions of central MN have differing surficial landscapes and geology, resulting in short streams that receive more diffuse groundwater from wetlands, seeps and lakes directly into stream courses, resulting in less buffered and warmer summer water temperatures. We propose to investigate and model winter dynamics of stream temperature buffering, and dynamics of winter active insects serving as food for trout, so management can be targeted to marginal trout streams to reduce the impact of increasing thermal regimes predicted by global warming models.

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.

PROPOSED ACTIONS LEADING TO SOLUTIONS:

We will intensively map and sample all trout streams of central Minnesota, shown on maps 18-24 provided on-line by the MN DNR (https://www.dnr.state.mn.us/fishing/trout_streams/south_mn_maps.html). These streams span a wide range of groundwater input intensities, and differ in geologic setting (compared to streams of the DR). We will generate results that lead 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 produce contrasting thermal regimes;
- understand how the changes in geology & groundwater input affect stream temperatures and therefore influence food availability for trout during winter, which directly control trout growth, and abundance;
- create quantitative Predictive Thermal Models that will be used to relate winter thermal regimes to food availability for trout;
- quantify and model insect emergence in winter in relation to groundwater inputs/thermal regimes;
- provide molecular profiles of winter-emerging insect species that can be used to determine patterns of growth, biomass and densities of insects that trout consume in winter;
- design interactive interfaces to transmit outcomes to stake-holder audiences in remote, on-line format.

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?

PROJECT OUTCOMES:

- Quantitative regression models for all 29 trout streams in central Minnesota;
- Recommendations based on quantitative models to enhance trout productivity via habitat modifications to protect or improve stream temperature, focusing on the winter period;
- Database of insect genetic patterns in relation to stream thermal regimes;
- Trout populations depend on cold, clean stream water, a resource threatened by climate warming. Environmental managers and landowners need to understand actions that can reduce impacts of warming. Consequently, we will develop digital materials that educate and utilize citizen volunteers to assist monitoring dynamics of winter-emerging aquatic insects in central Minnesota trout streams.

Activities and Milestones

Activity 1: Developing Predictive Thermal Model Relationships Between Ambient Air Temperatures and Daily Average Water Temperatures For Stream Sections in Trout Streams.

Activity Budget: \$92,772

Activity Description:

We will build on past research findings relating predictive modeling of how groundwater inputs interact with geology and streambed conditions to buffer water temperatures of trout streams. This will allow us to predict ranges of thermal suitability for maximum growth of different trout species in winter, and how the conditions vary within and 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 both historical and newly-measured air and water temperatures (we can collect & process data for 9 or 10 streams/yr.) to map groundwater influences at fine spatial scales. The predictive models we propose to develop will relate local geological conditions to a statistical model for prioritizing management actions. We will use the same field designs and lab techniques that we developed and refined during our previous and current LCCMR-funded projects based in the Driftless Region of SE Minnesota so that results of this project will be comparable and statistical contrasts at large spatial scales within Minnesota will be valid. The predictive models will allow us to recommend areas of priority for stream restoration and habitat modification efforts.

Activity Milestones:

Description	Completion Date
Collect temperature data and develop predictive thermal models (PTM) for 10 of 29 streams.	2022-06-30
Collect temperature data and develop predictive thermal models (PTM) for additional 10 of 29 streams	2023-06-30
Collect temperature data and develop predictive thermal models (PTM) for final 9 of 29 streams	2024-06-30

Activity 2: Assess emergence patterns of aquatic insect species active in winter and determine their genetic structure.

Activity Budget: \$228,225

Activity Description:

Our recent research discoveries show that emergence of aquatic insects in winter serves as one of the primary food for trout, and that trout eat large numbers of adults during emergence peaks. More than 30 species emerge during winter in streams of the DR. Emergences of the insects are highly variable among streams, over time throughout winter, and across different stream sites even within a stream. We are currently using newly developed molecular techniques that target mitochondrial and nuclear gene markers to differentiate species that are poorly defined morphologically, or are newly discovered. Several lines of evidence suggests that the differing genetic compositions could indicate species with differing thermal preferences in the streams, which may result in different abundances, growth rates and/or nutritional value for trout. Better understanding the insect dynamics will allow improved estimates of stocking rates and carrying capacity of trout among streams, and even longitudinally within streams. We will use the same methods we developed for our research of winter insect patterns in the DR. This includes monthly collections of larvae from stream bottom substrates, and adults from on snow banks near streams, to estimate emergence peaks, and quantify insect mass, in addition to genetic structure.

Activity Milestones:

Description	Completion Date
Monthly collections of larvae and adults (Dec-Feb) first 10 streams, all sites; determine genetic structure	2022-06-30
Monthly collections of larvae and adults (Dec-Feb) second 10 streams, all sites; determine genetic structure	2023-06-30
Monthly collections of larvae and adults (Dec-Feb) remaining 9 streams, all sites; determine genetic structure	2024-06-30

Activity 3: Identify stakeholder groups and coordinate with them to develop and refine communication strategies and educational research and outreach programs

Activity Budget: \$199,003

Activity Description:

Responding to Covid-19, K-12 classrooms, college campuses, businesses, and social life have pivoted to include significant online components. Our goal is to build online content that will keep classrooms and citizen volunteers engaged with science, scientists, and the environment, regardless of whether learning is in-person or remote. We will produce virtual content for K-12 students, teachers, conservation organizations, and outreach educators that will increase understanding of stream food webs and connections between healthy stream habitat, aquatic insects, and trout populations. We will create modules in which virtual field trips and online presentations (both live-streamed and archived) can be combined with lesson plans to illustrate concepts directly useful for educators and the public. In addition, we will encourage audience members to participate as community volunteers in our stream research via an online platform that includes data collection instructions and opportunities to connect with researchers. During year one, we will create pilot lesson plans and educational videos, and conduct focus groups/interviews with audience members to discover how we might make content more engaging and effective. Based on this research, additional materials will be developed during year 2-3 for key stakeholders, K-12 educators, extension educators, Trout Unlimited, 4-H clubs, and outdoor enthusiasts.

Activity Milestones:

Description	Completion Date
Identify Stakeholder groups, develop draft outreach materials, and prepare citizen science volunteers for winter sampling	2022-06-30
Evaluate effectiveness of citizen science participation, and educational materials, improve outreach and communication protocols	2023-06-30
Expand content and reach of educational outreach program, and add improvements and implement newest technologies	2024-06-30

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Troy McKay	Agricultural Education Program, Department of Applied Economics, CFANS, University of Minnesota	Dr. McKay will provide leadership and day-to-day coordination of tasks related to Activity 3. He, and undergraduate students working with him, will perform video recordings, editing and arranging video segments, voice-overs of audio, and coordinating on-line programming.	No
Dr. Bruce Vondracek	Emeritus Faculty, Department of Fisheries, Wildlife and Conservation Biology, CFANS, University of Minnesota, and US Fisheries Cooperative Program of the US Fish & Wildlife Service	Bruce Vondracek will be a volunteer member of our research team where he will advise on research design, data interpretation and technical report productions. He will assist supervising field teams. He will also provide assistance and coordination related to information transfer, and reporting results to US Fish and Wildlife Service.	No
Dr. James Perry	Department of Fisheries, Wildlife and Conservation Biology, CFANS, University of Minnesota	Dr. Perry will be a volunteer member of our research team where he will advise students on research design, data analysis and interpretation, and technical report production. He continues to maintain, an active research program dealing with aquatic ecology and policy initiatives for 38 years.	No
Dr. Amy Schrank	Minnesota Sea Grants Program & adjunct faculty member in the Department of Fisheries, Wildlife and Conservation Ecology, CFANS, University of Minnesota	Dr. Schrank will coordinate on tasks related to Activity 3, and will facilitate information transfer between public programs coordinated by Minnesota Sea Grants and the public education, outreach and Citizen Volunteer initiatives related to Activity 3.	No
Rebecca Swenson	Agricultural Education Program, Department of Applied	Dr. Swenson will serve as the Co-Project coordinator. She will supervise all tasks related to Activity 3, and will provide leadership and assistance will overall project coordination. She will serve as faculty research advisor for the GRA assigned to Activity 3, and will lead production of scientific and technical publications.	No

	Economics, CFANS, University of Minnesota		
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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?

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 identify areas in streams where thermal regimes are at or near levels that are likely to be sensitive to increasing to environmental warming predicted by climate change models for central Minnesota. 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 expand and extend the efforts of our student work force.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Improve Trout-Stream Management by Understanding Variable Winter Thermal Conditions	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 03i	\$400,000

Project Manager and Organization Qualifications

Project Manager Name: Leonard Ferrington

Job Title: Professor

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

Leonard C. Ferrington Jr. has maintained an active research program dealing with responses of aquatic invertebrates to water quality conditions for 39 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 that serve as diets for trout. He is a professor in the Department of Entomology at the University of Minnesota (2000-present) 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 four 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 Activities 1 and 2. See web site at --- <http://midge.cfans.umn.edu/current-fellows/ferrington>

Organization: U of MN - College of Food, Agriculture and Natural Resource Sciences

Organization Description:

The Department of Entomology does research related to the significance of insects in relation to agriculture, forestry,

fisheries and other areas of terrestrial and aquatic systems. The department also has Extension, Outreach and Service responsibilities related to insect management and public education. Faculty direct their individual research and service programs. Many research efforts are multi-disciplinary and interface with other research groups, both within the University of Minnesota and elsewhere. The persons involved with this research proposal are part of an interdisciplinary group that has worked together for 3-9 years on several projects related to predictive modeling of stream thermal regimes, the health of trout and trout habitats in Minnesota, and winter dynamics of aquatic insects. We have also worked with stakeholders involved in stream management or as Citizen Volunteers. The projects have been managed by Leonard Ferrington, who is a faculty member of the Department of Entomology (see web site for more details- <https://midge.cfans.umn.edu/current-fellows/ferrington>). The research laboratories are fully equipped for the type of research proposed in this application, and lab spaces are all located on the Saint Paul campus of the University of Minnesota.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Project Supervisor (Ferrington)		Ferrington will provide overall project coordination and day-to-day supervision of tasks related to Activities 1 & 2.			36.5%	0.3		\$54,806
Co-Project Manager (Swenson)		Swenson will supervise all personnel performing tasks related to Activity 3, and will assist with overall project coordination.			36.5%	0.3		\$44,283
Cooperating Investigator (McKay)		McKay will provide day-to-day leadership and supervision of tasks related to Activity 3			36.5%	0.3		\$36,014
Cooperating Investigator (Schrank)		Schrank will provide leadership related to tasks associated with Activity 3, and will facilitate transfer of results to Minnesota Sea Grants section for Public Programs			36.5%	0.12		\$13,737
Graduate Research Assistant (Entomology Position)		The Entomology GRA will perform tasks associated with Activities 1 & 2, including field collection of insect samples, sample processing, data analysis, thermal modeling, and genetic analyses.			19.9%	1.5		\$92,320
Graduate Research Assistant (Agricultural Education Position)		The Agricultural Education GRA will perform all tasks associated with Activity 3, including coordinating with stake holders, developing educational materials and coordinating Citizen Volunteer efforts and outreach.			19.9%	0.75		\$45,746
Four Undergraduate Student Hourly Assistants (Unnamed, each averaging 27% Annual FTE)		Assist with field work, sample collection, specimen sorting, data computerization, curation and day-to-day lab processes and clean-up.			0%	3.24		\$73,136
							Sub Total	\$360,042

Contracts and Services									
								Sub Total	-
Equipment, Tools, and Supplies									
	Tools and Supplies	Activity 2: Sample jars, collecting nets and sieves, microscope slides, shelf vials, reagents for genetic analyses, specimen preservatives, forceps preservatives, slide storage boxes, and disposable clean-up and sanitizing supplies.	Disposable field and laboratory supplies for sample collection, lab process, genetic analyses, specimen curation and measurement, long term storage and analyses						\$19,251
	Tools and Supplies	Tools: Activity 1--- Electronic water temperature recording devices for field acquisition of temperature data. 50 devices @ \$ 135/device.	In situ recording of water temperatures at hourly intervals at 50 sites/year.						\$6,950
	Tools and Supplies	Activity 3: Disposable project supplies, printing, material development, information storage devices, participant incentives, mailings	All are related to outreach activities, production of educational modules and communication/delivery of products.						\$7,900
								Sub Total	\$34,101
Capital Expenditures									
								Sub Total	-
Acquisitions and Stewardship									
								Sub Total	-
Travel In Minnesota									
	Miles/ Meals/ Lodging	Travel related to Activities 1 & 2, to place electronic recording devices in streams, to collect biological samples at stream sample sites and retrieve recording devices after data are recorded. Includes costs of vehicle rentals, mileage, lodging and per diem.	Travel to sample sites at streams, every three months in winter each year to collect samples and download stream temperature recordings.						\$39,688
	Miles/ Meals/ Lodging	Travel related to Activity 3: includes travel for participant interviews and outreach activities	Interviews, coordination of Citizen Volunteer activities and outreach						\$3,000
								Sub Total	\$42,688

Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
	Publication	Publication of results in professional journals, Activities 1 & 2. Anticipate 2/3 publications per year for each year of the project.	Communicate research results to peers and to stakeholders in formal research and trade journals					\$5,400
							Sub Total	\$5,400
Other Expenses								
		Purchase of permits	Permits are required to enter and sample in most state parks and must be obtained for special scientific and natural areas. Permits must be purchased annually for all persons performing field work.					\$695
		Tuition Fees for Graduate Research Assistants.	All GRA must be enrolled in graduate programs, and tuition reimbursement is required to be provided from research grants that the students are involved in for their thesis or dissertation research. Consequently, both GRA students employed in this research will integrate results from the project into their thesis or dissertation.					\$77,074
							Sub Total	\$77,769
							Grand Total	\$520,000

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
State				
			State Sub Total	-
Non-State				
			Non State Sub Total	-
			Funds Total	-

Attachments

Required Attachments

Visual Component

File: [ae917fa8-502.pdf](#)

Alternate Text for Visual Component

This visual shows a map prepared by the Minnesota DNR that provides on-line electronic access to detailed maps of trout streams in the states. Areas where we will do research are indicated within a black box, and includes all 29 trout streams on maps numbered 18-24. The streams are located north of the Minneapolis/Saint Paul metro, and bordered on the east by the Saint Croix River, on the West near Pope and Kandiyohi Counties and on the North to approximately the same latitude of the southern edge of Cloquet.

Optional Attachments

Support Letter or Other

Title	File
Fiscal Agent Statement and Letter of Endorsement	08f87062-661.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

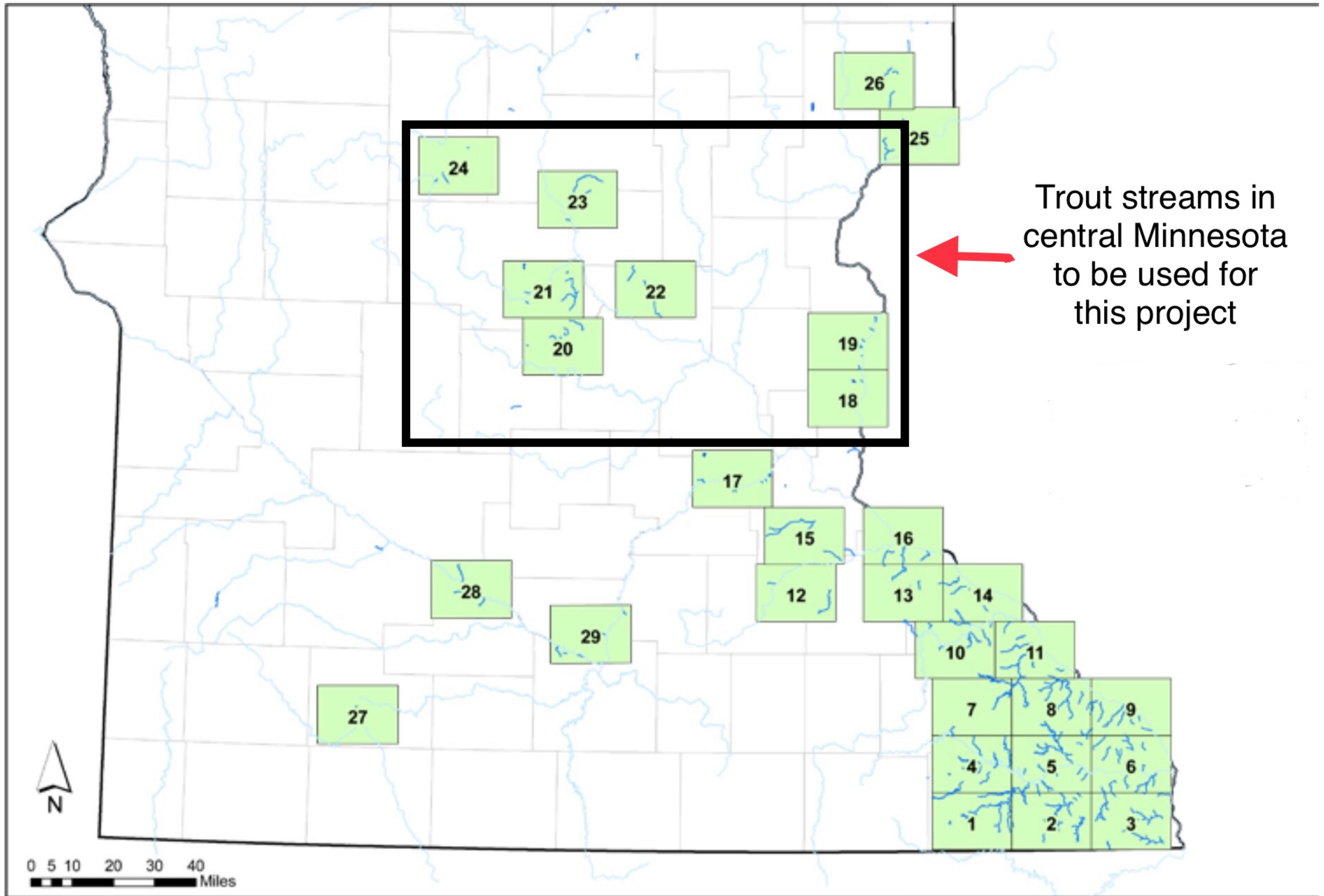
No

Does your project include research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration



Trout streams in central Minnesota to be used for this project