



# Environment and Natural Resources Trust Fund

## 2021 Request for Proposal

### General Information

**Proposal ID:** 2021-303

**Proposal Title:** Rainfall History Recovered from Old Oak Tree Rings

### Project Manager Information

**Name:** Daniel Griffin

**Organization:** U of MN, College of Liberal Arts

**Office Telephone:** (612) 625-2562

**Email:** griffin9@umn.edu

### Project Basic Information

**Project Summary:** Are southern and central Minnesota really getting wetter? We use tree rings from old growth bur oaks to compare recent rainfall extremes with changes over the past 300+ years.

**Funds Requested:** \$332,000

**Proposed Project Completion:** 2023-08-31

**LCCMR Funding Category:** Water Resources (B)

### Project Location

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

Region(s): Central, SE, SW, Metro,

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

Region(s): Central, Metro, SE, SW,

**When will the work impact occur?**

During the Project

## Narrative

**Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.**

SHOULD WATER RESOURCE STAKEHOLDERS IN SOUTHERN AND CENTRAL MINNESOTA BEGIN PLANNING FOR A “NEW NORMAL” WITH UNUSUALLY HIGH RAINFALL?

Farming, flood control, civil infrastructure, water management, and recreation are among the many sectors impacted by rainfall extremes and changes. Following a run of several wet years, 2019 was the wettest year on record for many parts of Minnesota. Was this a short-term fluctuation, or is our region shifting into a new wet period?

Not many Minnesota rain gauge records go back more than 100 years, limiting our long-term perspective on recent wetness, and preventing robust planning for sustainable management around natural rainfall cycles and possible future changes.

Tree rings can provide high quality information on rainfall for the past 300+ years, and they often reveal wet and dry events more extreme, persistent, and frequent than those in the modern record. In states like California and Colorado, water stakeholders have improved long term sustainability by incorporating tree ring records into hydrological models and worst-case planning for rainfall, streamflow, and groundwater. This project will develop tree ring data for southern and central Minnesota, where they do not currently exist, and recover 300+ years of rainfall history to guide sustainable water resources planning.

**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.**

TO RECOVER, UNDERSTAND, AND COMMUNICATE 300+ YEARS OF RAINFALL HISTORY IN SOUTHERN AND CENTRAL MINNESOTA, WE WILL:

1) DEVELOP NEW TREE RING RECORDS FOR SOUTHERN AND CENTRAL MINNESOTA.

We will collect and analyze tree-ring records from old growth bur oak on regional public properties. Tree-ring core samples will be gathered using methods that do not harm the trees. Samples will be scanned and processed into DendroElevator, an online platform for image analysis (<http://z.umn.edu/treerings>). The new online database developed by this project will be open to the public and suitable for student and citizen science research, and for science education.

2) USE TREE RINGS TO UNDERSTAND 300+ YEARS OF REGIONAL RAINFALL HISTORY.

We will reconstruct 300+ years of regional rainfall history through a systematic and comprehensive analysis integrating tree rings, rain gauge data, and simple statistics. We will characterize the magnitude, frequency, and duration of dry and wet episodes, and we will evaluate the recent wet period in a robust, long-term context. To guide water resource managers and stakeholders, our results will be shared online workshops similar to those run in western states (<http://treeflow.info>), and through project reports, websites, and social media.

**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?**

To plan for sustainable management around precipitation, streamflow, groundwater, flood control, civil infrastructure, natural ecosystems, and agriculture, this project will provide unique and high quality information about the long-term history of rainfall in southern and central Minnesota. The quantitative information produced by the project will be suitable for inclusion in hydrological modeling and scenario planning.



## Activities and Milestones

### Activity 1: DEVELOP NEW TREE RING RECORDS FOR SOUTHERN AND CENTRAL MINNESOTA

**Activity Budget:** \$256,603

**Activity Description:**

Our pilot study research indicates that old growth oak trees can be found on many public properties in southern and central Minnesota, and that these oak tree rings contain valuable information on rainfall history for the past 300+ years. Wide rings form in wet years, and narrow rings form during dry years, and average ring width across trees is highly correlated with spatial and temporal patterns of rainfall. For approximately 30 trees at each of 15 public property sites, we will conduct non destructive tree-ring increment core sampling during the fall and winter, when there is no concern for transmitting oak wilt fungus (<http://z.umn.edu/oakwilt>). Tree-core samples will be scanned at ultra-high resolution and processed with the DendroElevator (<http://z.umn.edu/treerings>), an online platform for image analysis and tree-ring dating that was developed in our lab. All data developed in this project will be made available through a publicly accessible database that will be ideal for stakeholder, student, and citizen science research and education.

**Activity Milestones:**

Description	Completion Date
Complete tree-ring core sampling fieldwork	2022-03-31
Complete tree-ring image acquisition and processing	2022-08-31
Complete tree-ring dating and width measurement	2022-12-31

### Activity 2: USE TREE RINGS TO UNDERSTAND 300+ YEARS OF REGIONAL RAINFALL HISTORY

**Activity Budget:** \$75,397

**Activity Description:**

We will reconstruct 300+ years of rainfall history using a systematic analysis that integrates tree rings, rain gauge data, and simple statistics. First, we will use correlation with rain gauge data to understand the strength and seasonality of the tree ring signals across the network of 15 sites. We will then use simple linear regression to scale the tree-ring records into inches of rainfall. We will then analyze these rainfall patterns across space and time to address the following questions: Is there any evidence for long-term changes in rainfall? How does 2019 and the recent run of wet years compare to earlier events? How do other extreme wet years such as 2016, 2010, 1993, 1986, 1977, 1967, 1965, and 1951 compare with earlier extreme wet years? How do extreme dry years such as 2012, 1988, 1934, and 1910 compare with earlier extreme drought years? Were multi year wet and dry periods in the past more severe, persistent, or frequent than any during the last 100 years? To guide water resource managers and stakeholders, our results will be shared online workshops similar to those run in western states (<http://treeflow.info>), and through project reports, websites, and social media.

**Activity Milestones:**

Description	Completion Date
Complete statistical analysis of tree ring and rain gauge data	2023-05-31
Develop reports, factsheets, and social media posts on project findings	2023-07-31
Complete three online workshops to inform water management stakeholders and guide long-term rainfall planning	2023-08-31



## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Matthew Trumper	University of Minnesota Department of Geography	Matthew Trumper, co-PI, will be participating in all aspects of the research, with a primary role in fieldwork, lab analysis, supervising graduate student and undergraduate research assistant work, and reporting of outcomes over the life of the project.	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?**

This project will culminate in presentation of the tree-ring rainfall history through stakeholder workshops, websites, project reports, and scientific papers. This project leverages connections between University scientists and the DNR, including with the resources management division and the Minnesota State Climatology Office, and will produce new collaborative relationships between scientists and stakeholders.

## Project Manager and Organization Qualifications

**Project Manager Name:** Daniel Griffin

**Job Title:** Assistant Professor University of Minnesota

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

PROJECT MANAGER: Daniel Griffin, Ph.D.

Department of Geography, Environment & Society, University of Minnesota, Minneapolis, MN 55455

E-mail: griffin9@umn.edu; Phone: 612-625-2562; Website: <http://z.umn.edu/griffinlab>

### PROFESSIONAL APPOINTMENTS AND PREPARATION

Assistant Professor, Dept of Geography, University of Minnesota, 2014-present

UCAR Visiting Scientist, Woods Hole Oceanographic Institution, 2015

Post-doc, Woods Hole Oceanographic Institution, 2013-2014

Ph.D. (2013) University of Arizona

M.A. (2007) & B.S. (2002) University of Arkansas

### HONORS (SELECTED)

Woods Hole Oceanographic Institution Scholar

NOAA Climate Fellow

EPA STAR Fellow

### AREAS OF EXPERTISE

Tree ring analysis and interpretation; water resources; climate; old growth forests; coupled environmental dynamics

### PROJECT MANAGEMENT EXPERIENCE

Lead PI or co-PI on science research projects (total funding, >\$1 million), on tree rings, water, and climate with federal funding (NSF, NOAA, EPA).

#### PEER-REVIEWED PUBLICATIONS

40 scientific papers and book chapters on tree rings, rainfall, climate, and old growth, including several in high profile journals (Science, Nature Climate Change, Global Change Biology).

#### PROJECT MANAGEMENT QUALIFICATIONS FOR THIS PROJECT

Background in old-growth forests, tree ring data development and interpretation, and applications of tree rings for water resources management. Prior experience with studies of climate extremes and natural climate processes and patterns in Arizona, California, New Mexico, and North Carolina. Previous success leading large science projects and managing teams of scientists and students.

**Organization:** U of MN - Twin Cities

#### **Organization Description:**

The University of Minnesota is both the state land-grant university, with a strong tradition of education and public service, and the state's primary research university.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
1 Principal Investigator		Professor Griffin requests 1.5 months of summer salary support for years 1 and 2. In FY2021, salary support will cover project management, fieldwork and lab work for tree-ring data collection and development. In FY 2022, salary support will cover project management, numerical data analysis, report preparation, and dissemination of findings through workshops, websites, and reports. A 2% increase in salary is included for each year. Professor Griffin will also help oversee graduate and undergraduate assistants during the life of the project.			26.74%	0.3		\$36,146
1 Co-Principal Investigator		100% FTE salary support is requested for Trumper in years 1 and 2. Trumper will be participating in all aspects of the research, with a primary responsibility for executing activities over the life of the project, including supervising graduate student and undergraduate research assistant work. A 2% increase in salary is included for each year.			26.74%	2		\$154,409
1 Graduate Research Assistant		Support is requested to hire one graduate research assistant for 100% FTE in summer of project years 1 and 2, and 50% FTE in one academic year semesters of project year 1 (Spring 2022) and one academic year semester of project year 2 (Fall 2022). This student will assist in field data collection, lab data analysis, supervision of undergraduate research assistants, preparation of the final report, and dissemination of findings. A 2% increase in salary is included for each year.			42.6%	1.23		\$78,361
3 Undergraduate Research Assistants		Support is requested to hire three undergraduate student research assistants to assist with fieldwork, lab analysis, and data development over the life of the project. We anticipate paying these students \$15/hr, with a total allocation of 1800			0%	1.3		\$40,770



		hours in project year 1, and 900 hours in project year 2.						
							<b>Sub Total</b>	<b>\$309,686</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Dendrochronology field supplies	To accomplish the tree-ring sampling in project year 1, we request \$5,138 for Dendrochronology research supplies: 2-thread increment borers (6x 16", 2-thread increment borers, \$294 each ; 4x 20" increment borers, \$ 484 each; and 2x24" increment borers \$594 each); and \$250 for expendable straws to transport individual tree cores back to the lab.					\$5,138
	Tools and Supplies	Dendrochronology lab supplies	To accomplish the tree-ring specimen preparation and analysis in project year 1, we request \$2276 to cover one case of Leica model 818 microtome razor blades (\$1,670), sanding supplies (\$206), and wooden mounts for increment cores (\$400).					\$2,276
							<b>Sub Total</b>	<b>\$7,414</b>
<b>Capital Expenditures</b>								
		Smartborer	We request \$6,500 for the SMARTBORER(R) Smart increment borer (Smartborer™, PAT. P.) is a device for automatic sampling of increment cores. It adapts a drill to traditional increment borers and converts the high-speed, low-torque input from a battery-operated Makita electric wrench to a low-speed, high-					\$6,500

			torque output via planetary gear system. This will minimize effort and time required to sample 900 tree cores, and improve safety for researchers.					
							<b>Sub Total</b>	<b>\$6,500</b>
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	Travel for fieldwork to collect tree ring samples	Support is requested for field efforts including UMN Fleet Services motor pool rentals, mileage costs, and per diem rates for lodging and food. Vehicle mileage and vehicle rental for travel to field sites (personal vehicle mileage at \$0.58/mile and UMN Fleet Services vehicle rentals at \$51.00/day plus \$0.37/mile). For each of 15 sampling site trips, we anticipate spending \$400, including two days of vehicle usage, an average of 300 miles roundtrip travel, and one hotel room, and partial day per diem for food for three people.					\$6,000
							<b>Sub Total</b>	<b>\$6,000</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
	Publication	Page charges for two publications	We request \$2,400 for publication page charges in project year 2.					\$2,400
							<b>Sub Total</b>	<b>\$2,400</b>

<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	<b>\$332,000</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>				
			<b>Non State Sub Total</b>	-
			<b>Funds Total</b>	-

## Attachments

### Required Attachments

#### *Visual Component*

File: [58f94c11-a4e.pdf](#)

#### *Alternate Text for Visual Component*

This graphic includes images and charts for the two project activities.

#### ACTIVITY 1: DEVELOP NEW TREE RING RECORDS FOR SOUTHERN & CENTRAL MINNESOTA

- Photographs illustrate old growth bur oak trees like those that survive on public lands across Minnesota.
- State map illustrates the locations of our planned sampling sites, along with existing tree-ring data locations from northern Minnesota and Iowa. Text notes that our sites will fill a spatial gap where existing data are not currently available from southern & central Minnesota.
- Photograph illustrates a girl measuring tree-ring samples using our online database platform:  
<http://z.umn.edu/treerings>

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#### ACTIVITY 2: USE TREE RINGS TO UNDERSTAND 300+ YEARS OF REGIONAL RAINFALL HISTORY

- Photographs illustrate farm fields and flooded neighborhoods. Text notes that agriculture, flood control, and many other stakeholder groups need robust rainfall information for planning.
- Map illustrates that many counties in southern and central Minnesota had record high rainfall for the period 2016–2019.
- Graph illustrates Minnesota rainfall history from rain gauges, with 2019 as the wettest year on record, and text notes that rain gauge records are too short to understand long-term cycles & patterns of rainfall history.
- Graph illustrates an example of tree-ring reconstructed rainfall from Iowa for the past 400+ years. Long term wet periods are evident for the 1680s-1690s, 1770s, 1870s-1900s, and 1990s-2010s. Long term dry periods are noted for the 1600s-1670s, 1830s, and the 1930s Dustbowl Drought. Text asks the question: are recent wet years part of climate change, or natural cycles?

## 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

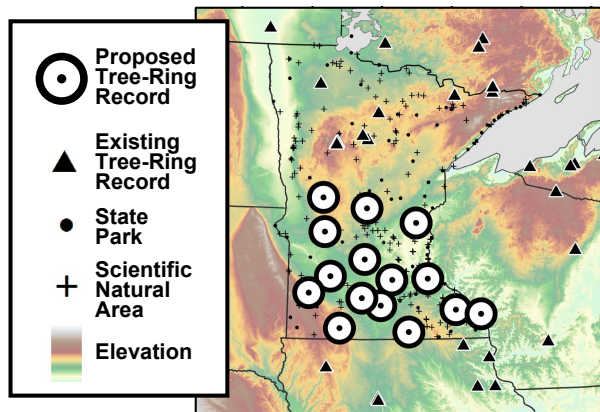
**Does the organization have a fiscal agent for this project?**

Yes, Sponsored Projects Administration

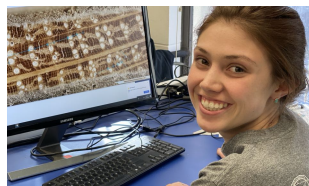
# ACTIVITY 1: DEVELOP NEW TREE RING RECORDS FOR SOUTHERN & CENTRAL MINNESOTA



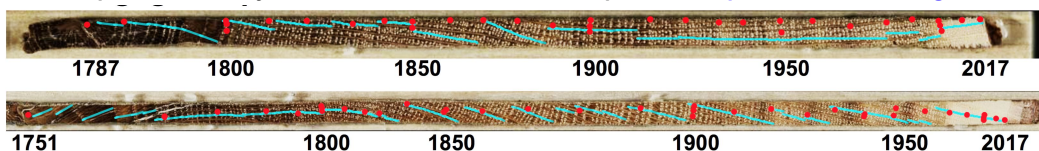
300+ Year old Bur Oak Trees survive On Public Lands Across Minnesota



Our New Tree-Ring Records Will Fill A Spatial Gap In Existing Data between Iowa & Northern Minnesota



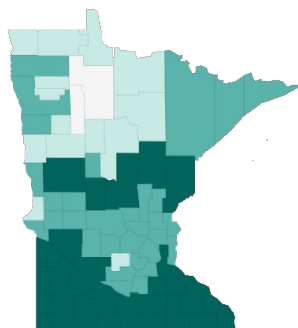
Tree ring cores will be gathered with methods that do not harm trees and samples will be analyzed with our new online database platform: <http://z.umn.edu/treerings>



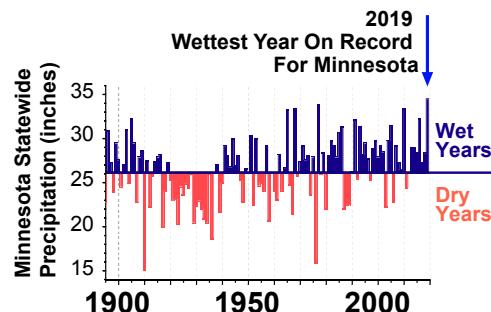
# ACTIVITY 2: USE TREE RINGS TO UNDERSTAND 300+ YEARS OF REGIONAL RAINFALL HISTORY



Agriculture, Flood Control & Many Other Stakeholders Groups Need Robust Rainfall Information for Planning



The Period 2016-2019 Had Record High Rainfall For Many Minnesota Counties



Rain Gauge Records Are Too Short To Understand Long-Term Cycles & Patterns Of Rainfall History

Are Recent Wet Years Part of Climate Change or Natural Cycles?  
An Example from Iowa on Tree-Ring Rainfall History for 400+ Years:

