

**Environment and Natural Resources Trust Fund
2015 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 098-E

Tree Productivity and Health Depend on Cold Winters

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

Total Project Budget: \$ 241,568

Proposed Project Time Period for the Funding Requested: 3 years, July 2015 - June 2018

Summary:

Cold temperatures are critical to tree life cycles. We will test the hypothesis that warmer winters may disrupt spring phenology, delaying budburst. Results will inform management strategies for climate change.

Name: Rebecca Montgomery

Sponsoring Organization: U of MN

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Web Address _____

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Images of buds, new leaves and fully expanded leaves. Bullet points encapsulating proposal. Problem: Counterintuitively, warmer winters could lead to delayed budburst. Solution: identify and monitor vulnerable species and adapt management to favor resilient species.

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



PROJECT TITLE: Tree productivity and health depend on cold winters

I. PROJECT STATEMENT

This project will identify tree species vulnerable to climate change because their life cycle will be disrupted by warm winters, and will thus enhance strategies that sustain productivity and ecosystem services of Minnesota forests. We will accomplish this by experimentally identifying those species whose budburst could be *delayed* by warm winters, and by predicting future growing season length for trees under a range of climate scenarios.

Forests cover 17.4 million acres or approximately one third of the state of Minnesota. These forests provide ecosystem services like fiber, fuel, carbon storage, clean water, clean air, and recreation. There is considerable uncertainty about the health and productivity of Minnesota's forests in the future. Across Minnesota temperatures have risen by ~2 degrees F over the last 50 years and are projected to rise by ~7-9 degrees F by the end of the century. Winters are warming faster than summers.

Warm winters threaten our forests. Without sufficient winter cold, trees may act strangely. For example, instead of leafing out earlier as generally expected, they may actually leaf out later. While this seems counterintuitive, the timing of budburst depends not only on spring warmth but also on winter cold. Trees must experience cold temperatures to effectively respond to the warmth and lengthening days of spring. At the extreme, a maple tree planted too far south will never leaf out because its buds haven't experienced enough chilling. Similarly, a tulip bulb that doesn't experience sufficient cold won't flower. Our preliminary experiments show that maple trees that experience fewer cold days during winter leaf out more slowly in spring. Thus, as winters warm, maple trees may actually show delayed leaf out. This will shorten the growing season and diminish the ecosystem services provided by that species. What other tree species could have shorter growing seasons because of warmer winters? We don't know.

As a result of this project, we will:

- identify tree species that are vulnerable to warmer winters associated with climate change
- predict potential changes in spring budburst and thus growing season length for trees in a warmer Minnesota
- provide data to natural resource managers for developing strategies that sustain forest productivity and ecosystem services in a changing climate

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Test 20 MN tree species for vulnerability to delayed budburst **Budget: \$ 131,417**
due to lack of winter chilling

We will experimentally manipulate the duration of chilling in 20 of Minnesota's 43 native winter deciduous species, by collecting cut branches every two weeks throughout the winter, starting in mid-December. Cut branches will be moved into warm conditions in greenhouses at the University of Minnesota-Twin Cities. We will include several levels of forcing temperatures (i.e. those that can "force" budburst). This will provide data on both winter cold and spring warmth as cues for budburst. We have used this technique successfully on several native tree species.



Outcome	Completion Date
<i>1. Vulnerability assessment of 20 tree species for propensity to delay budburst in warmer winters</i>	<i>June 2017</i>
<i>2. Webpages profiling vulnerable species & providing recommendations for action by forest managers for species at risk</i>	<i>January 2018</i>

Activity 2: Estimate future winter chilling and growing season length of vulnerable species **Budget: \$ 110,152**

We will use data from the MN Climatology Office to examine how winters have warmed. Specifically, we will calculate the rate at which climate stations across MN are changing in terms of the number of chilling hours or chilling days. We will then combine climate data with experimental results from Activity 1 on the sensitivity of tree species to chilling to project how the timing of budburst could change across the state in the future.

Outcome	Completion Date
<i>1. Tool to estimate the change in growing season length due to change in spring budburst given different climate change scenarios</i>	<i>June 2018</i>
<i>2. Projections for 20 MN tree species of change in budburst in the future</i>	<i>June 2018</i>
<i>3. Three statewide workshops for natural resources managers communicating our results and developing management strategies that sustain forest productivity in a changing climate</i>	<i>June 2018</i>

III. PROJECT STRATEGY

A. Project Team/Partners

Team. Rebecca Montgomery (Dept. of Forest Resources, FR-UMN) is the overall Project Manager (*in kind*). Peter Reich (FR-UMN) will collaborate (*in kind*). The following will receive ENTRF funds: one graduate student will lead winter chilling research and modeling (FR-UMN, 50% time); Chris Buyarski (FR-UMN, 25% time) will assist graduate student and lead dissemination through workshops and the web; one undergraduate student will provide research assistance on all aspects of the project.

B. Project Impact and Long-Term Strategy

Results will inform decisions by forests managers on species to favor through management activities such as timber harvesting, tree planting and seed zones. The University of Minnesota Department of Forest Resources and the Minnesota Phenology Network (MNP) will support the database and web dissemination after 2018. This project leverages current ENTRF funding: results will be validated using long-term phenology data and new data collected by the MNP.

C. Timeline Requirements

This project requires 3 years. Year 1: Conduct chilling experiments and begin compiling climate data. Year 2: Repeat chilling experiments to increase ability to generalize across different weather years and finish compiling climate data. Year 3: Develop future projections of budburst and change in growing season length and conduct workshops for natural resource managers.

2015 Detailed Project Budget

Project Title: Tree productivity and health depend on cold winters

IV. TOTAL ENRTF REQUEST BUDGET 3 years

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
Personnel:	
Chris Buyarski, Project coordinator (25% time), 66% salary 34% benefits, 3 yrs, soft money	\$ 78,244
Graduate Research Assistant (50% time), 55% salary, 45% benefits, 3 yrs, 1 person	\$ 113,400
Undergraduate students (10h/wk academic year r @ \$10/h, 93% salary, 7% benefits, 3 years, 1 person	\$ 24,487
Equipment/Tools/Supplies	
Supplies for greenhouse activities (buckets for cut branches [\$100], replacement light bulbs for growth chambers [\$200/yr], marking tape for branches [\$10])	\$ 710
Field supplies (flagging tape to mark trees, compasses to navigate in woods [1 @ \$40 each], snowshoes to get to trees in winter [3 @ \$125 each], field notebooks to record notes [2 @ \$10	\$ 435
Travel:	
Travel to collect branches (2 year * 12 trips * 2 person * 1 d * (mileage [250 mi/trip*0.565 cents/mile] + per diem/person [\$82 lodging + \$56 M&I]) per university reimbursement plan	\$ 10,014
Travel to conduct natural resource manager workshops: 1 year * 5 workshops * 2 persons * 1 d * (mileage [250 mi/workshop*0.565 cents/mile] + per diem [\$82 lodging + \$56 M&I]) per university reimbursement plan	\$ 2,086
Additional Budget Items:	
Greenhouse space rental (\$0.71/sq. ft./mo * 183 d * 400 sq. ft. * 2 yrs)	\$ 3,408
Growth chamber space rental (\$3/day * 8 chambers * 183 d * 2 yrs)	\$ 8,784
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 241,568

V. OTHER FUNDS

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
Other Non-State \$ To Be Applied To Project During Project Period:		
	N/A	
Other State \$ To Be Applied To Project During Project Period:		
	N/A	
In-kind Services To Be Applied To Project During Project Period		
Rebecca Montgomery, 1% effort per year	\$ 3,303	Secured
Peter Reich, 1% effort per year	\$ 8,490	Secured
Unrecovered indirect costs @ 52% of modified total direct cost base of \$193,940	\$ 100,849	Secured
Funding History:		
University of Minnesota Institute on the Environment Mini-Grant "Phenology: the Pulse of the Planet – developing science and engagement initiatives that explore plant and animal response to climate change"	\$ 2,500	
University of Minnesota Institute on Environment Resident Fellow Program "Minnesota Phenology Network (MnPN): an observer network to measure the pulse of the state and connect people to the land"	\$ 10,000	
University of Minnesota Institute on Environment Resident Fellow Grant "A Citizen Phenology Network to Inform Management of Urban Water Quality"	\$ 10,000	
Minnesota Agricultural Experiment Station RREA "Training volunteer observers in web-based reporting of the timing of biological events as key indicators of climate variability "	\$ 40,000	
Remaining \$ From Current ENRTF Appropriation: Project Title: Assessing species vulnerability to climate change using phenology, Project Manager: Rebecca Montgomery	\$ 175,000	Under consideration by legislature

**Winter cold is essential to the life cycle of a tree.
Warmer winters threaten our forests.**



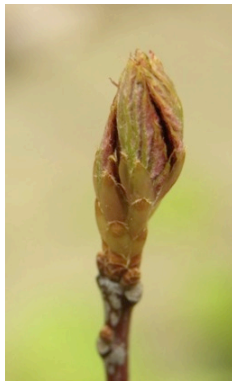
Cold winter circa 2014

days < freezing

130



Budburst
10 d after thaw



Warm winter circa 2050

days < freezing

80



Budburst
30 d after thaw



**Counterintuitively,
warmer winters could lead
to *delayed* budburst.**

The result...

- shorter growing season
- lower forest productivity
- disrupted food webs
- fewer ecosystem services

The solution...

- identify vulnerable species
- alter management to favor resilient species



Project Manager Qualifications and Organization Description

Project Manager: Rebecca A. Montgomery

Associate Professor, Dept. of Forest Resources, University of Minnesota, St. Paul, MN 55108.

Professional Appointments and Preparation

Associate Professor, Forest Resources, University of Minnesota, 2011-present
Assistant Professor, Forest Resources, University of Minnesota, 2004-2011
Research Associate, Forest Resources, University of Minnesota, 2003-2004
Instructor, Forest Resources, University of Minnesota, 2003-2004
Ph.D., Ecology and Evolutionary Biology, University Connecticut, 1999.
B.A., Biology, *magna cu laude*, Occidental College, 1994.

Honors, Professional Recognition and Service (Selected)

Invited speaker at regional, national and international symposia, seminars, and workshops, e.g. MN Sustainable Forest Education Cooperative, Michigan State, UW-Madison, University of Toronto, US-Japan Workshop on Photosynthetic Plasticity and Global Change. Received Richard C. Newman Art of Teaching award (2010) and College of Food, Agricultural and Natural Resources Sciences Distinguished Teaching Award (2010). I serve as chair of the Physiology Working Group of the Society of American Foresters and subject editor of *Forest Science*. I serve on the Science Team for the Minnesota Climate Change Vulnerability Assessment and on the Falcon Heights Environment Commission.

Areas of Expertise

Plant ecophysiology, forest ecology, forest regeneration and dynamics, herbivory, competition, invasive species, rare and endangered species biology, biological responses to climate change. Research spans temperate and tropical forests, managed and unmanaged ecosystems.

Project Management Experience

Principal investigator or co-principal investigator on >15 research grants from National Science Foundation, Minnesota Department of Natural Resources, US Department of Energy, US National Park Service and USDA Forest Service projects. Principal investigator on a seed grant from the University of Minnesota's Institute on Environment related to creating a phenology network in Minnesota. Supervise research staff, post-doctoral scholars, graduate students and undergraduate students.

Peer-reviewed publications

Twenty-seven publications, including articles, book chapters, and reports; twenty-five publications in the peer-reviewed literature, and many in preparation.

Project Management Qualifications and Responsibilities for this Project

Ten years of research experience in oak savanna, deciduous and boreal forest of Minnesota; organized of the highly successful workshop "Phenology: the Pulse of the State" (Bell Museum of Natural History, February 2012); co-organized annual Minnesota Phenologist meetings (2010-2013); manage a Facebook page aimed at bringing together researchers and citizens interested in phenology in Minnesota. Montgomery will provide scientific leadership, supervise funded staff, and both oversee and participate in all project activities.

Organization Description

The University of Minnesota has a strong tradition of education and public service through its role as both the state land-grant university, and the state's primary research university. The Department of Forest Resources is the leading research and educational institution on forest related issues in Minnesota. For over 100 years the department has played a key role in discovering and fostering sustainable forest resource management activities in Minnesota.