Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **111-E**

Assessing Species Vulnerability to Climate Change Using Phenology

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

Total Project Budget: $ 189,845

Proposed Project Time Period for the Funding Requested: 3 Years, July 2014 - June 2017

Summary:

Historical and new observations of timing of biological events such as flowering will assess change in the ecology of species, identify vulnerable species and inform management strategies for climate change.

Name: Rebecca Montgomery

Sponsoring Organization: U of MN

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Email rebeccam@umn.edu, awards@umn.edu

Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

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

PROJECT TITLE: Assessing species vulnerability to climate change using phenology

I. PROJECT STATEMENT

This project will identify plant and animal species that are vulnerable to climate change and enhance adaptive management strategies that sustain productivity of MN forests; support plant pollination and reproduction; and maintain the integrity of wildlife and fisheries in the face of climate change. We will accomplish this by analyzing historical records and collecting new data on phenology, the timing of seasonal biological events such as budburst, flowering, insect emergence and bird migration.

The Intergovernmental Panel on Climate Change recognized that "phenology … is perhaps the simplest process by which to track changes in the ecology of species in response to climate change." 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. There is a critical need to understand how our natural resources are responding to climate change. Phenology provides an excellent and tested indicator of climate change response. New knowledge gained from this project will improve natural resource decision-making in a changing climate.

Why is phenology an indicator of climate change? Many plants and animals use temperature as a cue for leafing, flowering, spawning or migration. When the climate changes so does the timing of these life cycle events. But not all species change the same way. For example, caterpillars that overwinter in Minnesota emerge when it gets warm in spring. However, migratory songbirds that winter in the tropics don't know when it's warm in MN. Instead, they follow the change in the length of the day to determine when to return to MN. Thus, with climate change, the birds return at the same time each year but the caterpillars that feed the songbird young emerge earlier and earlier. Such a mismatch in timing is responsible for songbird declines in England and Europe. We don't know if such mismatches are happening in Minnesota.

Change in phenology can have major impacts on natural resources. Longer growing seasons can increase forest productivity but early leafing and flowering can also expose plants to devastating frost damage. In 2012, apples flowered early in response to warm March temperatures. Then, a normal April frost caused major damage to apple flowers drastically reducing apple crop yields. Minnesota's native tree species such as oaks, maples and aspens showed a similar response. However, unlike commercial species such as apple, limited data on native species phenology inhibits our ability to anticipate and manage change.

As a result of this project, we will:

- identify plant and animal species that are vulnerable to climate change using historical datasets
- develop a network of observers and sites to monitor phenology of vulnerable species into the future
- provide data to natural resource managers for developing adaptive strategies that sustain environmental quality in a changing climate.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: ***Digitize and analyze historical phenology observations to predict species at risk*** **Budget: $96,759**

We know of at least ten localities ranging from Rochester to Finland with phenology datasets longer than 25 years. These represent daily to weekly observations on >50 plant and animal species for a total of >500,000 individual observations. We will compile, digitize and analyze these datasets. We will examine trends through time and model the relationship between climate and phenology. We will identify plants and animals that are vulnerable to climate change and provide a baseline against which to compare changes in the future.

Outcome	Completion Date
1. Online searchable database of >500,000 historical phenological observations	*June 2015*

2. Five statewide workshops for natural resources managers communicating our results and developing management strategies that sustain environmental quality in a changing climate	*June 2016*
3. Webpages depicting phenology of vulnerable species – updated quarterly with new data from Activity 2 and hosted by the University of Minnesota	*June 2017*

Activity 2: *Recruit and train a statewide network of observers to monitor vulnerable species* **Budget: $93,086**

We will collect new data on vulnerable species identified in Activity 1 by establishing observation sites statewide through partnerships with environmental learning centers, nature centers, parks, natural areas, arboreta, schools and interested citizens. Observers will participate in face-to-face or online training and will enter data via an existing online data entry system. We will validate and extend our models of the relationship between climate and phenology and our assessments of species vulnerability with new data collected in this activity.

Outcome	Completion Date
1. Training manuals and on-line training materials developed	*June 2015*
2. Statewide training workshops – at least 200 people trained	*December 2016*
3. Educated and engaged partners with 50 observers in each ecoregion generating >30,000 observations per year	*June 2017 and ongoing*
4. Combined online database of new and historical phenology observations	*June 2017*

III. PROJECT STRATEGY

A. Project Team/Partners

Team (ENRTF funds). Rebecca Montgomery (Dept. of Forest Resources, FR-UMN, in-kind) is the overall Project Manager. Chris Buyarski (FR-UMN, 50% time) will coordinate digitization and analysis of historical records and advise on science and implementation for Activity 2. Roger Moon (Dept. of Entomology, UMN, in-kind) will lead modeling of the relationship between climate and phenology. Stephan Carlson (FR-UMN, 10-16% time) will lead development and delivery of training workshops for new observers. Undergraduate students will digitize historical records. *Coordinating Partners (no ENRTF funds)*. Long-term phenology observers who will provide historical datasets include John Latimer (KAXE Phenology show, Grand Rapids), Jim Gilbert (retired professor, St. Peter), David Palmquist (retired naturalist, Whitewater State Park, Winona), Larry Weber (retired teacher, Carlton) and John Weber (Nevis). Other partners include Belwin Outdoor Science, Wolf Ridge Environmental Learning Center, Will Steger Foundation (contribute to training workshops); and the USA-National Phenology Network (USA-NPN, developed and manage the online data entry system).

B. Project Timeline

This project requires 36 months of funding. Year 1: digitize and analyze historical datasets, develop training materials. Year 2: conduct workshops for natural resource managers, conduct training workshops, begin new data collection. Year 3: conduct training workshops, evaluate and revise training materials, update phenology trends with new observer data, launch combined observation database.

C. Long-Term Strategy and Future Funding Needs

The database, training materials and web dissemination developed with ENRTF funds will be supported after 2017 by the Department of Forest Resources and the USA-NPN. The network of people and associated infrastructure represent an ongoing initiative to collect long-term phenology data across the state and make it available to resource managers, scientists, businesses and individuals. The approach can be adopted and adapted by other organizations in the future. For example, resource management in State Parks has expressed strong interest in phenology monitoring. In addition, materials could be used for future projects such as interpretive trails at parks, nature centers, etc. that focus on phenology.

2014 Detailed Project Budget

Project Title: Assessing species vulnerability to climate change using phenology

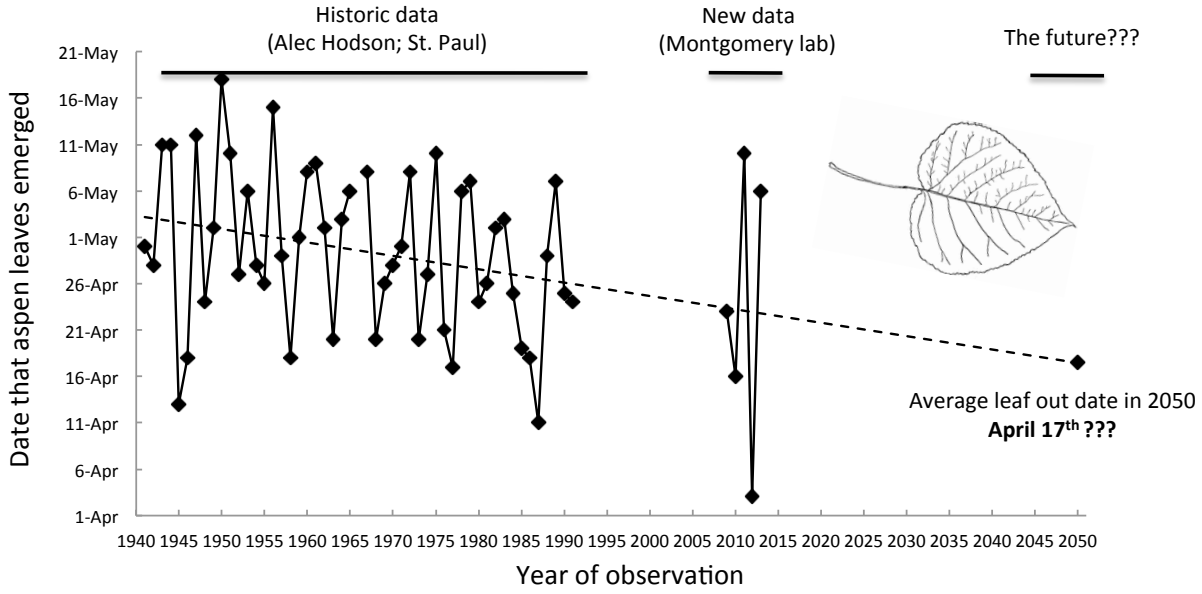
IV. TOTAL ENRTF REQUEST BUDGET *3* years

BUDGET ITEM	AMOUNT
Personnel:	
Chris Buyarski, Project coordinator (50% time), 67% salary 33% benefits, 3 yrs	$ 101,480
Stephan Carlson (UMN Extension faculty (Year 1 & 3 10% time, Year 2 16% time), 75% salary 25% benefits, 3 years	$ 37,016
Undergraduate students (10h/wk academic year and 40h/wk in summer @ $10/h, 93% salary, 7% benefits, 1 year, 3 persons	$ 24,487
Contracts:	
RFP for web developer to expand website, and create new data visualization tools	$ 12,500
Graphic designer from UMN Institute on the Environment to support design of website and training materials	$ 2,000
Equipment/Tools/Supplies:	
Printing materials for workshops and training sessions	$ 100
Printing training manuals	$ 6,000
Travel:	
Travel to consult with phenology record keepers during historical data digitization project (1 year * 3 trips * 1 person * 1 d * (mileage [250 mi/person*0.565 cents/mile] + per diem [$82 lodging + $56 M&I])	$ 838
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])	$ 2,086
Travel to conduct training workshops: 1 year * 8 workshops * 2 persons * 1 d * (mileage [250 mi/workshop*0.565 cents/mile] + per diem [$82 lodging + $56 M&I])	$ 3,338
Additional Budget Items:	N/A
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 189,845

V. OTHER FUNDS

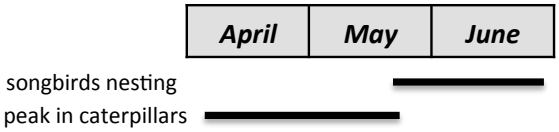
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:		
University of Minnesota Institute on Environment Resident Fellow Program "Minnesota Phenology Network (MnPN): an observer network to measure the pulse of the state and connect people to the land"	$ 10,000	Secured
University of Minnesota Institute on Environment Resident Fellow Grant "A Citizen Phenology Network to Inform Management of Urban Water Quality"	$ 10,000	Secured
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	Secured
Other State $ Being Applied to Project During Project Period:	N/A	
In-kind Services During Project Period:		
Rebecca Montgomery, 1% effort per year	$ 3,211	Secured
Roger Moon, 1% effort per year	$ 4,289	Secured
Unrecovered indirect costs @ 52% of modified total direct cost base of $189,845	$ 98,719	Secured
USA-National Phenology Network website and data hosting	$ 3,600	Secured
Remaining $ from Current ENRTF Appropriation (if applicable):	N/A	
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	

Q: Do all Minnesota tree species show trends like this?

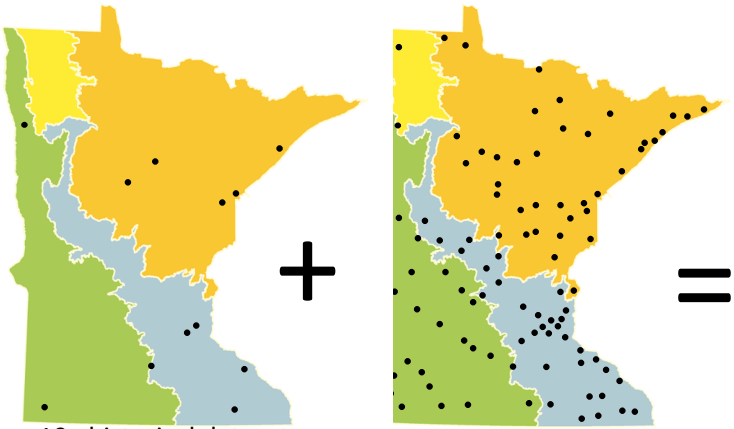


Q: Will some plants fail to produce fruits and seeds due to frost damage to flowers?

Q: Are songbirds at risk of decline in MN?



A: We don't know. Analysis of historic and new data will provide answers.



10+ historical datasets
>25 year of data
>500,000 total observations

Many new observers
2014-future
>30,000 new observations per year

Powerful tool to **identify, adapt and manage** natural resource changes

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. 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-four publications, including articles, book chapters, and reports; twenty-two publications in the peer-reviewed literature, and 8 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 it 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.