



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2014 Work Plan

Date of Report: 15 January 2014
Date of Next Status Update Report: January 2015
Date of Work Plan Approval:
Project Completion Date: 30 June 2017
Does this submission include an amendment request? No

PROJECT TITLE: Assessing species vulnerability to climate change using phenology

Project Manager: Rebecca Montgomery
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Location: Statewide

| | | |
|------------------------------------|-----------------------------|------------------|
| Total ENRTF Project Budget: | ENRTF Appropriation: | \$175,000 |
| | Amount Spent: | \$0 |
| | Balance: | \$175,000 |

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 05e

Appropriation Language:

\$175,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to compile and use historical datasets to assess change over time in the ecology of Minnesota species, identify vulnerable species, and inform management strategies for climate change. This appropriation is available until June 30, 2017, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Assessing species vulnerability to climate change using phenology

II. PROJECT STATEMENT:

Global climate change has the potential to profoundly impact natural resources and associated human communities worldwide. Phenology, the timing of seasonal biological events such as budburst, flowering, bird migration and leaf coloring, has provided the most compelling evidence to date that plants and animals are responding to changes in climate across the globe. Indeed 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 currently responding to climate change and develop tools for projecting natural resource responses into the future. Phenology provides an excellent and tested indicator of climate change response.

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.

The major objectives of this project include:

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

To achieve these objectives we will analyze historical records of phenology to understand past trends in timing of biological events, predict future trends using models based on historical data, collect new data on phenology to test models and provide continued monitoring into the future.

Historical phenology records are a valuable and endangered Minnesota resource, yet they are scattered, piecemeal across the state and at risk. These records are a critical resource for understanding natural resource changes already occurring. For example, a record from St. Paul, MN (AC Hodson 1941-1991) shows that aspen trees are leafing almost two weeks earlier now than in the past. Historical data could be lost if it is not digitized, documented and stored in a permanent database. We will locate, digitize and analyze handwritten historical records to examine whether and how phenology has changed in recent years. We will use these data to model the relationship between climate and phenology. These data will show us how plant and animals in Minnesota are responding to climate change and identify species that exhibit responses that make them vulnerable to various factors such as insect outbreak, early or late season frost, decreased productivity. They also provide a baseline against which to measure changes in the future. Models of the relationship between climate and phenology will allow us to predict future trends.

Phenology resonates strongly with the public. Who has not noticed when the leaves emerge or turn color, when the crocuses and daffodils bloom? We will harness this enthusiasm to *develop a new statewide observer network to monitor phenology* of a core set of species across the state's major ecoregions. Phenology observers will be recruited 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 online data entry system already developed by the USA-National Phenology Network. New observations can be used to test models built with historical data and can build on and extend the historical record dataset.

New knowledge gained from this project will improve natural resource decision-making in a changing climate. Better understanding of natural resource changes associated with climate change in Minnesota will 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.

III. PROJECT STATUS UPDATES:

Project Status as of: January 1, 2015

Project Status as of: July 1, 2015

Project Status as of: January 1, 2016

Project Status as of: July 1, 2016

Project Status as of: January 1, 2017

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Digitize and analyze historical phenology observations to predict species at risk

Description: 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. Some of these are in digital format but others are not. A key challenge for this activity will be to create a standardized database of plant and animal taxa with standardized phenological events or phases. Since there are many animals and plants that differ in life history this is a challenge. Project staff will develop the database structure in consultation with others that have conducted similar projects in other US states. We will then work with several of the naturalists who have collected the data to begin data entry/digitization. This will provide beta testing of the database by phenology experts. After beta testing, we will use University of Minnesota students to digitize additional datasets. The first step in our analysis process will be to examine trends in phenological events through time. The second step will be to model the relationship between climate and phenology. Climate data for locations and years for which we have data will be downloaded from the State Climatologist website and supplemented as necessary from other sources. Climate and phenology datasets will be linked and process-based models that use climate variables to predict phenology will be fit to the data. Both of these analyses will allow us to identify plants and animals that are vulnerable to climate change and provide a baseline against which to compare changes in the future. Our results will be used to develop collaborative workshops for natural resource managers to determine where, when and how phenological data can inform management as well as identify data gaps that could be filled in the future.

Summary Budget Information for Activity 1:**ENRTF Budget: \$ 81906****Amount Spent: \$ 0****Balance: \$81906****Activity Completion Date: June 30, 2017**

| Outcome | Completion Date | Budget |
|--|------------------------|---------------|
| 1. Online searchable database of >500,000 historical phenological observations | June 2015 | \$41056 |
| 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 | \$19937 |
| 3. Webpages depicting phenology of vulnerable species – updated quarterly with new data from Activity 2 and hosted by the University of Minnesota | June 2017 | \$20913 |

Activity Status as of: January 1, 2015**Activity Status as of:** July 1, 2015**Activity Status as of:** January 1, 2016**Activity Status as of:** July 1, 2016**Activity Status as of:** January 1, 2017**Final Report Summary:****ACTIVITY 2: Recruit and train a statewide network of observers to monitor vulnerable species**

Description: We will collect new data on vulnerable species identified in Activity 1 as well as a set of common species by establishing observation sites statewide through partnerships with environmental learning centers, nature centers, parks, natural areas, arboreta, schools and interested citizens. Partnerships will be developed through formal and informal contacts depending on the partner. For example, we will approach nature centers directly to introduce the project and invite participation. Interested citizens will be recruited via three existing Facebook groups (Duluth Phenology Watch, Season Watch and the Minnesota Phenology Network), various phenology related radio programs that run throughout the state (e.g. KAXE in northern MN, WCCO in central MN), Master Naturalist and Master Gardner programs and other natural history related groups (e.g. Audubon Society, MN Native Plant Society). New observers will participate in face-to-face or online training. We have conducted pilot training sessions through other funding sources that were highly successful. Observers will be trained in protocols that are developed at the national level by the USA-National Phenology Network. They will enter data via an existing online data entry system through a Minnesota specific web portal that is also currently under development. New data will be used to validate and extend models of the relationship between climate and phenology and our assessments of species vulnerability.

Summary Budget Information for Activity 2:**ENRTF Budget: \$ 93094****Amount Spent: \$ 0****Balance: \$93094****Activity Completion Date: June 30, 2017**

| Outcome | Completion Date | Budget |
|---|------------------------|---------------|
| 1. Training manuals and on-line training materials developed | June 2015 | \$25024 |
| 2. Statewide training workshops – at least 200 people trained | June 2016 | \$30362 |

| | | |
|---|-----------------------|---------|
| 3. Educated and engaged partners with 50 observers in each ecoregion generating >30,000 observations per year | June 2017 and ongoing | \$25024 |
| 4. Combined online database of new and historical phenology observations | June 2017 | \$12684 |

Activity Status as of: January 1, 2015

Activity Status as of: July 1, 2015

Activity Status as of: January 1, 2016

Activity Status as of: July 1, 2016

Activity Status as of: January 1, 2017

Final Report Summary:

V. DISSEMINATION:

Description: Historical datasets will be shared through an online, searchable database to be developed as part of this project and served by the University of Minnesota and accessed through the Minnesota Phenology Network website hosted by the USA-NPN (<https://www.usanpn.org/mnnpn>). New data collected by citizen observers will be publicly available through Nature’s Notebook, a program of the USA-NPN (https://www.usanpn.org/natures_notebook). Any training or workshop materials developed will be freely available via the Minnesota Phenology Network website. One of our project outcomes involves dissemination and presentation of results to natural resource professionals through workshops offered throughout the state. Presentation of the results will also occur through webinars (e.g. MN Woodland Advisors program), professional meetings (e.g. MN Society of American Foresters), and public events.

Status as of: January 1, 2015

Status as of: July 1, 2015

Status as of: January 1, 2016

Status as of: July 1, 2016

Status as of: January 1, 2017

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

| Budget Category | \$ Amount | Explanation |
|-----------------|-----------|--|
| Personnel: | \$162638 | 1 project coordinator at 50% FTE for 3 years; extension educator at 10% FTE for 2 years and 16% FTE for 1 year and undergraduate student at 34% for 1 year |

| | | |
|---|-----------------|--|
| Professional/Technical/Service Contracts: | \$4000 | 1 contract to web developer to implement online searchable database of historical observations |
| Printing: | \$2100 | Printing materials for natural resource manager and training workshops |
| Travel Expenses in MN: | \$6262 | Mileage, lodging and meals for consultations with phenology dataset owners and for workshops |
| TOTAL ENRTF BUDGET: | \$175000 | |

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than \$5,000: N/A

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 3

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 0

B. Other Funds:

| Source of Funds | \$ Amount Proposed | \$ Amount Spent | Use of Other Funds |
|--|--------------------|-----------------|--|
| Non-state | | | |
| | \$ | \$ | |
| State | | | |
| University of Minnesota, Rebecca Montgomery and Roger Moon, 1% FTE (in-kind) | \$7500 | \$0 | Supports faculty member effort on project by project manager and project partner |
| University of Minnesota | \$90,909 | \$0 | Unrecovered indirect costs at 52% of direct cost base of \$175,000 |
| TOTAL OTHER FUNDS: | \$98409 | \$ | |

VII. PROJECT STRATEGY:

A. Project Partners:

Project partners not receiving funds:

- Roger Moon (Dept. of Entomology, UMN, in-kind) will lead modeling of the relationship between climate and phenology.
- 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)
 - John Weber (Nevis).
- Belwin Outdoor Science, Wolf Ridge Environmental Learning Center, Will Steger Foundation will contribute to training workshops
- USA-National Phenology Network has developed and will manage the online data entry system.

B. Project Impact and Long-term Strategy:

Understanding the causes and consequences of alteration of phenology is critical for predicting future pathways of ecological communities. As a result of the work proposed here, we will identify trends in the phenology of plants and animals of Minnesota. *This new knowledge is significant because it will facilitate prediction of possible alterations in species interactions, forest community composition and forest productivity under climate change.* Forest composition and productivity critically impact the timber industry, natural resource based recreation and conservation of flora and fauna. Better understanding of the potential for alteration of economic (fiber production), recreational (parks and trails) and ecological (carbon sequestration, water quality provision) functions of forest resources under climate change will reduce uncertainties that currently hinder decision-making.

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.

C. Spending History: N/A

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. VISUAL ELEMENT or MAP(S): See attached.

X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET: N/A

XI. RESEARCH ADDENDUM: N/A

XII. REPORTING REQUIREMENTS:

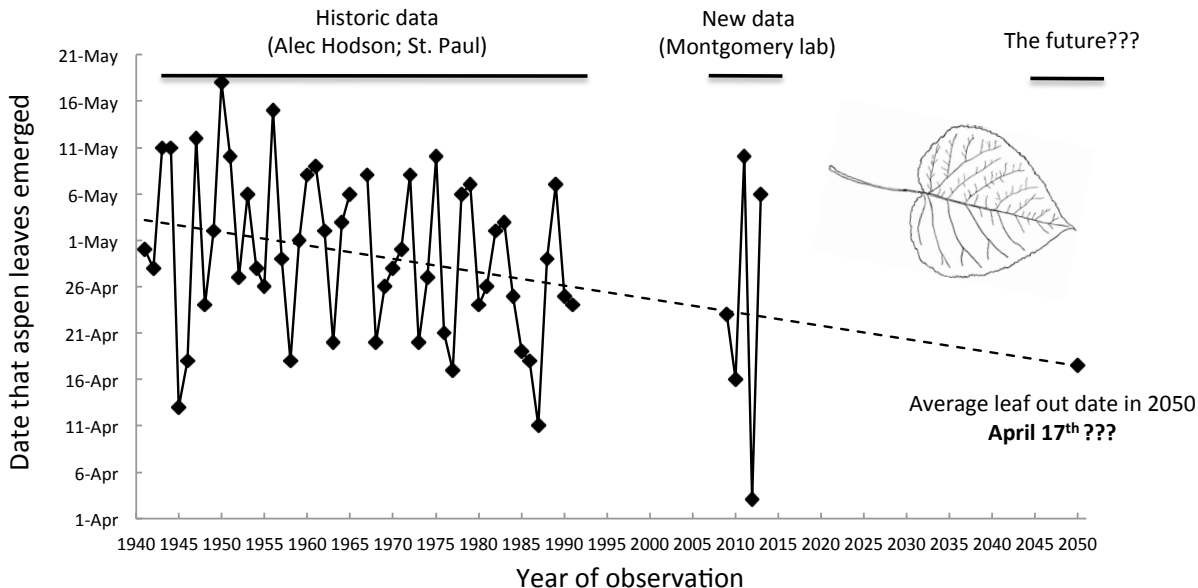
Periodic work plan status update reports will be submitted no later than January 1, 2015; July 1, 2015; January 1, 2016; July 1, 2016; January 1, 2017. A final report and associated products will be submitted between June 30 and August 15, 2017.



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|---|--|--|--|--|--|--|--|--|
| Environment and Natural Resources Trust Fund | | | | | | | | |
| M.L. 2014 Project Budget | | | | | | | | |
| Project Title: Assessing species vulnerability to climate change using phenology | | | | | | | | |
| Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 05e | | | | | | | | |
| Project Manager: Rebecca Montgomery | | | | | | | | |
| Organization: University of Minnesota | | | | | | | | |
| M.L. 2014 ENRTF Appropriation: \$ 175,000 | | | | | | | | |
| Project Length and Completion Date: 3 Years, June 30, 2017 | | | | | | | | |
| Date of Report: January 15, 2014 | | | | | | | | |

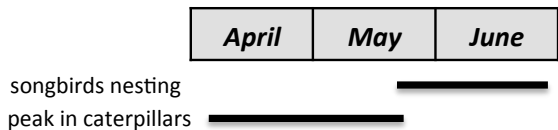
| ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET | Activity 1 Budget | Amount Spent | Activity 1 Balance | Activity 2 Budget | Amount Spent | Activity 2 Balance | TOTAL BUDGET | TOTAL BALANCE |
|---|--|---------------------|---|--------------------------|---------------------|---------------------------|---------------------|----------------------|
| BUDGET ITEM | <i>Digitize and analyze historical phenology observations to predict species at risk</i> | | <i>Recruit and train a statewide network of observers to monitor vulnerable species</i> | | | | | |
| Personnel (Wages and Benefits) | \$74,882 | \$0 | \$74,882 | \$87,756 | \$0 | \$87,756 | \$162,638 | \$162,638 |
| Chris Buyarski, Project coordinator: \$101,480 (67% salary 33% benefits); 50% FTE for 3 years | | | | | | | | |
| Stephan Carlson, UMN Extension faculty: \$37,016 (75% salary 25% benefits); 10% FTE for 2 years; 16% FTE for 1 year | | | | | | | | |
| 3 Undergraduate students: \$24,142 (93% salary, 7% benefits); 115% FTE for 1 year | | | | | | | | |
| Professional/Technical/Service Contracts | | | | | | | | |
| TBD (competitive bid): web developer to implement searchable online database of historical observations | \$4,000 | \$0 | \$4,000 | \$0 | \$0 | \$0 | \$4,000 | \$4,000 |
| Printing | | | | | | | | |
| Printing materials for natural resource manager workshops that emerge from Activity 1 and printing training manuals for Activity 2 | \$100 | \$0 | \$100 | \$2,000 | \$0 | \$2,000 | \$2,100 | \$2,100 |
| Travel expenses in Minnesota | | | | | | | | |
| Mileage, lodging and meals to consult with phenology record keepers, conduct natural resource manager training workshops and conduct training workshops | \$2,924 | \$0 | \$2,924 | \$3,338 | \$0 | \$3,338 | \$6,262 | \$6,262 |
| COLUMN TOTAL | \$81,906 | \$0 | \$81,906 | \$93,094 | \$0 | \$93,094 | \$175,000 | \$175,000 |

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?

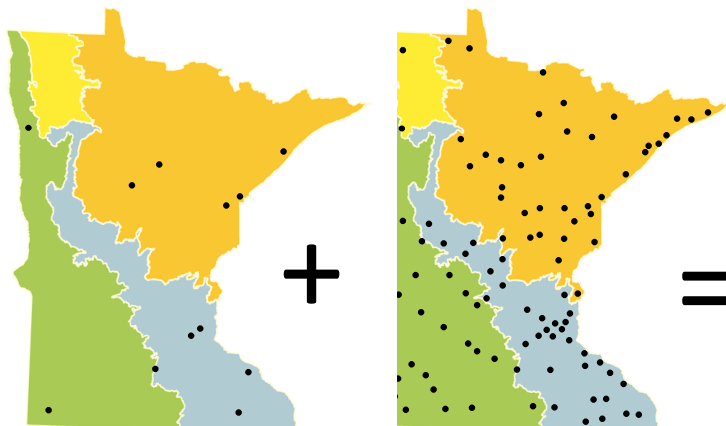
Q: Are songbirds at risk of decline in MN?



April frost threatens Minnesota apple crop
 Article by: KIM PALMER, Star Tribune | Updated: April 11, 2012 - 11:06 AM



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



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

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

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

