Using Local Phenology to Understand Climate Variability

Nature’s Notebook Webinar
November 1, 2016
Stephan Carlson
My Backyard Wednesday am:
How many phenophase’s can you count
To date, phenology has provided the most widespread and coherent signal of climate change.
Greatest changes near the border

Left: © University of Minnesota Press: J. Tester, 1995. Fig. 1.6
Right: MN DNR map image
Seasonal Temperature Trends in MN

- Winter (D, J, F)
- Spring (M, A, M)
- Summer (J, J, A)
- Fall (S, O, N)
2095 seasonal climate comparisons

Union of Concerned Scientists report:
growing season length
pest outbreaks
pollination services
human health
management decisions

Eastern Canada – timing of shad fishing

Wampanoag of Cape Cod – timing of corn planting
Maple syrup producers experience worst year in memory
by Curtis Gilbert, Minnesota Public Radio
March 30, 2012

FOREST LAKE, Minn. — There are some wonderful things about our early spring. But it hasn’t been good for everybody — especially not Minnesota’s maple syrup producers.

One by one, Jeff Edelen pulls empty milk jugs off the sugar maples near his house in Forest Lake. He tosses them into a trailer attached to his three-wheeler. Of Edelen’s 200 taps, this cluster is always the last to produce sap.

"Even these did pretty poor this year," Edelen said.

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

Craig Schaper, son of apple grower Lowell Schaper, checked buds for damage on Tuesday after overnight freezing temperatures.
Connect with nature

BACKYARD PHENOLOGY

Tracking nature's cycles in a changing climate
MN has 20+ years of data

- Birds = 45
- Butterflies = 41
- Plants = 140
Phenology data helps understand climate change impacts.
7AM: 18°C WW - click this arrow and we have a cloudy day. Not as much wind today. We have a slight cloud. In the PM, the temperature will reach 30°C again. I walk on the road at 8 AM, and the wall is very pleasant. I deal with the couple of the coast of the time. I have some work to do. After the wall, I go to the beach again. I work on the beach by the river. Some water at the St. Leon beach and in the sea nearby, I am more wet with a wind and the day feels cold. At home, I go for a ski on the next trail for 3 km. From 7 to 10 am, we have a small wind and a small wave. After that, I find a couple of black bears near the beach. I see lots of the white things - and they are visible. I play with the black bears. Other things of note: Nineteen report across 15 Turkey in the valley. I see some more. Salted rabbit here. Are the waterfood with some water in the sea. We have a small wave, and the moon is small. Some waves, 8 PM. 7:45 PM.
Connecting with Students
Developing tomorrow’s Citizen Scientists

Phenology &
_Nature’s Notebook_
_A Driven to Discover Curriculum_

Photo: C. E. Price
A Stepwise Process

FIGURE 1. Scientific discoveries are made through the process of investigation, though scientists often use the word “research” or “the scientific method” to describe what they do. Investigations involve detailed examination of phenomena with the goal of discovering and interpreting new knowledge, whether the knowledge is new to humankind, to a small group of people, or even just to the person doing the research.
Observe & Wonder
“I Wonder” Board
Develop testable questions

• Students become **scientist** when they pose questions

• **Develop a Hypotheses:** best guess

• **Plan and test** to confirm or contradict their hypothesis

• **Analyze and Interpret** the results

• **Conclude and Report** if hypothesis is supported with data, use charts or graphs
Claim, Evidence, Reasoning & Rebuttal

- **Claims** answer the research question
- **Evidence** supports the claim
- **Reasoning** provides a logical connection between evidence and the claim
- **Rebuttal** looks at alternative explanations
Record what you see!

Lake Minnetonka officially ice free

Updated: March 21, 2012 - 7:42 AM

Sheriff declares it ice-free. Third earliest ever?
Evidence, Claim & Reasoning

- draw claims from the data -

Aligning Scientific Explanations with Scientific Inquiry and Citizen Science Projects
### Build a Scientific Explanation

<table>
<thead>
<tr>
<th>Evidence: scientific data that can support a claim</th>
<th>Claim: a statement that answers a question</th>
<th>Reasoning: a justification for why the evidence supports the claim using scientific principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>You observe birds in the early morning and afternoon over 5 days. On average, you see 6 kinds of birds in the morning, and 3 kinds in the afternoon.</td>
<td>More species of birds are active in the morning than the afternoon.</td>
<td>The insects that many birds eat tend to be more active in the morning. OR, birds of prey, which eat many other bird species, are more active in the afternoon because they can catch thermals (warm air rising), which makes it easier for them to fly. Thus, by being out early, smaller birds may be avoiding predators.</td>
</tr>
</tbody>
</table>
Focus on a few species
Data visualizations
Outcomes
Eastern tailed blue (*Cupido comyntas*)

![Graph showing first seen dates from 1994 to 2014 for the Eastern tailed blue butterfly. The graph indicates a general trend of decrease in first seen dates over the years.]
Sandhill Crane arrival

![Graph showing date of Sandhill Crane arrival over years]
Yellow-rumped Warbler arrival

![Graph showing dates of Yellow-rumped Warbler arrival from 1980 to 2015. The dates range from 3/23/2015 to 5/4/2015, with fluctuations year to year. A bird image is also shown.]
Baltimore Oriole arrival
Earlier leafing in central MN

Historic dataset (A Hodson; St. Paul)

Current data
(C Buyarski; E. Bethel)

Montgomery, Buyarski & Moon, unpublished
Date that aspen leaves emerged vs. Year of observation

Montgomery, Latimer, Buyarski, Hastings & Moon, unpublished
NON-RESPONDER

Date that red maple leaves emerged vs. Year of observation

- 31-Mar
- 10-Apr
- 20-Apr
- 30-Apr
- 10-May
- 20-May

Year of observation:
- 1990
- 1995
- 2000
- 2005
- 2010
- 2015

Graph showing the trend of red maple leaf emergence over the years.
Bud Break for Red Maples???

- Red Maple **may** be sensitive to winter chill days

- # of days below zero
THE INFLUENCE OF COLD IN STIMULATING THE GROWTH OF PLANTS

By Frederick V. Coville

Botanist in Charge, Office of Economic and Systematic Botany, Bureau of Plant Industry, United States Department of Agriculture

1 An address delivered before the National Academy of Sciences Apr. 27, 1920.
Como Lake Neighborhood Phenology

MnPN
Minnesota Phenology Network

nature's notebook
A project of the USA-NPN
Street sweepers

- Reduces P if used at correct intervals
  - Only $40-100 per kg of P removed

- Impact of phenology on street sweeping timing
  - What species are the biggest contributors of P into lakes
    - Decomposition experiment in a parking lot
  - St. Paul Norway maples in 2011

*Figure out when to sweep based on the phenology of the most problematic species*
Seasonality in **stormwater** P matches tree phenology

![Seasonality graph](image-url)

- **Leaf Out**
- **Leaf Drop**

Janke et al., in prep.
Street sweepers

• Reduces P if used at correct intervals
  – Only $40-100 per kg of P removed

• Impact of phenology on street sweeping timing
  – What species are the biggest contributors of P into lakes

• Decomposition experiment in a parking lot
  – St. Paul Norway maples in 2011
*Figure out when to sweep based on the phenology of the most problematic species
Northern, boreal species
- Balsam fir
- Paper birch
- Jack pine
- White spruce
- Trembling aspen
- Red maple
- Bur oak
- White pine
- Sugar maple
- Red oak

Southern, temperate species
ceramic heaters

buried cables
## Northern red oak – April 27, 2010

<table>
<thead>
<tr>
<th></th>
<th>Open Canopy</th>
<th>Closed Canopy</th>
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<tbody>
<tr>
<td><strong>Ambient</strong></td>
<td><img src="image1" alt="Bud not broken" /></td>
<td><img src="image2" alt="Bud not broken" /></td>
</tr>
<tr>
<td><strong>+3.6</strong></td>
<td><img src="image3" alt="Bud broken" /></td>
<td><img src="image4" alt="Bud broken" /></td>
</tr>
<tr>
<td>Ambient</td>
<td>Open</td>
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<td><img src="image1.png" alt="Open Branch" /></td>
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<tr>
<td></td>
<td><img src="image3.png" alt="Open Buds" /></td>
<td><img src="image4.png" alt="Closed Buds" /></td>
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+3.6
## Northern red oak – May 11, 2010

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<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><strong>Broken</strong></td>
<td><strong>Broken</strong></td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
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<td></td>
<td><strong>Broken</strong></td>
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</tr>
<tr>
<td></td>
<td><strong>One Leaf Full</strong></td>
<td><strong>One Leaf Full</strong></td>
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<td><strong>+3.6</strong></td>
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Northern red oak – May 18, 2010
Extended growing

Betula papyrifera

Populus tremuloides

Acer rubrum

Acer saccharum

Quercus macrocarpa

Quercus rubra

ambient

+3.4° C

April 30

May 10

May 20

May 30

...Day of year...

Sept 7

Sept 17

Sept 27

Oct 7

Oct 17

Boreal

Temperate
9-17 days longer
Recruit and train a 1000 statewide network of observers to monitor plants and animals
The Phenology Walk and Trail Guide

An experiential education tool for site-based community engagement

USA-NPN Education & Engagement Series 2016-001  July 2016

naturesnotebook.org
Getting Started

Start a Phenology Trail

A Phenology Trail is a network of Nature’s Notebook observation sites. Linked together, these sites provide the participant with places to visit, enjoy nature, collect data, and learn about supporting organizations. They provide researchers and managers a wealth of information about the phenology of local species of interest.
Trail signage

Phenology trails are excellent community engagement tools, designed to develop local partnerships.

Image credit: Brian F. Powell
Belwin Nature Center Phenology Trail

**Plants & Animals**
- Ruby Throated Hummingbird 1
- Bur oak 1
- But oak 2
- Bur oak 3
- Milkweed 1
- Eastern Bluebird 1
- Eastern Bluebird 2
- Staghorn Sumac 1
- Staghorn Sumac 2
- Staghorn Sumac 3
- Staghorn Sumac 4
- Box Elder 1
- Box Elder 2
- Box Elder 3
- Monarch Butterfly 1
- Monarch Butterfly 2 (monarch way station)
Tracking nature’s cycles in a changing climate
Backyard Phenology Questions:

• What changes you have observed in nature over your life time?

• What is your theory of change?

• How does change happen?