



The USA National Phenology Network serves science and society by promoting a broad understanding of plant and animal phenology and its relationship with environmental change.

2016 Annual Report

Taking the Pulse of Our Planet



Letter from the Executive Director

Greetings! It is with great pleasure that I share with you some of the key accomplishments of the USA-NPN in 2016. We've been working hard to develop and improve data products and associated resources that can be used to support decision-making and scientific discovery. And, we've worked to improve tools and frameworks that can be used to engage a variety of participants and partners in *Nature's Notebook*.

This year, we expanded our suite of available data products into the realm of gridded maps and data. We now offer real-time maps—and six-day forecasts—that portray the accumulation of spring warmth as it spreads northward across the nation, and up in elevation across the

Phenology... is perhaps the simplest process in which to track changes in the ecology of species in response to climate change.

Rozenzweig et al., Intergovernmental Panel on Climate Change, 2007

mountainous western US. Our Spring Index and Accumulated Growing Degree Day maps are rendered daily for the continental United States (to be expanded to include Alaska in 2017), but retain kilometer-scale resolution appropriate for local decision-making. These maps can be viewed through our newly

updated online Visualization Tool, or accessed as a web service, making them readily available for use in a wide range of applications, from education & outreach & resource management to ecological research.

We also developed and hosted our first certification course for Local Phenology Leaders. Participants in this course learned skills and tools to help them manage their Local Phenology Projects, while improving the quality and quantity of phenology observations submitted to *Nature's Notebook*. We are committed to cultivating and supporting the phenology observing Community of Practice to benefit not only USA-NPN, but also the broader citizen science community.

Thank you for your continued support. We are grateful to be part of such a diverse community, and are enthusiastic to serve the phenology needs of the nation for years to come.



Sincerely,

Jake F. Weltzin
Executive Director



2.4 MILLION

Phenology records submitted

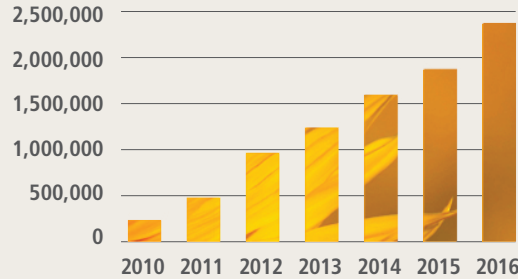
38



Publications using contemporary data and models since 2009

28%

Increase in records submitted over 2015



7%



Increase in active participants over 2015

29



Data products released in 2016

7



Published in 2016

174



Local Phenology Projects submitting data in 2016

9%



Increase in Local Phenology Projects submitting data over 2015

97



New Local Phenology Projects established

NATURE'S NOTEBOOK'S 2016 ACHIEVEMENTS

Advance Science

The USA-NPN aims to improve understanding of plant and animal phenology as a key response to environmental variation and change.

The beautiful maps of seasonal green-up and brown-down in vegetation that satellite-borne sensors provide at a continental scale are valuable for understanding large-scale patterns in phenology. However, these maps reflect the composite response of all plants in a region, and communicate little information about individual species. Ground-based observations, like those being collected by participants in *Nature's Notebook*, offer critical information for assessing how well patterns in seasonal phenology captured via satellite reflect individual species at a location.

Through the PopClock campaign, scientists at the University of Maryland Center for Environmental Science encouraged *Nature's Notebook* participants to document leaf phenology of balsam poplar and quaking aspen and then compared these observations of tree phenology to satellite imagery collected by the Moderate Resolution Imaging Spectrometer (MODIS). The researchers documented several data processing steps that improved the concordance between the timing of leaf-out reported by observers on the ground and the timing of landscape-scale green-up for stands of poplar and aspen identified in the satellite imagery.

This study was one of the first to use observations collected via *Nature's Notebook* to ground-truth remotely-sensed landscape-scale vegetation phenology, and is an outstanding example of research applications now possible because of the data being produced by the USA-NPN.

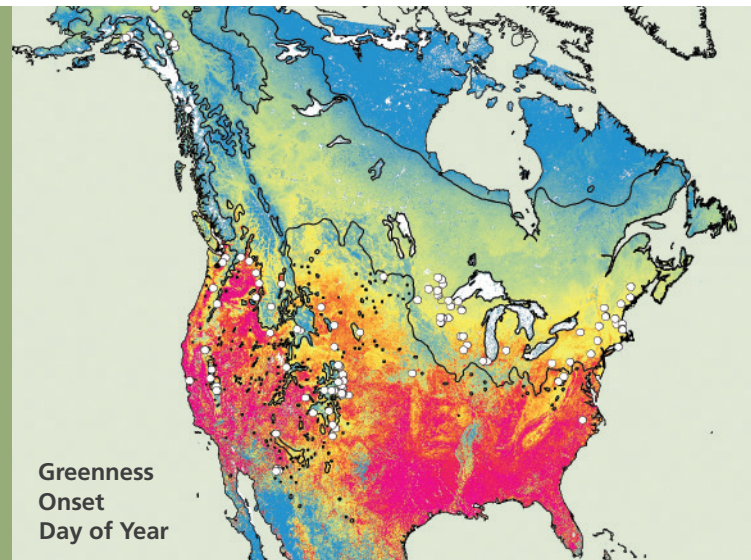
Elmore, A.J., Styliniski, C.D., and Pradhan, K. 2016 Synergistic Use of Citizen Science and *Remote Sensing* for Continental-Scale Measurements of Forest Tree Phenology. *Remote Sensing*. Doi:10.3390/rs8060502.



Working with the National Phenology Network was a rewarding experience and a great way to engage volunteer scientists in interesting research.

Andrew Elmore, Associate Professor, University of Maryland Center for Environmental Science

The PopClock research team was funded by the National Science Foundation (Grant #1461868).



High : 160
Low : 160
Poplar range
NPN observations

Average (2000-2014) start of spring based on remotely sensed imagery. Map credit: **A. Elmore**.

Inform Decisions

In three out of every four U.S. National Parks, spring is arriving earlier than it has in previous decades. The rapid change in the start of the spring season presents unique management challenges for the Park Service, whose mission is to preserve natural and cultural resources for this and future generations. With earlier springs come longer park visitation seasons, a proliferation of

invasive species, and a mismatch in the timing of popular park events, such as the annual Cherry Blossom Festival on the National Mall in Washington, D.C. and the flowering of the iconic cherry trees.

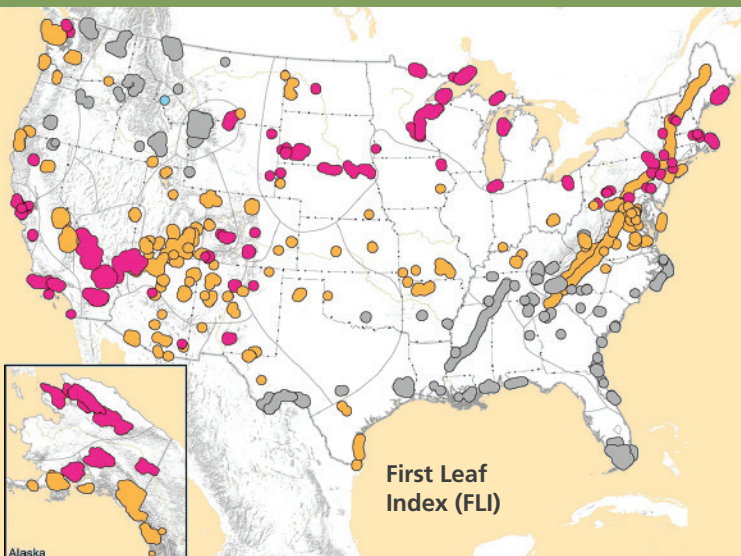
The changes in the arrival of spring were documented in a study using the Spring

The USA-NPN provides phenological information to inform risk management, the conservation and management of natural resources, and human health, recreation and land use decisions in variable and changing climates.

Indices—models that are based on the timing of leaf-out and flowering in common and widely distributed plants, and which thus represent the biological start of spring at a given location. The research team, a partnership between the USA-NPN, the National Park Service, Cornell University and the University of Wisconsin-Milwaukee, analyzed patterns in the timing of spring over the past 100 years using Spring Index maps created and maintained by the USA-NPN. Spring Index maps are available on the USA-NPN website and are a powerful way to track the progression of the spring onset across the country.

Read more: www.nps.gov/subjects/climatechange/springonset.htm

Monahan W.B., Rosemartin A., Gerst, K., Fischelli N.A., Ault T., Schwartz M.D., Gross J.E., and Weltzin J.F. 2016. Climate change is advancing spring onset across the US national park system. *Ecosphere* 7(10): e01465 doi: 10.1002/ecs2.1465



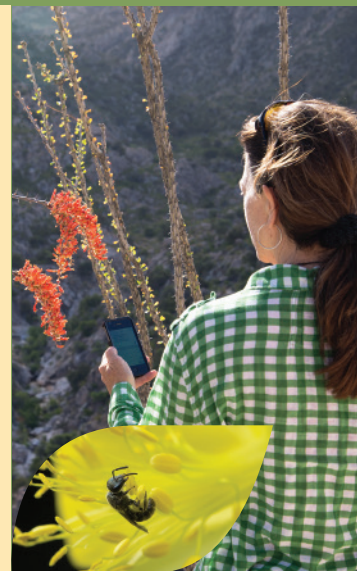
USA-NPN produces and delivers daily maps and short-term forecasts of accumulated growing degree days and spring onset dates at fine spatial scale for the United States. Maps can be viewed using the USA-NPN Visualization Tool or accessed via the USA-NPN Geoserver.

Learn more: www.usanpn.org/data/phenology_maps.

Percentile

● < 5% ● 5-25% ● 25-75% ● 75-95% ● > 95%

Recent changes in the timing of spring onset relative to the 1901-2012 historical range of variability. Units shaded red show the greatest advancement in the timing of spring onset.





Communicate and Connect

The Arnold Arboretum Tree Spotters program is a volunteer effort to collect phenology observations at the Arboretum using *Nature's Notebook*. Since its launch in 2015, this citizen science program has collected over 66,000 phenology records from 11 trees, directly supporting Arboretum scientists in their studies of the effects of a changing climate on plants.

The USA-NPN aims to cultivate meaningful, long-term engagement in phenology monitoring, research and applications among individuals, partner groups and stakeholders.

Arnold Arboretum Tree Spotters leaders continually implement new and creative methods to attract and retain volunteers, and have found that feeding the belly as well as the mind is quite effective. Gatherings often include expert speakers sharing tree facts and biology as well as tree-themed refreshments such as hickory nut cookies, tree-shaped waffles, shortbreads made with red acorn flour, and birch beer. The project's statistics reveal the efficacy of these techniques: over 200 volunteers have been trained in the brief two-year span of the program's existence.



I have been having a terrific time working with the Temporal Ecology Lab, the Arboretum staff, the Tree Spotter volunteers, and now the NPN folks. I have learned so much about so many things since the project started—and not just about phenology! It's very gratifying to see how the program is growing. I can't wait to get started again this spring.

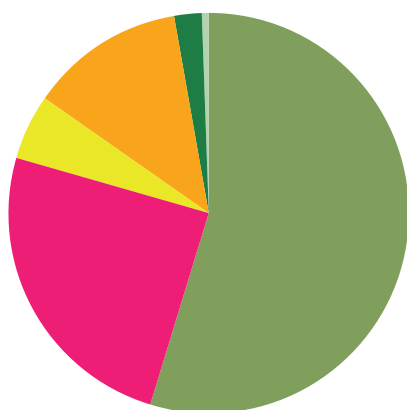
Suzanne Mrozak
Arnold Arboretum Tree Spotters volunteer coordinator



Resources for FY 2015

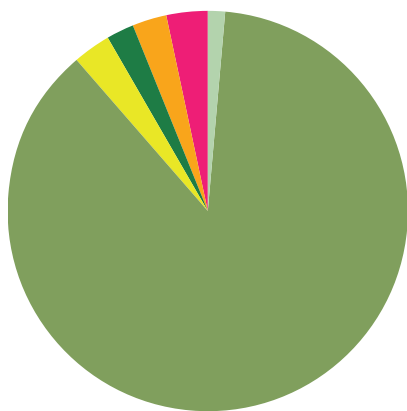
Base funding for operations is provided primarily by US Geological Survey. The USA National Phenology Network gratefully acknowledges the additional sponsoring organizations: University of Arizona, University of Wisconsin-Milwaukee, The Wildlife Society, US National Park Service, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, National Science Foundation, Oak Ridge National Laboratory, and US Fish and Wildlife Service.

Our financial reporting follows the Federal fiscal year. The Network's constituent entities may have different fiscal years and reporting formats; each organization—and agreements between organizations for the Network's activities—provide for fiscal responsibility and accountability.



SOURCES

USGS Ecosystems Mission Area	\$578,218
USGS Climate and Land Use Change	\$262,000
USGS Core Science Systems	\$56,948
US Fish and Wildlife Service	\$131,431
NASA	\$23,872
National Science Foundation	\$3,160
TOTAL	\$1,055,629



EXPENSES

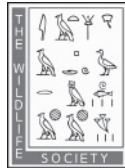
USGS Ecosystems Mission Area	\$16,000
University of Arizona	\$922,143
University of Maryland	\$29,737
University of New Hampshire	\$24,000
University of Florida	\$29,999
USGS Climate and Land Use Change	\$33,750
TOTAL	\$1,055,629

Thank You

Partnerships are the heart of the USA-NPN, and participants are critical to *Nature's Notebook*. Together, we work to collect, store, and share phenology data and information. We are truly grateful for the support we receive, in its many forms, from our partners, participants, sponsors, and friends.

Our success is your success: thank you.

Our Sponsors



USA-NPN National Coordinating Office Staff

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Alyssa Rosemartin, Partner and Application Specialist;
University of Arizona

Sara Schaffer, Web Designer & Developer;
University of Arizona

Jeff Switzer, System Analyst; University of Arizona

Call to Action

Tracking the status of just one plant in your backyard offers endless opportunities for scientific discovery. Not only will you gain a greater awareness of the changing of the seasons, your sensitivity to finer details will be heightened, and you'll witness tiny crab spiders perched inside tubular flowers and green inchworms hidden among lush leaves.

These observations are also invaluable to advancing science and informing resource management. Track seasonal changes of just one plant or animal in your yard using *Nature's Notebook* and contribute to a national-scale data resource!

Join a Campaign

Nature's Notebook campaigns are a great way to learn about the phenology of species of special interest, and see how the timing of their phenology changes over time. By collecting data for these campaigns, you also contribute to important scientific research.



Earn this badge by participating in the Nectar Connectors campaign! **Sign up for a 2017 campaign at www.naturesnotebook.org!**

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Brian Forbes Powell—cover photos; pages 2 and 5

Andrew Elmore—page 4

Suzanne Mrozak—page 6

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