USA npn
National Phenology Network

The Impact of the USA-NPN's Products and Tools in Science, Management, and Communication:
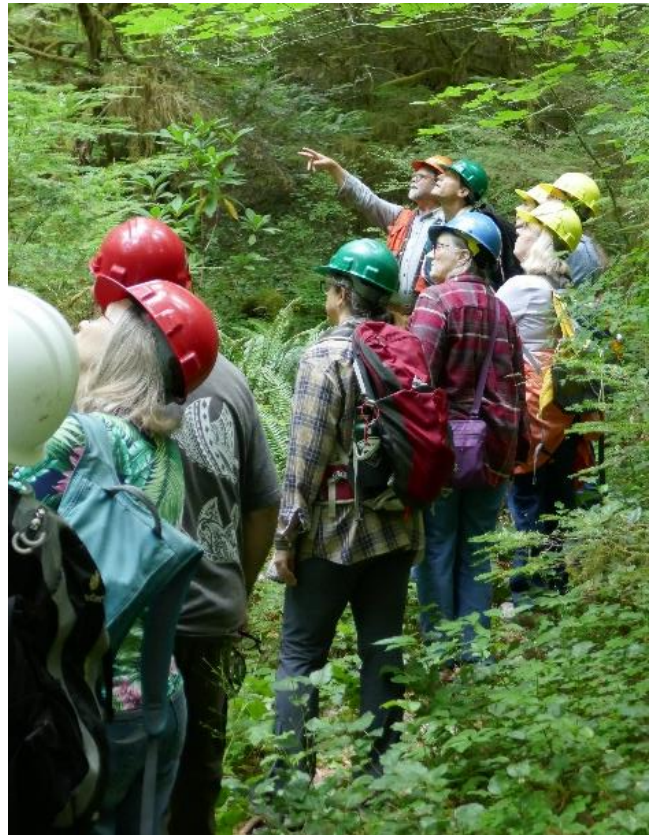
Testimonials from Our Partners

THE UNIVERSITY OF ARIZONA

USGS
science for a changing world

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Crowdsourcing data to understand the advantage of invasive species

Erynn Maynard-Bean, Postdoctoral Researcher, Penn State University

Why do you use USA-NPN Products and Tools?

I am a plant ecologist. As part of my PhD dissertation work, I wanted to better understand the novel leaf phenology of an invasive plant functional group that is growing in species richness and abundance across eastern forests - invasive shrubs. Basically, do invasive shrubs have extended leaf phenology compared to native shrubs and how does this change across space. A handful of local-scale research projects from sites across the region have had conflicting results, but our results provide a regional framework for understanding previously contradictory results from across the eastern U.S. I never would have been able to collect high-quality data across this large region to explain these conflicts on my own!

Shady Invaders badge for observers

## What did you do with USA-NPN Products and Tools?

With the USA-NPN platform and staff, I was able to launch a citizen science campaign with a website, and provide webinars and monthly eNewsletters to train and motivate participants to make observations at least weekly. The amazing efforts of citizen scientists revealed regional patterns in the differences between native and invasive shrubs that would have otherwise been impossible. Using several hundred citizen scientist observations, we found that invasive shrubs can have leaves more than 70 days longer than native shrubs each growing season. This gap decreases northward - the magnitude of extended leaf phenology decreases by 2.9 [1.6, 4.2] days per degree northward in the spring, and 2.2 [0.6,1.9] in the fall [95% credible intervals].

What impact has USA-NPN had on your work?

Without the USA-NPN, this project would have been implemented on a much smaller spatial scale (i.e. PA instead of eastern US), and regional patterns would not have been revealed. Even with the much smaller number of participants that I had without the USA-NPN, data collection and compilation would have been much more difficult and time consuming without the USA-NPN Nature's Notebook platform. The results from this research should (1) help with early detection and timing of management of invasive shrubs to avoid non-target native species, (2) inform policy limiting the sale of invasive shrubs where they have the most impact, and (3) allow local-scale research from different to be placed into a regional context (e.g. the difference and impact seen in NY will be greater than in GA).

Is there anything else you'd like to share with us?

Working with all of the staff at the USA-NPN has been an absolute pleasure. The collaborative nature of the organization is amazing. Specifically, the wonderful help of the USA-NPN Outreach Coordinator, Erin Posthumus, made the campaign possible and successful. From scheduling and recording my webinars to translating data, figures and content into website and eNewletter material, Erin really made the process smooth and the Shady Invaders campaign successful.
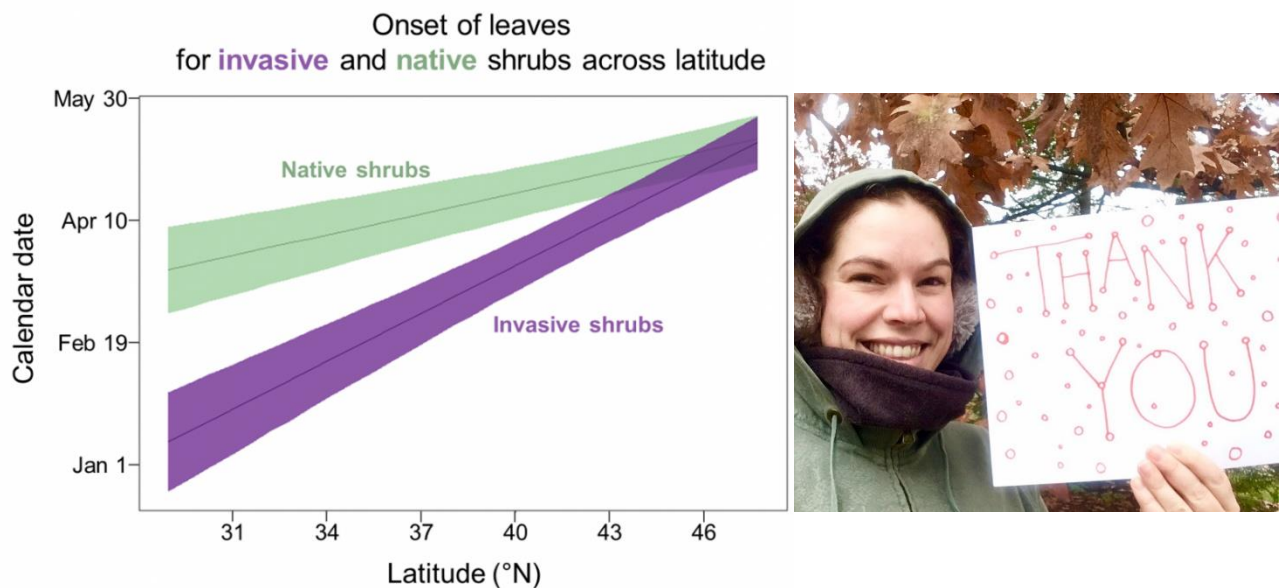
Results from the Shady Invaders data collection campaign showing the difference in onset of leaves between invasive and native shrubs across the eastern U.S. Erynn Maynard-Bean holds a sign thanking the volunteer observers who contributed to the campaign.

Linking individual plant data to canopy-scale and ecosystem-scale data

Andrew Richardson, Regents' Professor, Northern Arizona University

Why do you use USA-NPN Products and Tools?

Phenology is one of the key indicators of the biological impacts of climate change. USA-NPN data are vitally important benchmarks with which we can evaluate these impacts. There is no other comparable data set in North America.

What did you do with USA-NPN Products and Tools?

I am a researcher who has used USA-NPN data to develop and test models to predict phenological transitions, and to evaluate satellite remote sensing. We have used these data in papers published in many peer-reviewed journal articles. The ability to link from individual organism (USA-NPN) to canopy scale (PhenoCam) to ecosystem scale (satellites) is what makes these data useful.

The PhenoCam network uses imagery from digital cameras to track vegetation phenology in ecosystems across North America. Credit: Victor Leshyk

What impact has USA-NPN had on your work?

USA-NPN data provide important on-the-ground observations at organism scale. This level of detail is not currently possible with satellite data products, for example, and the continental-scale coverage of USA-NPN data is truly impressive. In the coming decades these data sets will be a veritable goldmine for researchers and land managers alike.

Setting standards for herbarium phenology guides

Katie Pearson, Project Manager, California Phenology Collections Network**,** Cal Poly State University, San Luis Obispo

Why do you use USA-NPN Products and Tools?

As project manager for an herbarium digitization network, I use USA-NPN data standards and phenological guides to help guide my development of herbarium-based phenological standards and guides.

What did you do with USA-NPN Products and Tools?

I use phenological guides developed by the USA-NPN as inspiration for developing herbarium-based phenological guides.

What impact has USA-NPN had on your work?

Our digitization network chose to preferentially digitize some of the taxa that the USA-NPN monitors so that we can provide historical data that can be compared to modern, observational data. The USA-NPN has also generally raised awareness of the importance of phenology in the citizen science world.

Herbarium specimen, California Phenology Collections Network.

Creating novel models to understand changes in plant phenology

Luke Zachmann, Senior Scientist, Conservation Science Partners

Why do you use USA-NPN Products and Tools?

We used the USA-NPN phenology data because of its large sample size, wealth of information on various phenophases, and broad geographic coverage of the United States. These characteristics make NPN data particularly useful for modeling exercises and for gaining an improved mechanistic understanding of plant phenology.

What did you do with USA-NPN Products and Tools?

We used USA-NPN phenology data (and software -- rnpn and the Observation Portal, for example) to facilitate the development of novel plant phenology models. These models help generate new inference and a deeper understanding of how phenology is changing and what factors are driving those changes.

What impact has USA-NPN had on your work?

The USA-NPN phenology data allowed us to iterate the development of our model by evaluating it against the many species for which USA-NPN has phenology data. This ultimately improved our model as well as the quality of the software that we developed to accompany it.

Is there anything else you'd like to share with us?

We have one publication forthcoming that details our model and demonstrates it using USA-NPN phenology data. We are hoping that the larger scientific community will make use of our model, particularly with USA-NPN data, to advance the science of phenology and our understanding of the natural world.

Aiding the understanding, assessment, and validation of remotely sensed land surface phenology

Josh Gray, Assistant Professor, NC State University

Why do you use USA-NPN Products and Tools?

USA-NPN products and tools are a critical source of plant phenology data. Because they are the most extensive and consistent database of (sub)organism-scale, direct observations of phenological events, USA-NPN data play an important role in understanding and assessing the remotely sensed land surface phenology products we create.

The median day of year (2001-2017) the greenness of a pixel first reached 50% of the annual maxium. Available at www.usanpn.org/data/land_surface_phenology

What did you do with USA-NPN Products and Tools?

My primary use of USA-NPN products is in understanding, assessing, and validating satellite remotely sensed land surface phenology products. They have been important in helping us understand the ecological meaning of our more abstract orbital measurements, and have revealed important scaling behaviors.

What impact has USA-NPN had on your work?

USA-NPN products and tools, as well as the community, have transformed the way I think about citizen/public science. These are high-quality measurements that have filled an important knowledge gap in my field. Effectively using these data have also pushed me to learn innovative statistical approaches that have improved my work.

Is there anything else you'd like to share with us?

Keep up the good work. I'm thrilled that Theresa will be at the helm, and I look forward to a bright future working with the outstanding USA-NPN team.

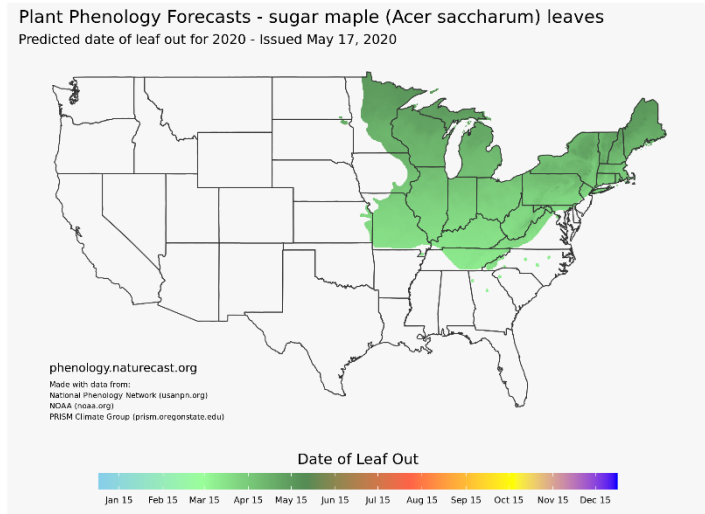# Supplying data for the creation of forecasted phenology models

Shawn Taylor, Research Ecologist, USDA-ARS

Why do you use USA-NPN Products and Tools?

I research large-scale phenology forecasting methods. By large scale, I mean several hundred individual species across each of their relative ranges, which encompasses the entire continental USA.

What did you do with USA-NPN Products and Tools?

I used USA-NPN data to build near-term forecasting models to predict the flowering and leaf out of plants across the USA (available to view at phenology.naturecast.org). This allows

Phenology forecast for sugar maple from phenology.naturecast.org.

users in the early winter and spring to plan for recreational and research activates revolving around, for example, when a specific plant will be in flower.

What impact has USA-NPN had on your work?

Besides the forecasting tool I also performed basic research into phenology models for my PhD dissertation, which I completed in 2019. As there is no other comparable dataset for plant phenology in North America, my dissertation work and the findings from it would not have been possible without the USA-NPN dataset.

Is there anything else you'd like to share with us?

As a user of numerous large datasets (i.e. t hose with over 1 million entries and/or 1GB in total size) I can attest that the USA-NPN team has developed one of the best interfaces for accessing and utilizing data. Their online interface provides an excellent tool for small queries and visualization, and their API and download tools are robust and well documented with ample documentation and metadata. They should be commended for setting a standard for data portals.

Professional decision support for pest management

Leonard Coop, Entomologist, Oregon State University

Why do you use USA-NPN Products and Tools?

There are numerous uses for products offered by USA-NPN. Mainly the tools are good for tracking and predicting the timing of plant and insect life history events.

What did you do with USA-NPN Products and Tools?

I compare the forecasts with other models.

What impact has USA-NPN had on your work?

They have helped me to better visualize how the seasons progress. They are a great example of a professionally developed decision support system for assisting in pest management decisions.
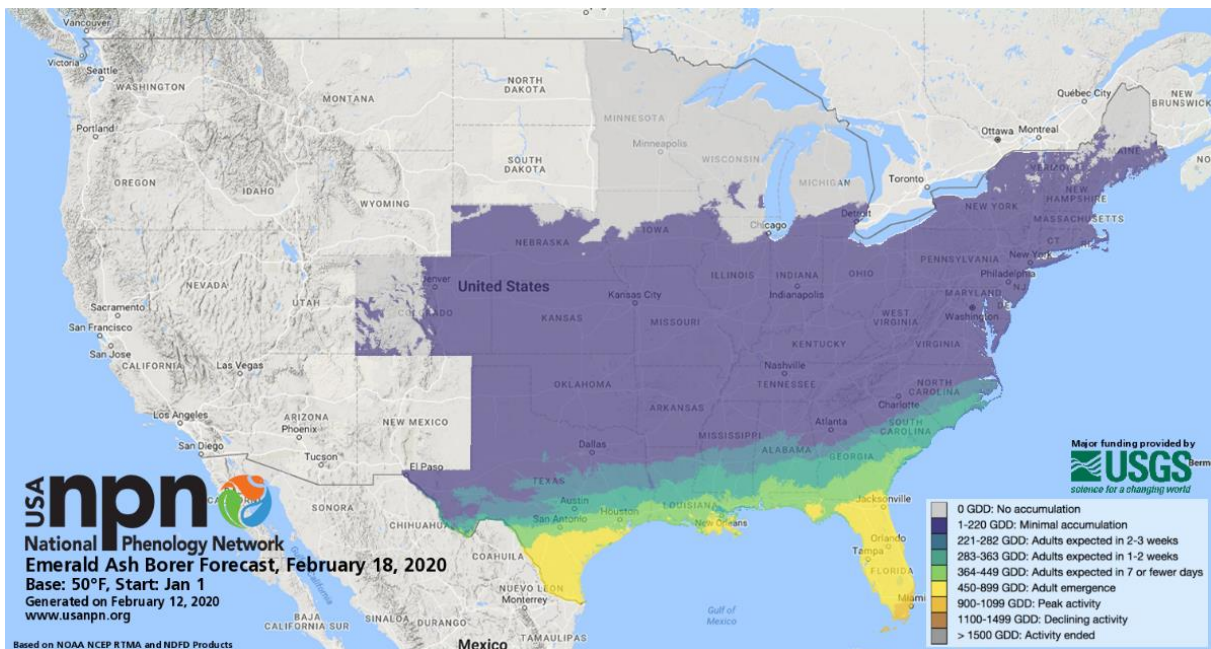
USA-NPN's 6-day Pheno Forecast for emerald ash borer. Colors indicate the status of adult emergence; yellow indicates adult emergence.

More accurate pest management to reduce pesticide use

Dan Herms, Vice President of Research and Development, The Davey Tree Expert Company

Why do you use USA-NPN Products and Tools?

I conduct research on tree health care management, including insect pest management, and make pest management recommendations to be applied by our company offices across the country.

What did you do with USA-NPN Products and Tools?

The Davey Tree Expert Company has operations in all 50 states. USA-NPN degree-day and pest phenology projections greatly facilitates the logistics of making geographically-specific pest phenology forecasts and pest management recommendations.

What impact has USA-NPN had on your work?

USA-NPN has made our pest phenology forecasting and pest management programs more accurate on a national level, which decreases pesticide use, exposure, and environmental impacts.

Is there anything else you'd like to share with us?

We hope that USA-NPN continues to expand and support their excellent tool-box!

Reliable AGDD information for timing pest treatment

Patrick Anderson, Arborologist, Rainbow Treecare Scientific Advancements

Why do you use USA-NPN Products and Tools?

I work as a consultant on IPM strategies with tree care and landscape management companies nation wide. I use USA-NPN products to help guide these companies on when to make treatments for pests in the landscape. Most often I use the visualization tool.

Photo: Patrick Anderson

What did you do with USA-NPN Products and Tools?

I've used the USA-NPN visualization maps to create treatment AGDD window calendars, and the pest maps to see what pest may become active. I also have been tracking bloom of several plant species local to me and record AGDD from the visualization maps.

What impact has USA-NPN had on your work?

USA-NPN products have been extremely helpful in my work. Finding reliable GDD information was a challenge prior to finding USA-NPN tools. Timing is so critical when making treatments for landscape pests, and these tools have helped me to guide companies in being more responsible with their IPM programs.

Is there anything else you'd like to share with us?

Keep up the good work. I'd like to see more pests added to the visualization maps, especially scale insect crawler activity.

Observational data to improve efficacy of treatment of a forest pest

Nicholas Dietschler, Research Technician, Graduate Student, Cornell University

Why do you use USA-NPN Products and Tools?

I use USA NPN tools to organize and coordinate the NYS Hemlock Initiative's Hemlock Woolly Adelgid Phenology Project. I worked with USA NPN staff to develop protocols for enabling hemlock woolly adelgid phenology observations. The goal of this project is to observe and record key HWA life stages for biological control research and management.

What did you do with USA-NPN Products and Tools?

I used *Nature's Notebook* and the *Nature's Notebook* app to record observations for HWA. This app and program was taught at 13 training sessions in New York state since 2017, and used by volunteers to enter observations. Pheno Forecast maps were used to help decide when volunteers should begin observing for key phenological events. These observations provided necessary data to decide when and where to release HWA biological control agents and conduct other management research.

What impact has USA-NPN had on your work?

The tools and programs surrounding HWA has improved our ability to observe and record HWA phenological events that are important to management throughout the landscape. Our program has also increased volunteer participation in some key areas of the state leading to biological control releases at multiple sites. HWA has a very complicated and mysterious life cycle, so there is room for improvement with the protocols and Pheno Forecast maps. That being said these tools are the beginnings to more effective management of HWA.

Is there anything else you'd like to share with us?

I am looking forward to future collaborations with the USA-NPN and helping to improve HWA observation tools. I strongly believe that our partnership will lead to important tools that HWA managers throughout the east coast will be able to use to increase management success.

Improving the scheduling of data collection efforts

Rebekah Wallace, Data Coordinator at Bugwood Center for Invasive Species and Ecosystem Health

Why do you use USA-NPN Products and Tools?

Phenology data and tools are important in invasive species management and mapping programs. Knowing when to expect different phenological and morphological stages helps to direct calls for data and outreach efforts.

## What did you do with USA-NPN Products and Tools?

Outreach and data calls through social media and other methods is important when working with citizen scientists and casual observers. Tools such as phenological maps and calendars allow more precise timing of these efforts as well as providing direction on the life stages or characteristics to look for.

What impact has USA-NPN had on your work?

Precise timing of when to call for data on certain species can increase awareness of the invasive species as well as data submitted. This is important when certain years may have more mild winters, wetter years, or other factors which can change the timing of plant or insect development.

Is there anything else you'd like to share with us?

The tools USA-NPN develops and makes broadly available will continue to be important for invasive species monitoring and management.
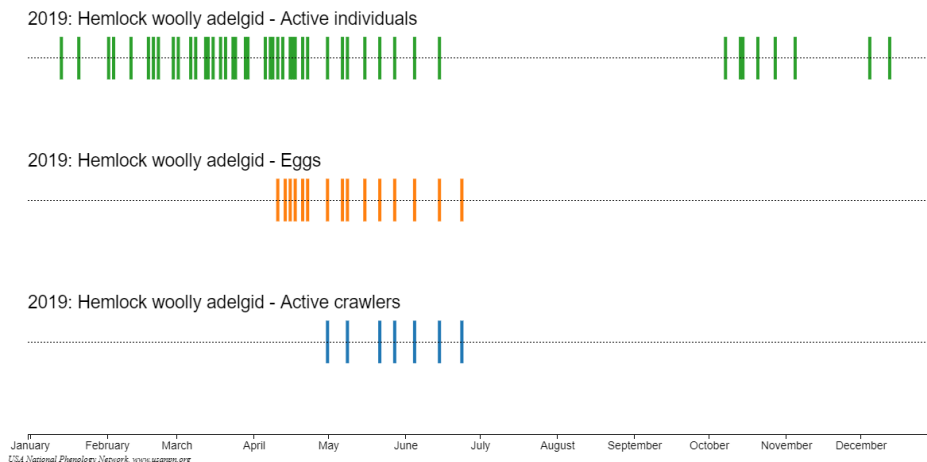

Phenology calendar from USA-NPN Visualization Tool showing data collected via *Nature's Notebook* on presence of hemlock woolly adelgid active individuals, eggs, and active crawlers in 2019.

Understanding changing spring timing in National Parks

John Gross, Ecologist, Climate Change Response Program, National Park Service

Why do you use USA-NPN Products and Tools?

I work across the NPS system (~420 parks) to help parks with climate adaptation. One of my key responsibilities is to inform parks about climate changes (past and future), about impacts that have been observed or are projected, and to work with them to design strategies to respond to changes. Changes in phenology are integrative, easy to understand and communicate, and important to many park resources and operations.
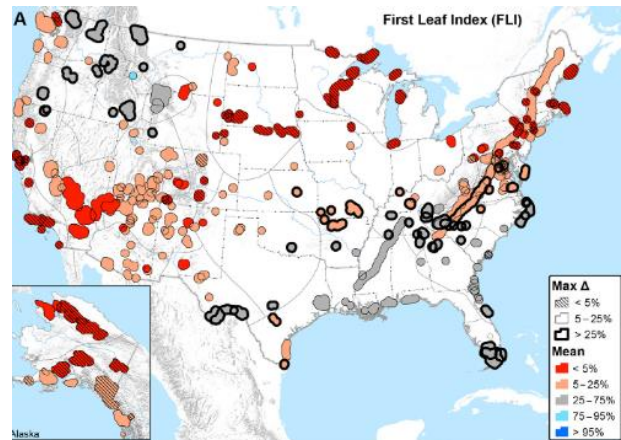
Spring leaf out in the National Parks. Red = recent decades are much earlier than the last century, gray = little change, blue = later than last century. From *Monahan er al. 2016*

What did you do with USA-NPN Products and Tools?

I, and the other scientists in the NPS Climate Change Response Program, routinely use data from USA-NPN, particularly the estimates of first leaf and first flower from the extended spring index (SI-x). Park staff readily understand changes in phenology that have already occurred, and this helps them interpret the more challenging physical climate data.

What impact has USA-NPN had on your work?

We present USA-NPN phenology data to about 20 parks per year, for a total of about 80 parks (for the 4 years these data have been available) or maybe 1600 people. It's really helped us make sense of and interpret changes like "the average temperature has increased 2.2 degrees" - nobody understands what a 2 degree temperature means, but the totally get it when you say first leaf is about 10 days earlier.

Is there anything else you'd like to share with us?

I've only talked about my experiences. MANY parks have active phenology monitoring programs. These are great for interpreters - they can easily talk to the public. Phenology has also been great to engage NPS cultural resources staff. Many homesteads planted lilacs and other plants that can be monitored for phenological changes. So it's a unifying activity that attracts a broad range of staff and visitors.

Helping the WaPo weather desk understand changes in spring

Jason Samenow, Weather editor, The Washington Post

Why do you use USA-NPN Products and Tools?

The maps are critical for our weather desk, which reports on local, national, and international weather, for tracking the progress of spring.

What did you do with USA-NPN Products and Tools?

The maps and spring indices help us put the season and its progression into historical context.

What impact has USA-NPN had on your work?

We have cited USA-NPN in several stories this year and in past years, in which we report on the evolution of spring and how the season may be changing due to climate change. We have also reached out to director Theresa Crimmins for expert commentary/quotes.

Adding credible science and significance to weather reporting

Elliot Williams, Staff Writer, DCist

Why do you use USA-NPN Products and Tools?

I write about all things D.C. and often, that includes the weather. The USA-NPN maps and data have come in handy as I cover the effect of the warm weather on the cherry blossoms at the Tidal Basin.

What did you do with USA-NPN Products and Tools?

I quoted USA-NPN director Theresa Crimmins and cited the early leaf out data published early this year to inform my articles.

What impact has USA-NPN had on your work?

It's been incredibly helpful to have a direct, credible source to go to for these stories. My editor has been impressed and it's added significance to my reporting.

Is there anything else you'd like to share with us?

Reporters rely on resources like the USA-NPN for our work. It's an invaluable resource. Thanks for all you do!

Studying the phenological sensitivity of plants to climate change

Susan Mazer, Professor of Plant Ecology and Evolution, University of California, Santa Barbara

Why do you use USA-NPN Products and Tools?

To enhance both undergraduate teaching and ecological research.

What did you do with USA-NPN Products and Tools?

I've used the data visualization tool to help students in my field botany class use variation in the timing of plant phenophases observed across space and time to articulate predictions regarding longer term responses of plants to climate change.

I've also used the NPNdb to compare the phenological sensitivity of plants to climate observed in situ to their sensitivity to climate as estimated from herbarium specimens.

What impact has USA-NPN had on your work?

I've published one paper that has included USA-NPN-derived data for the purpose of comparing observational vs. herbarium-derived electronic records, and this component of the publication wouldn't have been possible without the on-line accessibility of the NPNdb.
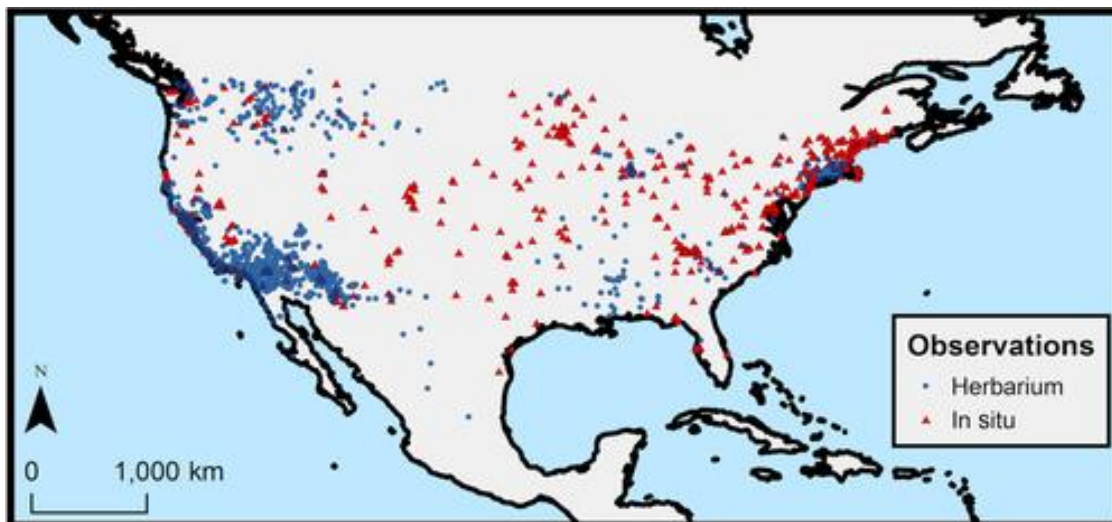
Distribution of herbarium specimens and repeated in situ observations from Nature's Notebook.
From *Park and Mazer 2018*

Streamlining citizen science data collection

Jessica Savage, Assistant Professor, University of Minnesota - Duluth

Why do you use USA-NPN Products and Tools?

I use *Nature's Notebook* in a local phenology program that I started in Lake Superior. I use the program because I find it a useful way to collect data and make phenology information accessible to the public for outreach and citizen science projects. I also find NPN tools useful in the classroom.

What did you do with USA-NPN Products and Tools?

We have a local program where volunteers monitor the same species at three sites that are different distances from Lake Superior. We have collected data weekly this last year and plan to continue in the future. There have been over 30 people involved but we have about 12 committed volunteers.

I use the USA-NPN Visualization tool in college courses that I teach. We have developed activities to examine phenology and climate change, and invasive species using this tool. Over 130 students have completed these activities since we developed them. We distribute the material we developed along with other activities available through the USA-NPN website when I run a continuing education workshop on citizen science in the summer for K-12 teachers.

What impact has USA-NPN had on your work?

I probably would not have started a citizen science network if a resource like *Nature's Notebook* was not available. It made it easy to streamline data collection and allowed we to focus on the program and not developing an app. In terms of the classroom, the data available through the visualization tool allowed me to explore long term phenology trends with my students in a way that I would not have been able to do otherwise. It provides a nice tool for analyzing data without the need for secondary programs that are not always accessible to everyone.

A platform for phenology data collection across Oregon State

Jody Einerson, Education Program Assistant, Benton County Extension, Oregon State University

Why do you use USA-NPN Products and Tools?

Oregon Season Tracker (OST) aims to broaden discussion and understanding about climate science, linking natural resource managers, educators, researchers and others in the community to the science they use through collaborative citizen science. Volunteers contribute scientific data on precipitation and plant phenology at their home, woodland, farm, ranch or school for their own land management decisions and to share with research partners both locally and nationally.

What did you do with USA-NPN Products and Tools?

In 2019 we continued to concentrate on areas from the previous year 1.) Reaching out to partners within Extension from previously untapped counties to train volunteers. 2.) Concentrating on supporting/retaining our volunteers through continued education opportunities and communications. This included our first volunteer/researcher learning retreat at partner HJ Andrews Experimental Forest LTER 3.) Continuing work with classrooms, offering teacher professional development, OST curriculum materials, and classroom support through 4-H.

Photo: Jody Einerson

What impact has USA-NPN had on your work?

By the end of 2019 the OST citizen scientists accounted for 189 unique registered rain gauge stations tracking precipitation with the OST program and the Community Collaborative Rain Hail & Snow Network (CoCoRaHS) national database. OST partners with the USA National Phenology Network to track plant phenology observations through *Nature's Notebook*. Volunteers associated with OST partner group are submitting data from their own home sites. In 2019 we also were able to reach out to Southwest Oregon with a training in collaboration with an Extension partner - training 14 new observers from that area. In 2019 we also worked with HJ Andrews to secure a $5000. grant to support the program in schools. This allowed us to bring the first group of 50 students to the forest to tour, meet the researcher, and go out in the field and share data collection.

Crowdsourcing data collection for research on high elevation wildflowers

Benjamin Blackman, Assistant Professor, UC Berkeley

Why do you use USA-NPN Products and Tools?

I use USA-NPN products and tools to promote and collect data for the Walking with Wildflowers program, a funded collaboration with USA-NPN to set up phenological monitoring by citizen scientists along two stretches of the Pacific Crest Trail (PCT).

What did you do with USA-NPN Products and Tools?

In the course of this collaboration, we have used *Nature's Notebook* to post materials for PCT hikers to find sites, identify species and focal individuals, assess phenophase, and record their data. We also worked with the USA-NPN to develop a subsite on their website to promote the program. I also used the database tools available through the USA-NPN to track the records that have accumulated as part of our program.

What impact has USA-NPN had on your work?

Collaboration with USA-NPN has helped my group secure NSF funding for our research and broader impacts efforts. The products and tools made available by USA have facilitated connections with and training of citizen scientists, standardized collection of data, and gathering of summary statistics to report back to the funding agency.

Exploring the connections between climate and plant responses

Ryan Boyles, Deputy Director, Southeast Climate Adaptation Science Center, USGS

Why do you use USA-NPN Products and Tools?

USA-NPN has a set of unique data and visualizations that help me explain the connections between weather/climate and plants/habitat response.

What did you do with USA-NPN Products and Tools?

I use USA-NPN spring index maps and GDD models when training students and professionals about how climate drives plant phase. Most recently, I used these USA-NPN products in a course designed for 2nd year undergrads learning ecology. USA-NPN maps help them to explore and understand the close connection between weather and spring emergence, and also showed them the value (and risks) of making forecasts.

What impact has USA-NPN had on your work?

I would not be been able to teach (professionals and students) as effectively without USA-NPN tools and data.

USA National Phenology Network
Spring Leaf Index Anomaly, May 19, 2020
www.usanpn.org
Based on NOAA NCEP RTMA and NDFD Products

20 Days Early — No Difference — 20 Days Late

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