USA National Phenology Network

Phenological changes in the National Wildlife Refuge System

Region 5: Connecticut, Deleware, DC, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia

Observations of phenology — the seasonal timing of life cycle events in plants and animals such as flowering, hibernation, and migration — describe key aspects of ecological variability, and serve as indicators of climate change impacts on refuge ecosystems.

WHY PHENOLOGY?

Phenology is used to improve our understanding of which climate cues and other factors trigger key biological events such as migration and breeding, and the resulting impact on ecosystem dynamics such as water availability, carbon cycling, and disturbances such as fire and insect emergence. Knowing whether flowering is becoming decoupled from pollinator activity, or whether leaf production tracks with earlier snowmelt, helps managers understand the threats to ecosystem integrity.

The USA National Phenology Network (USA-NPN) has partnered with the USFWS since 2014 to provide a standardized data collection platform for National Wildlife Refuges (NWRs) to track phenology of wildlife and their habitats, as well as inform management with synthesized phenology data products such as maps forecasting spring and activity of species of interest.

PHENOLOGY PERSPECTIVES

Phenology provides a critical tool for insect pest management. Hemlock woolly adelgid (*Adelges tsugae*) is an insect pest that kills hemlock trees (Tsuga spp.) by preventing new twig and needle growth. Forest managers and tree care specialists need to know when to release insect predators to most effectively control this pest. Through a collaboration with the New York Department of Environmental Conservation and Cornell University, volunteers in New York are collecting phenology observations of the adelgid using Nature's Notebook to determine when adelgids are most vulnerable to treatment.

"Our partnership with USA-NPN will lead to important tools that HWA managers throughout the east coast will be able to use to increase management success."

— Nicholas Dietschler, New York State Hemlock Initiative

SHIFTS IN PHENOLOGY

Globally, animals have advanced their phenology by nearly three days per decade since 2050[1]. Many phenological events are influenced by temperature, particularly in areas that have experienced more climate change[1], though authors of a study that used USA-NPN data found that in northern ecosystems, decreasing precipitation also plays a role in earlier leaf out in plants[2].

CHANGING CLIMATE IN THE REGION

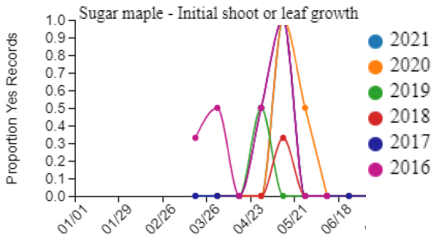
This region is expected to see increased annual temperature, warm nights, annual precipitation, heavy precipitation, and sea level rise[5].

The timing of reproduction, migration, and hibernation in animals, and the timing of flowering and seeding in plants are all shifting in response to climate change, in many cases with negative impacts on fitness[3]. The relative timing between interacting species has changed significantly over the last 35 years, though there has been no consistent trend in the direction of the changes[4]. Smaller organisms and ectotherms may track change better than larger ones and herbivores may track temperature changes more closely than carnivores. The arrival timing of migrating animals tracks changes the least compared with peak seasonal abundance and breeding activities[1].

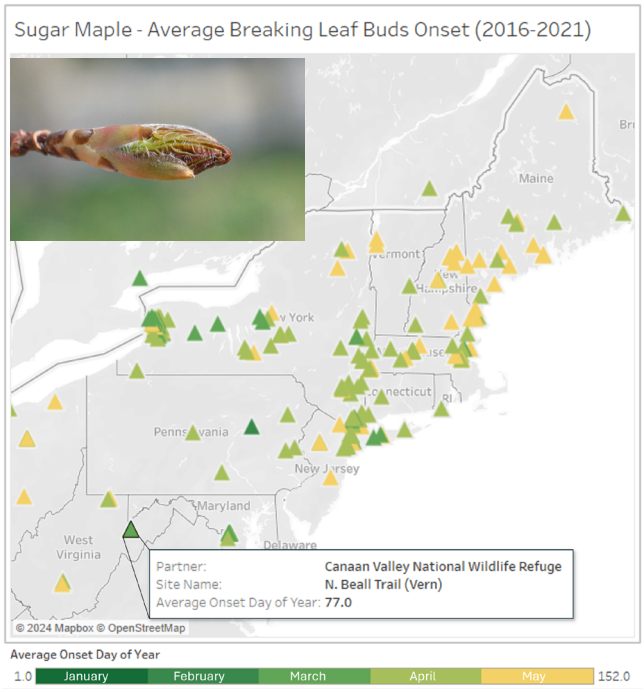
Differential changes in plants and animals may lead to mismatches, with significant decreases in reproductive fitness observed for some species. Tri-trophic systems, such as those of oak trees, caterpillars that eat their young leaves, and insectivorous birds that feed on caterpillars, have increased potential for mismatches[3].

PHENOLOGY CHANGES IN THE NATIONAL WILDLIFE REFUGE SYSTEM REGION 5: CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT, VA, WV

January 2024



Proportion of "yes" reports forsugar maple (*Acer saccharum*) breaking leaf bud at Canaan Valley NWR across the year (left) and average timing of breaking leaf bud onsets at Canaan Valley NWR and across the Northeast region (right) from 2015-2021.



UNDERSTANDING PHENOLOGICAL CHANGES

Canaan Valley, WV sits at over 3,000 feet above sea level, nestled in a valley that hosts species that typically occur at higher latitudes such as Maine and Canada. By monitoring the life cycle events of these species, Canaan Valley NWR staff better understand the environmental cues of phenology for these species in the Valley and how these cues compare to those in the rest of the species' ranges.

The first step in identifying climate cues is to document the start of life cycle stages such as breaking leaf buds in species of interest. The Refuge has recorded six years of data on sugar maple as well as grasses, nectar plants, shrubs, and other trees - the key ingredients for determining what weather conditions lead to plants undergoing transitions such as leaf-out and flowering. This example demonstrates how a long-term dataset can be collected for exploring the influence of climate on phenology at the regional level.

PHENOLOGICAL MONITORING, BY THE NUMBERS: A CASE STUDY FROM RACHEL CARSON NWR

What does it take to establish a phenology monitoring program at a refuge? Rachel Carson NWR is using phenology monitoring to better understand how climate change is impacting plants at the Refuge.

How long has the Refuge been participating? Since 2012.

Who collects the data? Mostly seasonal interns, with some assistance from staff.

What is the time investment? Weekly monitoring runs from June to September, monthly in other times of the year. A single visit takes about 15 minutes to complete.

What does the Refuge plan to do with the data? Staff have limited current capacity to analyze data, but if they attain resources, they plan to use the data to understand timing of food resources for wildlife (e.g. wild blueberry fruiting timing) and understand shifts in timing of other species.

OPPORTUNITIES FOR ACTION

Refuges are invited to use USA-NPN's scientifically-vetted, species-specific monitoring protocols, data management infrastructure, and data visualization tools. The *Nature's Notebook* app enables crowdsourcing of data collection to leverage the power of visitors to record observations on many different species. A refuge can track shifts in phenology and develop more focused monitoring on the species that demonstrate shifts of concern.

Refuges can capitalize on USA-NPN's Local Phenology Program partners as well as data collected by independent observers in areas near refuges to understand changes at landscape scales, supporting the USFWS Climate Change Action Program (2021).

Phenology can be used in the Resist, Accept, Direct framework to inform the timing of invasive species management and prescribed fire or to provide guidance on planting species for future climate conditions. For example, to support pollinators during a particular season, knowing the flowering timing for a suite of plant species can guide species selection.

Phenology can also be used in vulnerability assessments to assess species sensitivity to climate changes[6]. It can also be used for targeted land acquisition to guide selection of new areas that will match the phenology of protected areas that are no longer suitable due to shifts in climate.

Visit the USFWS Phenology Network hub at fws.usanpn.org or email info@usanpn.org to learn more.

THE UNIVERSITY OF ARIZONA

Photo credits: Ellen G Denny (front and back top, back bottom), HWA Conn Ag Exp Station Archive, Bugwood.org (front bottom)

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