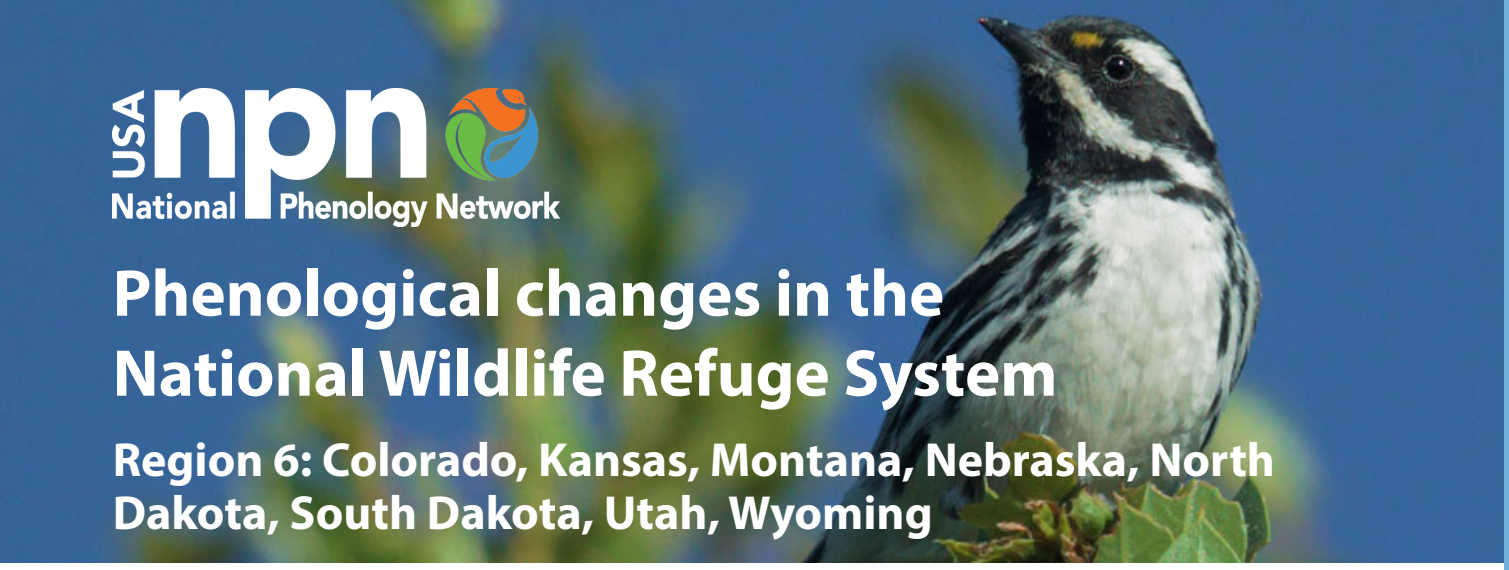


Phenological changes in the National Wildlife Refuge System

Region 6: Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, Wyoming

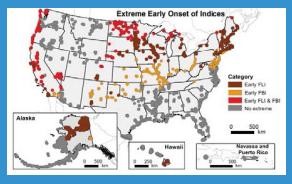
Observations of phenology — the seasonal timing of life cycle events in plants and animals such as flowering, hibernation, and migration — describe key aspects of ecological variability, and serve as indicators of climate change impacts on refuge ecosystems.

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



The USA-NPN's Spring Index maps, which indicate the timing of early spring activity, offer a concrete visual of changing phenomena. Tools available at fws.usanpn.org help managers understand when spring is arriving on their refuge and how the current year stacks up to a long-term average.

"The [USA-NPN's] study findings, and resultant dynamic tools, have direct management application by helping staff better align the timing of management actions to changing environmental conditions, potentially increasing the efficacy of these actions."

— Jana Newman, Former Inventory & Monitoring Branch Chief, USFWS

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, annual precipitation, and heavy precipitation[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].

January 2024

Proportion of "yes" records for breaking leaf buds in *Populus*, *Prunus*, and *Acer* genera in the Mountain Prairie region in 2023. Photos of leaf buds of cottonwood (Credit: Erin E Posthumus), cherry and maple (Credit: Ellen G Denny).

UNDERSTANDING PHENOLOGICAL CHANGES

Dominant overstory trees such as cottonwoods (*Populus*), cherries (*Prunus*), and maples (*Acer*) provide critical habitat for migrating birds in spring. Many neotropical migrants rely on the abundance of caterpillars that emerge in sync with budburst as a source of food.

The USA-NPN has abundant data on the timing of leaf out in deciduous trees across the country. The curve above displays data from across the Mountain Prairie Region of breaking leaf bud timing in 2023. Cottonwoods were the first to leaf out, followed by cherries and maples.

Long-term observations of leaf out can help managers identify mismatches in timing of green-up and migrating bird arrival as bird ranges shift in time and space.

PHENOLOGICAL MONITORING, BY THE NUMBERS: A CASE STUDY FROM MINNESOTA VALLEY NWR

What does it take to establish a phenology monitoring program at a refuge? The Minnesota Valley NWR involved school groups and volunteers in tracking the phenology of deciduous trees and nectar plants important for migratory birds, pollinators and resident wildlife species.

How long has the Refuge been participating? From 2017-2021.

Who collects the data? Staff, school groups, and volunteers.

What is the time investment? Observations were made weekly between May and October at three different sites, occasionally including visiting school groups on field trips. Each site visit took an average of 45 minutes of travel time, 75 minutes of observation time.

What does the Refuge plan to do with the data? Refuge staff hope to use the data to shed light on mismatches in timing between plants and the animals that use them.

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: Tom Grey (front top), Erin E Posthumus (back top) Ellen G Denny (back top and bottom).

REFERENCES: [1]Cohen J.M. et al. 2018: A global synthesis of animal phenological responses to climate change. Nat. Clim.Change, 8, 224–22; [2]Wang, J. et al. 2022: Decreasing rainfall frequency contributes to earlier leaf onset in northern ecosystems. Nat. Clim. Change, 12, 386–392; [3]Inouye, D.W., 2022: Climate change and phenology. WIREs Climate Change, 13, e764; [4]Kharouba, H.M., et al., 2018: Global shifts in the phenological synchrony of species interactions over recent decades. Proc Natl Acad Sci USA, 115, 5211–5216; [5]USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., et al. Eds. U.S. Global Change Research Program, Washington, DC, USA; [6]Enquist, C.A. et al. 2014 Phenology research for natural resource management in the United States. Int J Biometeorol. 58, 579-89

CONTACT:
USA National Phenology Network
1311 East 4th Street,
Tucson, AZ 85721
info@usanpn.org
fws.usanpn.org