

Phenological changes in the National Wildlife Refuge System

Region 2: Arizona, New Mexico, Oklahoma, Texas

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.

SHIFTS IN PHENOLOGY

Globally, animals have advanced their phenology by nearly three days per decade since 2050¹. Many phenological events are influenced by temperature, particularly in areas that have experienced more climate change¹, 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 plants².

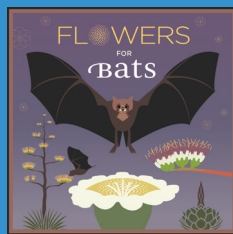
CHANGING CLIMATE IN THE REGION

This region is expected to see increased annual temperature, warm nights, and heavy precipitation, and a decrease in annual precipitation⁵.



PHENOLOGY PERSPECTIVES

Phenology can support Species Status Assessments and monitoring for the delisting process. As part of the Post-delisting Monitoring Plan for the lesser long-nosed bat, *Leptonycteris yerbabuena*, the USFWS needs to track food availability during the bat's breeding season. USA-NPN engages volunteer and professional scientists including three NWRs in Arizona in tracking flowering and fruiting of columnar cacti and agave that are used by the bats through the Flowers for Bats campaign.



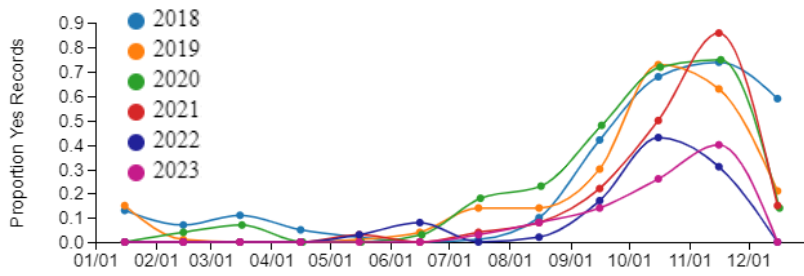
"Using the USA-NPN resources provides us with defensible, understandable, and ecologically meaningful data that are useful in all aspects of implementing the Endangered Species Act."

– Scott Richardson, USFWS Supervisory Biologist

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 fitness³. 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 changes⁴. 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 activities¹.

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 mismatches³.

Rio Grande cottonwood Falling Leaves



Timing of Rio Grande cottonwood (*Populus deltoides wislizenii*) falling leaves in 2018-2023. Photo of fallen leaves by acRodewig.

UNDERSTANDING PHENOLOGICAL CHANGES

The Rio Grande Phenology Trail encompasses multiple NWRs – Valle de Oro NWR and Sevilleta NWR – and other organizations along the Rio Grande in New Mexico. Trail partners track phenology of species that are critically important for the Middle Rio Grande, including the Rio Grande cottonwood (*Populus deltoides wislizenii*), a keystone species of the Rio Grande Bosque ecosystem and important source of food and shelter for wildlife. Knowing when this species spreads its seeds indicates the best time to flood to encourage

germination. Also, knowing when this species drops leaves indicates the best time to collect cuttings from cottonwoods for pole planting to propagate the trees.

The activity curve above shows the timing of “falling leaves” in cottonwoods on the Trail over the last six years. These observations suggest that the best time to collect cottonwood poles for planting is between October and November. This example highlights the actionable information that can be gained from a multi-year phenology monitoring program.

PHENOLOGICAL MONITORING, BY THE NUMBERS: A CASE STUDY FROM LESLIE CANYON NWR

What does it take to establish a phenology monitoring program at a refuge? Leslie Canyon NWR is using phenology monitoring to contribute to the Lesser Long-nosed Bat Post-Delisting Monitoring Plan.

How long has the Refuge been participating? Since 2018

Who collects the data? Refuge staff and interns

What is the time investment? Weekly monitoring from May to early November of flowering of five individual agave; travel time is 40 minutes, phenology observation time is 1-2 minutes per plant.

What does the Refuge plan to do with the data? Data support post-delisting monitoring and provide information about nectar availability when lesser long-nosed bats are raising their young.

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 changes⁶. 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.



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

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