Phenological changes in the National Wildlife Refuge System

Region 3: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin

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 is an ideal topic for engaging visiting school groups. Project WILD is an education program emphasizing awareness and understanding of wildlife and natural resources hosted by the Ohio Division of Wildlife. The program utilizes the USA-NPN's *Nature's Notebook* plant and animal observation platform as a tool for educators to help students investigate the landscape around them, explore citizen science opportunities, and learn more about local ecology.

"*Nature's Notebook* is an easy to use platform that helps participants learn more about the landscape around them. Educators and students alike appreciate the fact that their data is getting used for real science research."

– Jen Dennison, Wildlife Education Coordinator/State Project WILD Coordinator, Ohio Division of Wildlife

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, 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].

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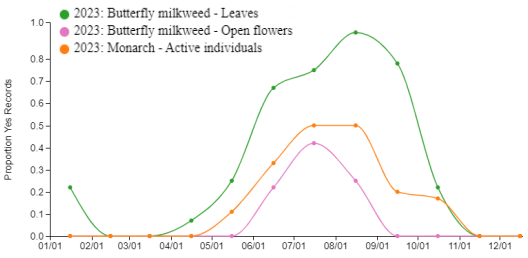

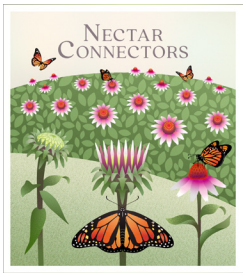

Timing of butterfly milkweed leaves and open flowers and monarch adults, photo by Karen Viste-Sparkman of monarch on butterfly milkweed, the *Nature's Notebook* Nectar Connectors data collection campaign logo.

UNDERSTANDING PHENOLOGICAL CHANGES

Science and Visitor Services staff at Neal Smith NWR took part in a USA-NPN workshop in 2017 to determine priorities for phenology monitoring at their Refuge. They identified a suite of focal species for monitoring from two key ecosystems - prairie and oak savannah.

Inspired by their interest in pollinator and nectar plants, the Refuge participates in the *Nature's Notebook* Nectar Connectors campaign. The USA-NPN initiated this campaign in 2017 to assist the USFWS and other natural resource managers concerned about monarchs and other pollinators to improve collective understanding of nectar resource availability throughout the growing season across the United States. Participants monitor flowering of important monarch butterfly and pollinator nectar plants.

Data collected by Neal Smith NWR and other refuges help provide a picture of where and when nectar resources are available over the growing season and how this corresponds to the migration and breeding needs of monarchs and other pollinators. These data will help the USFWS evaluate habitat quality and landscape-scale connectivity in space and time.

PHENOLOGICAL MONITORING, BY THE NUMBERS: A CASE STUDY FROM NEAL SMITH NWR

What does it take to establish a phenology monitoring program at a refuge? Neal Smith NWR is using phenology monitoring to answer questions related to the timing of nectar availability for monarchs at the refuge.

How long has the Refuge been participating? Since 2017.

Who collects the data? Mostly regular volunteers with some staff and intern support.

What is the time investment? Biweekly monitoring occurs from January-March, then weekly monitoring from April-Dec. Observers spend 35 minutes per site visit at two sites in two different ecosystems - savannah (tracking bur oak, two other savannah plants, and Red-headed Woodpecker) and prairie (tracking monarchs and three nectar plants).

What does the Refuge plan to do with the data? The data will inform the timing of mowing and burning activities to have least impact on wildlife. They also will use the data for visitor services, providing interpretation for visitors and letting them know when to see species of interest.

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: Nicole Menard (front), Karen Viste-Sparkman (back top), USFWS HQ (back 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

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