Phenological changes in the National Wildlife Refuge System

Region 7: Alaska

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

Explaining climate change impacts to the public can be challenging. The USA-NPN's Spring Index maps, which indicate the timing of early spring activity, offer a concrete visual of changing phenomena. Tools at fws.usanpn.org help managers understand when spring is arriving on their refuge and how the timing of the start of spring has changed over recent decades.

"We present USA-NPN phenology data to about 20 National Parks per year. 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 change in temperature means, but they totally get it when you say 'first leaf is about 10 days earlier.'"

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

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].

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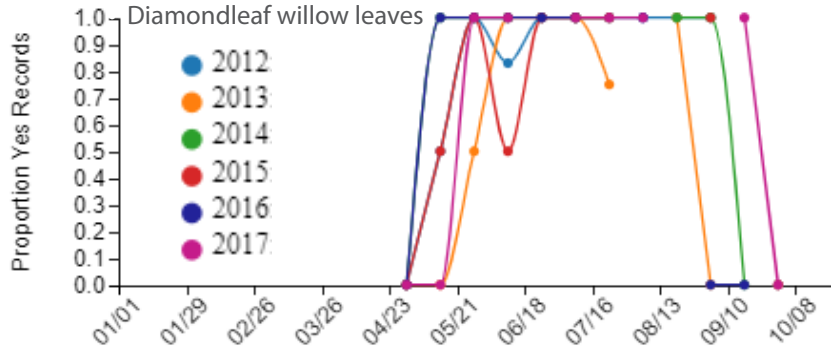

Proportion of "yes" records for leaves on diamondleaf willow (*Salix planifolia*) from 2012-2017. Photo of diamondleaf willow (Credit: Matt Lavin, CC BY-SA 2.0 DEED).

UNDERSTANDING PHENOLOGICAL CHANGES

From 2010-2017, the Arctic National Wildlife Refuge staff collected observations in locations around Alaska using Nature's Notebook to document phenological shifts driven by climate change. The Refuge staff monitored plants important for caribou, elk, beaver, and birds, including diamondleaf willow (Salix planifolia).

The plot above shows when leaves were documented between 2012 and 2017, showing interannual slight variation in the start and end of forage availability.

By carefully documenting plant phenology, refuge staff know when leaves, flowers, and fruits will be available as forage on and around the Arctic NWR.

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

What does it take to establish a phenology monitoring program at a refuge? Kodiak NWR uses cameras at remote sites to monitor phenology of berry producing shrubs to document shifts in bears' food resources.

How long has the Refuge been participating? Since 2015

Who collects the data? Staff operate trail cameras to monitor four berry-producing shrubs at 12 sites over the growing season. Staff inspect images and document dates of phenological transitions such as flowering and fruit ripening. Observations are imported to the USA-NPN database on an annual basis.

What is the time investment? Monthly visits to 12 sites between April and October take about 32 hours total annually. Phenology classification from photos takes about 48 hours total annually, which includes data quality control.

What does the Refuge plan to do with the data? The data are used to make predictions about future changes in the timing of berry production, particularly the peak in production. This will inform management actions to support bear populations at Kodiak.

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: USFWS (front top and back bottom), Matt Levin, CC BY-SA 2.0 DEED (back top).

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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