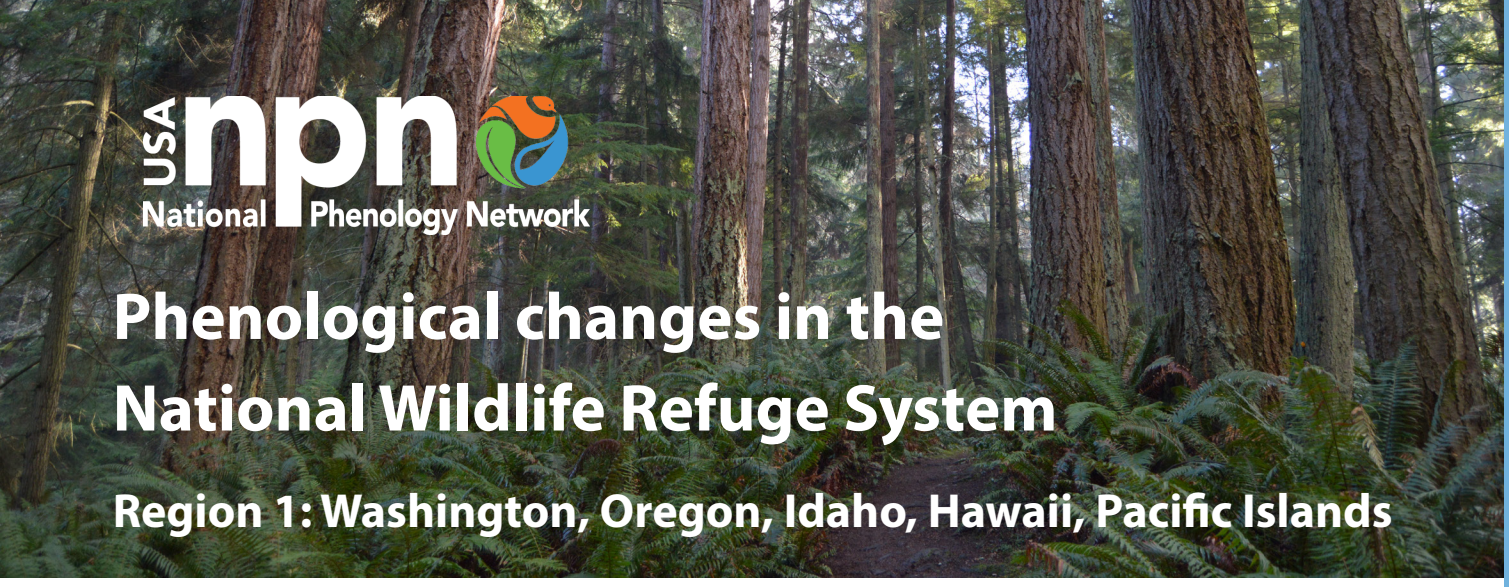

USA npn National Phenology Network

Phenological changes in the National Wildlife Refuge System

Region 1: Washington, Oregon, Idaho, Hawaii, Pacific Islands

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

Phenological monitoring provides educational opportunities and inspires stewardship of local resources. Oregon Season Tracker (OST) aims to broaden discussion and understanding about climate science, linking natural resource managers, educators, researchers and others in the community through collaborative citizen science. Volunteers contribute scientific data on precipitation and plant phenology at their home, woodland, farm, ranch or school for their own land management decisions and to share with research partners both locally and nationally.

"These data are used by Oregon and national researchers to better understand weather, climate, and native plant interactions. In addition, our volunteers gain important insight on the microclimate and ecology of the place they live."

– Jody Einerson, Founder of Oregon Season Tracker

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].

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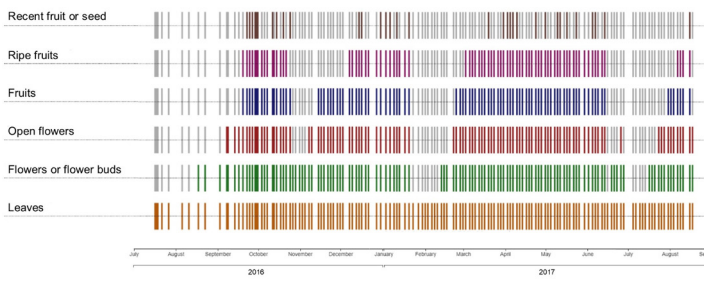

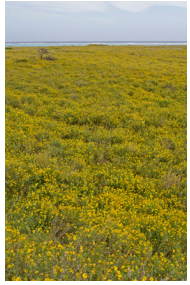

Number of Days from 'Leaves' to 'Recent fruit or seed drop' for *Verbesina encelioides*

	Minimum number of days	Maximum number of days	Range of days
August to October	31	53	22
December to April	89	110	21

Timing of life stages of Verbesina enceliodes on Midway Atoll NWR from 2016-17, dense coverage of Verbesina (photo by Dan Clark USFWS), and summary table of timing between leaves and recent fruit drop.

UNDERSTANDING PHENOLOGICAL CHANGES

In 2016, Midway Atoll National Wildlife Refuge began a phenology monitoring project to document the timing between leaf out and seed development of invasive Verbesina encelioides, or golden crownbeard. Verbesina is fast-growing and forms dense, monotypic stands, and used to cover 70% of the land surface across both Eastern and Sand Islands at Midway. This species disrupts and degrades surface-nesting seabird habitat and is linked to lower reproductive success and survival of albatross.

Fewer than two years of monitoring generated sufficient data to estimate the number of days required for this invasive plant to reach seed maturity (see table above). The time it takes for Verbesina to reach seed maturity can vary threefold within a year, from 31 days in summer to 89 in winter.

This information is being used to guide weed treatment on the refuge. Specifically, the minimum number of days it takes for the plant to reach seed maturity is used as the maximum duration between visits by the weed control technicians. This example demonstrates the actionable information that can result from even a short-term phenology monitoring effort.

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

What does it take to establish a phenology monitoring program at a refuge? Midway Atoll NWR used phenology monitoring to identify the window to remove invasive Verbecina enceliodes between initial growth and seeding.

How long has the Refuge been participating? The Refuge collected data from 2016-17.

Who collects the data? Staff and interns.

What is the time investment? The Refuge collected data on 36 plants at four different sites between July of 2016 and August of 2017. Visiting sites 2-3 times per week took an average total time of 45 minutes each week.

What does the Refuge plan to do with the data? Knowing the duration of time in between initial growth and recent seed drop helps managers know how much time they have to get out to pull or treat this invasive species before it goes to seed.

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: Erin Posthumus (front top), Jody Einerson (front bottom), Dan Clark, USFWS (back)

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