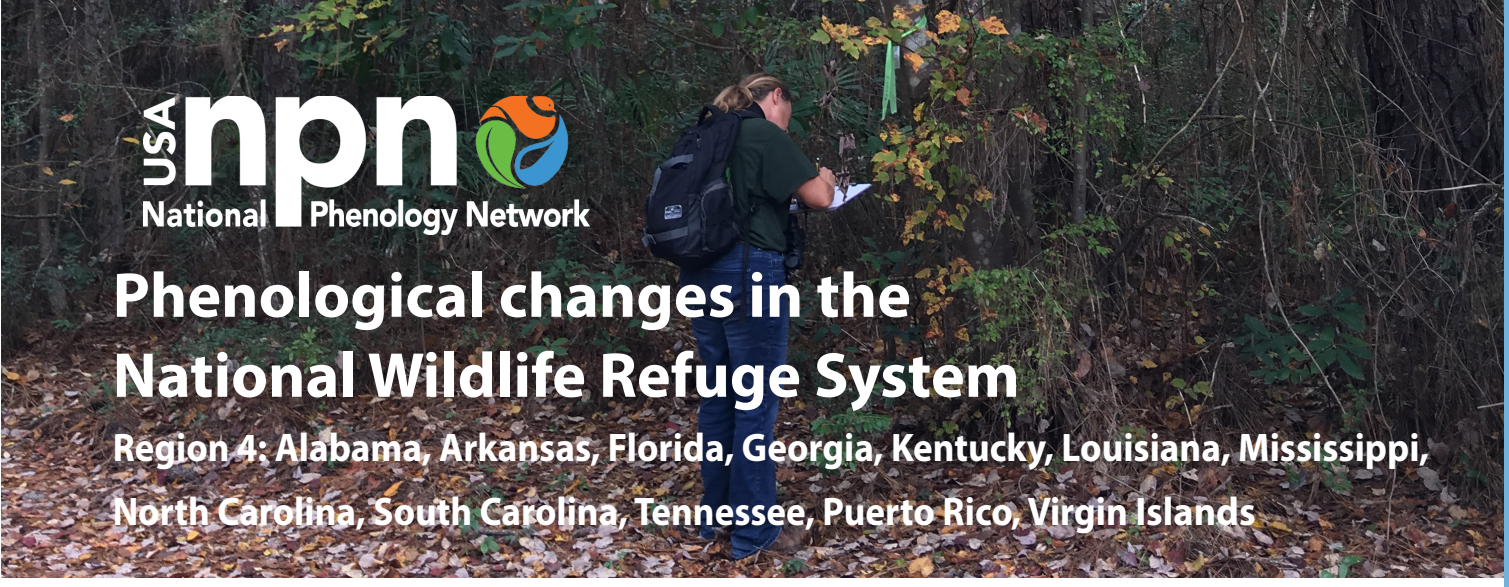


Phenological changes in the National Wildlife Refuge System

Region 4: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Puerto Rico, Virgin 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

The Gulf Coast Phenology Trail was established in 2016 to better understand the effects of climate change along the Gulf Coast. Trail partners include National Wildlife Refuges, National and City Parks, an Audubon Center, an Arboretum, and a Community College. The virtual Trail -- comprised of multiple sites in the region -- allows comparison of phenology across refuge and non-refuge locations, providing a landscape-level context to the changes occurring along the Gulf Coast.

"Refuge biologists are seeing a lot of the changes, but they're not necessarily able to document them. Through our partnership with USA-NPN we're able to start really documenting the changes that we're seeing."

— Sue Wilder, Retired Ecologist, Gulf Zone Inventory & Monitoring/Fire Ecology, US Fish & Wildlife 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].

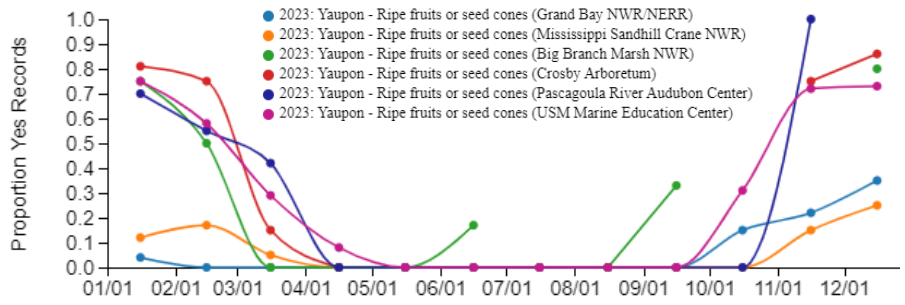
CHANGING CLIMATE IN THE REGION

This region is expected to see increased annual temperature, warm nights, annual precipitation, heavy precipitation, and flooding[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 observers reporting "yes" to ripe fruit of yaupon (*Ilex vomitoria*) at multiple Gulf Coast Phenology Trail locations, yaupon ripe fruit (Credit: Gail Bishop).

UNDERSTANDING PHENOLOGICAL CHANGES

The Gulf Coast Phenology Trail brings together 14 partners, including three National Wildlife Refuges -- Grand Bay NWR/NEER, Mississippi Sandhill Crane NWR, Big Branch Marsh NWR, and Bauyou Sauvage NWR -- to track phenological changes in native and invasive species. One species tracked by multiple partners is yaupon (Ilex vomitoria), a native evergreen shrub that produces berries consumed by birds and other wildlife.

The curve above shows the proportion of observers reporting berries throughout the year. The Arboretum and Audubon Center report berries for a single long season, while Big Branch Marsh NWR report berries during both summer and winter months.

These observations provide a landscape-level look at seasonal activity and allow refuges to evaluate fruit availability both on and off of refuge to understand whether they are meeting their mission of providing resources for species of interest.

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

What does it take to establish a phenology monitoring program at a refuge? Staff at the combined Grand Bay National Estuarine Research Reserve and National Wildlife Refuge are studying long-term trends in phenology of selected species of plants and animals to improve conservation efforts.

How long has the Refuge been participating? Since 2016.

Who collects the data? Staff, interns, and volunteers.

What is the time investment? Weekly visits are made to two sites and observations are collected on two species of animals, four native plants, and one invasive plant. Data collection at each site takes 30-60 minutes depending on the season.

What does the Refuge plan to do with the data? Data are used to understand climate change impacts on key species and study the interplay between phenology and fire along the trail.

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: Gail Bishop (front and back top), Sue Wilder (back bottom).

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