

Phenology Monitoring On Refuges: Don Edwards San Francisco Bay National Wildlife Refuge

The USA-NPN/Refuge Partnership: A commitment to science-based management

Best management practices and refuge goals are driven by science; a thorough understanding of the biological, as well as ecological, needs of natural resources is key to effective resource management. One component of this understanding is phenology, the study of naturally occurring lifecycle events. If land managers are interested in removing invasive plants before they begin to reproduce, phenology can be used to find the best time to increase removal efforts. If naturalists are interested in knowing when particular bird species will be present in a region, phenology can help them plan their visit accordingly.

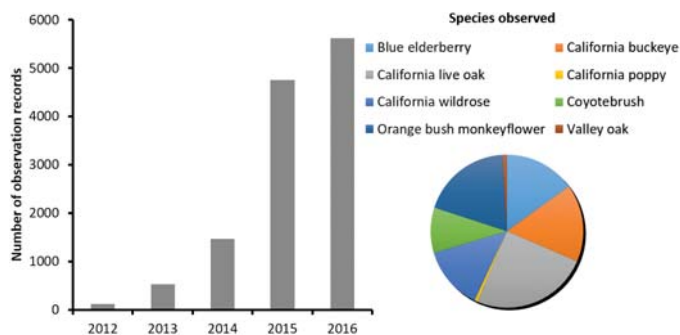
The US Fish & Wildlife Service's National Wildlife Refuge System is partnering with the USA National Phenology Network (USA-NPN) to document changes in phenology across the Refuge System. Refuges utilize the USA-NPN's scientifically-vetted, species-specific monitoring protocols, data management infrastructure, and data visualization tools to make comparisons in plant and animal phenology across refuges and surrounding areas. Since 2009, refuge staff and citizen scientist volunteers have collected over 170,000 observations on focal plants and animals at 22 refuges.



Phenology observations at Don Edwards NWR are being used to create interpretive signs, teach the public about the potential impacts of climate change, give volunteers an escape from the hustle of Silicon Valley, and show the power of citizen science to collect meaningful data.

Nature's Notebook on the Don Edwards San Francisco Bay National Wildlife Refuge

In 2012, Don Edwards San Francisco Bay National Wildlife Refuge began collecting phenology observations using the USA-NPN's plant and animal observation program, *Nature's Notebook*. Refuge staff use the program as a tool to teach the public about the potential impacts of climate change. They have also used the data to help decide what species to plant in restoration sites. Since 2012, eight volunteers and three staff across the refuge have collected 12,482 phenology observations on eight different species at two different sites..



Don Edwards NWR *Nature's Notebook* observations as part of the California Phenology Project

For refuges just starting phenology observations, establishing a baseline—or a general state of the refuge—is an important first step. Each observation collected is a step towards understanding the activity patterns of local plants and animals. Even in these early stages, however, refuge data can be compared with *Nature's Notebook* observations from outside the refuge to find out whether the same patterns in phenology are seen on and off the refuge. The **California Phenology Project (CPP)**; cpp.usanpn.org was launched in 2010 with funding from the National Park Service Climate Change Response Program to implement long-term phenological monitoring to better understand phenology of California plants and to educate the public about phenology. Don Edwards is a partner of the CPP and monitors some of the same

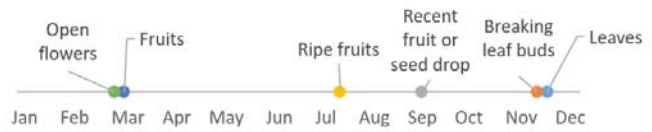
focal species. This partnership creates a larger dataset that can be used to measure and predict the effects of climate variation and climate change on the seasonal cycles of ecologically important and iconic California species.

For example, Don Edwards observes the California live oak (*Quercus agrifolia*), which is a focal species of the CPP. The live oak is an evergreen tree native to coastal California that is used by wildlife for food and shelter. In the graph below, observations from Don Edwards NWR are pooled with observations from the CPP to show the proportion of individual live oak trees that are fruiting over weekly periods in 2015 and 2016. Observers reported live oak fruiting in all months of the year. This is reflective of the intermittent nature of leafing, flowering, and fruiting seen plants in water-limited ecosystems such as in California. Unlike regions with temperate climates, where these phenophases occur during more distinct seasons, acorns may be present on live oak trees in California during any month of the year. The timing of acorn production is critical as these fruits are an important food source for many animals.

Another focal species is the California wildrose (*Rosa californica*), a colorful native rose observed by both Don Edwards and the CPP.

figure below shows that the wildrose puts on flowers in the collected at Don Edwards will help the Refuge establish a general baseline for when the rose is active and use that reference to track changes in the future, particularly with respect to climate.

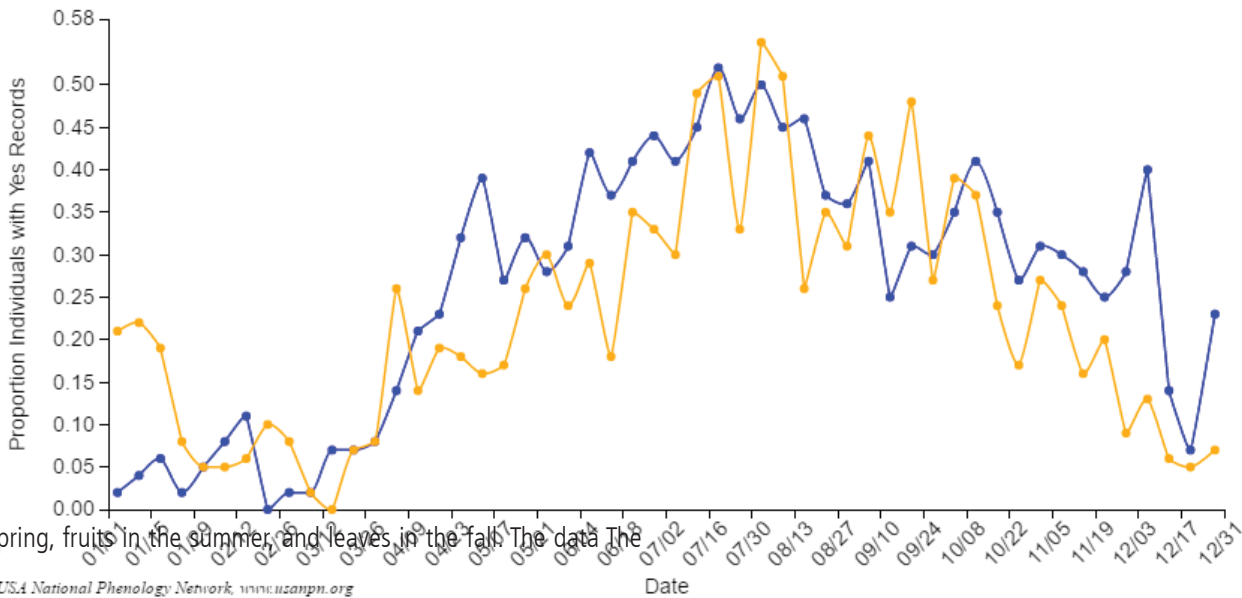
California Wildrose Average Phenophase Onsets, 2013-15



Understanding how climate and phenology are interacting across the U.S. and around refuges is vital to natural resource management. *Nature's Notebook* provides an opportunity for refuges to involve staff and volunteers in science, as well as provides a framework to answer questions about climate impacts. With continued observations, *Nature's Notebook* can be implemented as a tool for community engagement and for tracking large-scale ecological changes, one observation at a time.

Activity Curves

- 2015: California live oak - Fruits
- 2016: California live oak - Fruits



spring, fruits in the summer, and leaves in the fall. The data The

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