

The California Phenology Project: a phenological monitoring network to track climate change impacts

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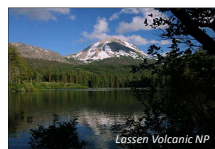
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ABSTRACT: Phenology is the study of seasonal biological events such as flowering, leaf-out, insect emergence, and animal migration. Long-term observational studies have found that the timing of phenological events responds to environmental variation and climate change. To assess the potential effects of climate change on California's flora, the National Park Service (NPS), the University of California, Santa Barbara (UCSB-PSP), and the USA National Phenology Network (USA-NPN) established The California Phenology Project (CPP) in 2010 with funding support from the NPS Climate Change Response Program. The CPP is a three-year pilot project, whose primary goals are to develop and test protocols and to create tools and infrastructure to support long-term phenological monitoring and public education in California national parks. Longer-term goals are to: (1) engage and educate people of all backgrounds and ages in the study of phenology, (2) detect how phenology is linked to climatic conditions that vary over time and space, and (3) provide data to support stewardship of wildland ecosystem. To this end, the CPP has identified scientific questions to guide monitoring efforts across all NPS units in CA, selected focal plant species, and established monitoring infrastructure in seven pilot parks that represent a range of bioclimatic regions. Focal species were selected based on their ability to address scientific questions of interest and to engage Citizen Scientists; they include native and non-native species, widespread and endemic species, and species of local management concern. The CPP is currently adapting and testing standardized phenology monitoring protocols developed in collaboration with the USA-NPN for tracking the phenological status of 25 plant species across key environmental gradients (e.g., latitude, elevation, and precipitation). The CPP seeks to build a large phenological monitoring network across the state by working with students, volunteers and other partners including the University of California Natural Reserve System, Naturebridge and the California Native Plant Society. The project is being designed and implemented as a potential model for replication across other NPS units or regions, as well as other protected areas, across the nation.

The CPP is monitoring plant phenology at seven pilot parks, representing desert, coastal, and mountain ecosystems.



PROGRESS TO DATE

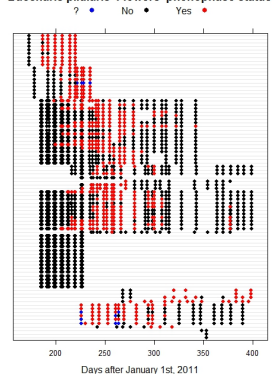
Since its initiation in late 2010, the CPP has:

- Actively monitored > 650 marked plants in 7 pilot parks and recorded > 70,000 observation records of individual phenophases for focal plant species in California.
- Examined how phenological patterns in 2011 of widespread species vary across environmental gradients (see *Baccharis pilularis* summary figure).
- Conducted annual training and education events for teachers, citizen scientists and park staff in seven pilot parks in California (see images lower right).
- Developed web-based tools and protocols to support park monitoring and education activities.

At Sequoia National Park:

- Phenology monitoring at 2 sites: Foothills Visitor Center and Lower Kaweah.
- 4 target species are monitored on a weekly or twice/week basis year-round.
- Two years of baseline data have been collected (see example below).

Baccharis pilularis 'Flowers' phenophase status



'Flower' phenophase observation records representing each *Baccharis pilularis* individual observed by the CPP. The individual plants are sorted by latitude, with plants occurring at higher latitudes (near Redwood National Park) plotted at the top of the y-axis and plants occurring at lower latitudes (at Santa Monica Mountains NRA) at the bottom of the y-axis.

SCIENTIFIC QUESTIONS TO BE ADDRESSED BY THE CPP

- How do widespread and ecologically important species of the California flora respond to variation in climate (and, by extension, to alternative scenarios of climate change)?
- Which plant species in California are most sensitive to climate (and, by extension, to climate change)?
- Are relationships between inter-dependent plant and animal mutualists at risk due to climate change? For example, are pollinators and their floral resources tracking climate change at the same pace?
- How will particular communities or vegetation types differ in their phenological response to climate change? Will some communities be more buffered against climate change?
- What are the earliest indicators of spring?
- How will end-of-season phenological events and patterns be affected by long-term climate change?
- Across all species and habitats, how is climate change affecting the length of the growing season?
- Across all species and habitat types, are certain functional groups (e.g., winter annuals, perennial herbs, evergreen shrubs) more sensitive to climate and to climate change than others?

For more detailed information about these and other scientific questions identified CPP, visit the Resources tab on the CPP website (www.usanpn.org/cpp/resources).

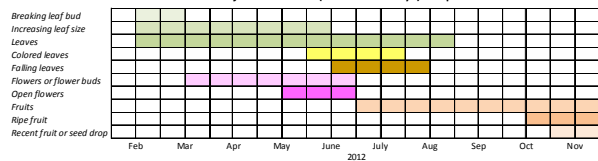
HOW CAN I GET INVOLVED?

Visit the CPP website at www.usanpn.org/cpp to learn how to:

- Join the CPP listserv to get frequent updates about the CPP
- Attend a training session at a National Park
- Partner your organization with the CPP and the USA-NPN
- Monitor plants in your own backyard using *Nature's Notebook*
- Introduce phenology to your classroom and outdoor education students



Aesculus californica No. 457 (California buckeye) - Sequoia National Park



Sample phenophase results for 1 of the 7 California buckeye trees monitored at Sequoia National Park. Colored boxes indicate duration of the given phenophase (colors vary for ease of viewing only).

CPP Teacher Training & Citizen Science Activities

