

Appendix G: Sequoia and Kings Canyon National Parks CPP Monitoring Guide

Version 1 (June 2013)

Revision History Log:

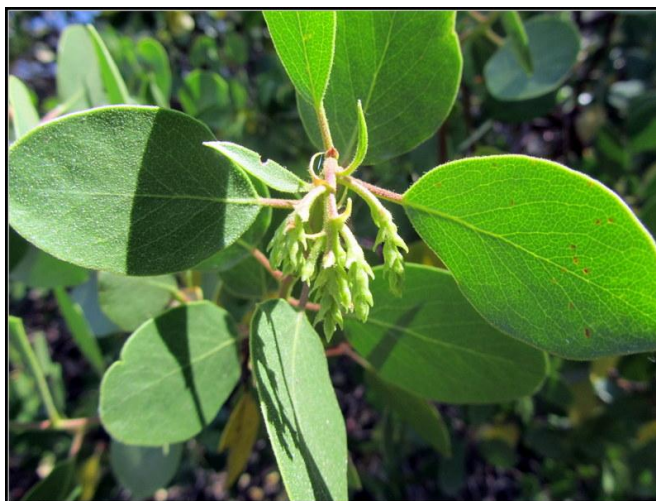
Version #	Revision Date	Author	Changes Made	Reason for Change
1.00		Matthews, Huber, Haultain		

Phenological monitoring guide: Sequoia and Kings Canyon National Parks

A designated monitoring site of
The California Phenology Project



Penstemon newberryi



Arctostaphylos patula



Quercus douglasii



Aesculus californica

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I. Introduction

Phenology is the study of the timing of seasonal biological events such as the flowering and fruiting of plants; the annual emergence of insect pollinators and pests; and the migration of birds and mammals. With funding from the National Park Service (NPS) Climate Change Response Program, the **California Phenology Project (CPP)**; www.usanpn.org/cpp was launched in 2010 as a pilot project to develop and test protocols and to create tools and infrastructure to support long-term phenological monitoring and public education activities in California's national parks. On-the-ground pilot activities focused on seven California parks: Joshua Tree National Park (JOTR), Santa Monica Mountains National Recreation Area (SAMO), Golden Gate National Recreation Area (GOGA), John Muir National Historic Site (JOMU), Lassen Volcanic National Park (LAVO), Sequoia and Kings Canyon National Parks (SEKI), and Redwood National Park (REDW).

The goals of the *California Phenology Project* are to: (1) recruit and to train NPS staff in the Divisions of Resource Management, Education, and Interpretation; formal and informal educators; students; and the public in the skills needed for recording and interpreting phenological data; (2) establish baseline phenological patterns and track long-term phenological trends to document the effects of climate change on wild plants and animals; and (3) guide adaptive management of California's natural resources. For a detailed description of the CPP's scientific goals, please refer to the *Plant Phenology Monitoring Protocol*.

Products of the pilot period include a *Plant Phenology Monitoring Protocol* (with step-by-step instructions for conducting monitoring) and *park-specific monitoring guides* for each of the seven pilot parks. The material in this monitoring guide is meant to serve as a reference for CPP participants who are observing plants at **Sequoia and Kings Canyon National Parks (SEKI)**. It identifies and describes all of the CPP and USA-NPN resources that observers will need to start monitoring plants at SEKI (e.g., *Nature's Notebook* datasheets, SEKI monitoring sites and locations, and CPP species profiles). This guide, however, is not meant to replace participation in an official training event, nor is it meant to provide detailed background information about phenology and the USA-NPN monitoring protocols. Please refer to the *Plant Phenology Monitoring Protocol* for detailed monitoring instructions. For more information about the USA-NPN monitoring protocols, visit the *Nature's Notebook* "Learn How to Observe" webpage (<http://www.usanpn.org/nn/guidelines>). To learn more about phenology, visit the CPP (www.usanpn.org/cpp) and USA-NPN websites (www.usanpn.org), where you can download newsletters, project briefs, presentations, and more (<http://www.usanpn.org/cpp/resources>).

II. Points of Contact

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III. CPP Species Monitored at SEKI

There are four species targeted for phenological monitoring at Sequoia and Kings Canyon National Parks: California buckeye (*Aesculus californica*), blue oak (*Quercus douglasii*), greenleaf manzanita (*Arctostaphylos patula*), and mountain pride (*Penstemon newberryi*).

Two-sided CPP species profiles for each species are available for download from the CPP website (front and back images are also included below): <http://www.usanpn.org/cpp/AllSpecies>. Species profiles include a brief description of each species, as well as photographs of most phenophases. Please note that some profiles are missing phenophase photos -- *we encourage CPP participants to continue taking photos of phenophases and updating the species profiles.*

Table 1. CPP species monitored in SEKI, with their USA-NPN protocol category and the other National Parks where they are monitored. (Abbreviations used: LAVO=Lassen Volcanic National Park; JOMU=John Muir National Historic Site)

Common Name	Scientific Name	USA-NPN Protocol Category	Parks
California buckeye	<i>Aesculus californica</i>	Deciduous Trees & Shrubs	SEKI, JOMU
Blue oak	<i>Quercus douglasii</i>	Deciduous Trees & Shrubs	SEKI, JOMU
Greenleaf manzanita	<i>Arctostaphylos patula</i>	Broadleaf Evergreen Trees & Shrubs	SEKI, LAVO
Mountain pride	<i>Penstemon newberryi</i>	Forbs	SEKI, LAVO

To see the complete list of CPP focal species, please visit <http://www.usanpn.org/cpp/AllSpecies>

A brief description of the four species targeted for monitoring at SEKI is provided below.

(1) California buckeye (*Aesculus californica*)




- CPP four letter code: AECA
- Download the *Nature's Notebook* datasheet and the CPP profile here: <http://www.usanpn.org/cpp/AECA>
- California buckeye is a mostly deciduous large shrub or small tree that is widespread throughout California and parts of southwest Oregon (1). California buckeye is an early indicator of spring in the Sierra Nevada foothills. When in bloom, its distinctively large spike of flowers can easily be seen as one drives past it on the hillsides. It is one of the first trees or shrubs to leaf out in the spring and one of the earliest to drop its leaves in the summer (2). Buckeye plants begin to enter dormancy in the late summer or fall, depending on its local climate. Buckeyes growing in the hotter and drier areas (like the Sierra Nevada foothills) begin to drop their leaves in mid- summer, while those in coastal regions tend to retain their leaves until mid-autumn (3).
- California buckeye's large brown nuts were an important food source for indigenous California tribes. After a lengthy leaching process to remove the poisonous toxins found in the raw seeds, the ground flour was cooked and eaten. The plant was also used for medicinal purposes (e.g., the seeds were used to treat hemorrhoids and the bark was used to treat snakebites). Many tribes also poured the mashed nuts into quiet pools to stupefy or kill fish (2).
- California buckeye was selected for monitoring for its showy flowers, the distinctive nature of the deciduous phase, and large, attractive fruits. Visitors are drawn to this plant and are interested in its life cycle. Plants being monitored are adjacent to the Foothills Visitor Center at park headquarters, providing a unique interpretive opportunity. One of two park Pheno-cams is also focused on one of these trees.

Literature Cited

1. William J. Stone (2012). *Aesculus californica* in Jepson Flora Project (eds.) *Jepson eFlora*, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=12026. Accessed September 17, 2012.
2. M. Kat Anderson and Wayne Roderick. California Buckeye, in the USDA NRCS Plant Guide. USDA. http://plants.usda.gov/plantguide/pdf/cs_aeca.pdf. Accessed September 17, 2012.
3. Elna S. Bakker (1984). *An island called California: an ecological introduction to its natural communities*. University of California Press. p. 74

Aesculus californica species profile (Version 2; March 2012):

California Phenology Project:
species profile for
California Buckeye
(*Aesculus californica*)

CPP site(s) where this species is monitored: Sequoia National Park; John Muir National Historic Site




Photo credit: Martin Jambon (flickr)

What does this species look like?

This deciduous species is a large shrub or tree, up to 12 meters tall. The leaves are palmate (the leaflets emerge from a single point) and made up of 5 to 7 leaflets, each 6 to 17 cm long. Flowers are white to pale rose-colored, with petals 12 to 18 millimeters long. The flowers are clustered in an erect inflorescence with many showy, ill-smelling flowers. Only the flowers at the tip of each inflorescence are fertile and produce fruit. Each fruit contains one large (2 to 5 cm) glossy brown seed.

Species facts!

- The CPP four letter code for this species is **AECA**.
- The bark, leaves, stems, fruit, and seeds of this plant contain toxic glycosidal compounds.
- Native Americans used the ground seeds to poison fish, but the seeds could also be used for food when leached of their poison and mashed.
- Although honeybees are the primary pollinator of buckeye, the nectar and pollen can be toxic to them.




Photo credit: randomtruth (flickr)




Photo credit: James Gailther (flickr)

Where is this species found?

- This species is endemic to California.
- It is found in dry slopes, canyons, and the edges of streams.
- Found at elevations less than 1700 meters

For more information about phenology and the California Phenology Project (CPP), please visit the CPP website (www.usanpn.org/cpp) and the USA-NPN website (www.usanpn.org)

Version 2, March 2012

California Phenology Project:
species profile for
California Buckeye
(*Aesculus californica*)







Terrie Schweitzer

Breaking leaf buds
A leaf bud is considered "breaking" once a green leaf tip is visible at the tip of the bud, but before the first leaf from the bud has unfolded to expose the leaf stalk or base. *Can you see the leaf tips emerging from the bud in this picture?*



Eugene Zelenko

Leaves
Can you see the base of the leaflets? New leaflets may need to be bent backwards to see whether the petiole is visible.



Cliff Hutson

Colored leaves



Liz Matthews

Increasing leaf size



Devra

Flowers or flower buds
When monitoring flower or flower bud abundance for this species, count each inflorescence as a single flowering structure! For example, if there are two inflorescences with many flowers or buds each, then abundance should be recorded as <3.



Dawn Endico

Open flowers
Do you see the pollen-producing anthers protruding from the flowers? **Proportion of open flowers** should be recorded at the scale of individual flowers, not inflorescences (i.e. estimate the proportion of individual flowers that are open!)



Eugene Zelenko

Fruits
The fruit is a large, leathery capsule that changes from green to tan or grayish-tan and splits open to release a large seed when ripe.



randomtruth

Ripe fruits
A fruit is considered ripe when it splits open. **Note:** fruit phenophases are nested; if you record Y for "ripe fruits" you should also record Y to "fruits"

Note: flower phenophases are nested; if you record Y for "open flowers" you should also record Y for "flowers or flower buds"

Phenophases not pictured: Falling leaves, recent fruit or seed drop

Version 2, March 2012

(2) Blue oak (*Quercus douglasii*)




- CPP four letter code: QUDO
- Download the *Nature's Notebook* datasheet and the CPP profile for QUDO here: <http://www.usanpn.org/cpp/QUDO>
- *Quercus douglasii* is a deciduous tree, with leaves that are typically shallowly lobed and blue-green on the upper-side (1). Male flowers are borne in slender drooping catkins that originate in the axils of the previous year's leaves, while female flowers form from leaf axils of the current year. Flowering occurs from late March to mid-May. Abundant acorn crops are produced every 2-3 years, with bumper crops every 5-8 years (mast years) (2).
- Blue oaks are widespread but endemic to California. They are generally found on the dry, low to mid elevation slopes that surround the Central Valley. Blue oak woodlands form extensive stands on the state's interior foothills, but they are also scattered across other areas of the state, reaching as far north as Shasta County and as far south as Los Angeles County (2).
- Native cultures relied heavily upon blue oak acorns for food and used various parts of the tree for a great number of uses including medicine (arthritis), dyes, utensils, games, toys, basketry, firewood, and many other daily uses (3).
- Blue oak is predicted to be vulnerable to climate change, especially in the southern Sierra Nevada foothills (4, 5).
- SEKI is home to one of the few remaining Blue Oak Woodlands in California that is not grazed by cattle. Oak woodlands occurring in rangelands are often thinned of shrubs and young trees in order to increase forage, creating forb-dominated oak savannahs (2).
- Blue oak provides a local comparison to valley oak (*Quercus lobata*), which is the focal species of SEKI SPROUTS, a *Rangers in the Classroom* lesson plan with the goal of educating students about phenology.

Literature Cited

1. John M. Tucker (2012). *Quercus douglasii* in Jepson Flora Project (eds.) *Jepson eFlora*, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=40581. Accessed September 21, 2012.
2. Philip M. McDonald. *Quercus douglasii*, in the USFS Silvics Manual, vol. 2. http://na.fs.fed.us/pubs/silvics_manual/volume_2/quercus/douglasii.htm. Accessed September 17, 2012.
3. M. Kat Anderson. Blue Oak, in the USDA NRCS Plant Guide. USDA. http://plants.usda.gov/plantguide/pdf/cs_qudo.pdf. Accessed September 17, 2012.
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5. L.M. Kueppers, M.A. Snyder, L.C. Sloan, E.S. Zavaleta and B. Fulfrost (2005). Modeled regional climate change and California endemic oak ranges. *Proceedings of the National Academy of the United States of America* 102(45):165281-16286.

Quercus douglasii species profile (Version 2; March 2012):

California Phenology Project:
species profile for
Blue Oak
(*Quercus douglasii*)

CPP site(s) where this species is monitored: Sequoia National Park and John Muir NHS




Photo credit: loarie (flickr)

What does this species look like?

This deciduous tree is short and straight. It grows from 6 to 20 m tall and has thin and flaky light grey bark. The waxy bluish-green leaves are 3 to 8 centimeters long with wavy margins. This species is monoecious, having male and female flowers separate, but on the same plant. Male flowers are yellow green hanging catkins, and female flowers are small and solitary, growing in the axis of leaves. This species is wind pollinated. The acorns are 2 to 3 centimeters long and take one year to mature.

*When monitoring this species, use the USA-NPN **deciduous trees and shrubs (with pollen)** datasheet.*

Species facts!

- The CPP four letter code for this species is QUDO.
- Exhibits masting behavior; all individuals in a population will have synchronized episodic acorn productions. This is thought to satiate seed predators so that some acorns can survive to germinate the following year.
- Susceptible to Sudden Oak Death disease, a plant pathogen that can have a devastating impact on forests.




Photo credit: loarie (flickr)




Photo credit: KQED Quest (flickr)




Where is this species found?






- Endemic to California.
- Found on dry slopes, interior foothills, and woodland habitats.
- Covers the foothills surrounding the Central Valley of California.
- At elevations less than 1200 meters.

For more information about phenology and the California Phenology Project (CPP), please visit the CPP website (www.usanpn.org/cpp) and the USA-NPN website (www.usanpn.org)

Version 2, March 2012

California Phenology Project:
species profile for
Blue Oak
(*Quercus douglasii*)

	<p>Breaking leaf buds</p>	 <p style="font-size: small; text-align: right;">Eugene Zelenko</p>	<p>Leaves</p>
	<p>Increasing leaf size</p>	 <p style="font-size: small; text-align: right;">Eugene Zelenko</p>	<p>Colored leaves</p>
	 <p style="font-size: small; text-align: right;">Keir Morse</p>	<p>Flowers or flower buds</p> <p>The male inflorescence is a catkin which is initially compact and stiff, but eventually unfolds, lengthens, and hangs loosely from the branch. Female flowers are very small and petal-less, emerging from the growing stem at the point where a new leaf is attached.</p>	 <p style="font-size: small; text-align: right;">Todd Hamilton</p>
	<p>Fruits</p> <p>The fruit is an acorn that changes from green to yellowish-green to brown or dark brown.</p>	 <p style="font-size: small; text-align: right;">© 2007 Neal Kramer</p>	<p>Ripe fruits</p> <p>The fruit is considered ripe when it is brown or dark brown.</p>

Important Note: USA-NPN flower and fruit phenophases are nested. If you say "Y" to "open flowers" you should also have said "Y" to "flowers or flower buds" and if you say "Y" to "ripe fruits" you should also have said "Y" to "fruits"

Phenophases not pictured: **Falling leaves, Pollen release, Recent fruit or seed drop**

Version 2, March 2012

(3) Greenleaf manzanita (*Arctostaphylos patula*)



- CPP four letter code: ARPA
- Download the *Nature's Notebook* datasheet and the CPP profile for ARPA here: <http://www.usanpn.org/cpp/ARPA>
- Greenleaf manzanita is an easily identified shrub that is often found in relatively accessible locations. It is common in the coniferous forests of the western U.S. at moderate to high elevations. In the Sierra Nevada, it can be found in oak woodlands, chaparral, and forests generally above 2,450 ft. in elevation and as high as 11,000 ft. (750-3350 m) (2) (3).
- Its showy flowers are bee-pollinated and hang in bunches. The many-flowered inflorescence of greenleaf manzanita is formed *the year before* the flowers mature and open the following spring. The fruits contain hard-coated seeds that provide important forage for many species of wildlife. Seeds are dispersed by seed-caching small mammals and fruits are eaten by larger animals such as bears, coyotes, and foxes (3).
- Greenleaf manzanita is well-adapted to periodic fires. The leaves are highly flammable. Its seeds require fire (or other scarification) followed by cold weather in order to germinate, and the seeds can remain viable in the soil for hundreds of years. It is not entirely dependent upon fire however, as it can reproduce vegetatively by sprouting from the root crown (3).

Literature Cited

1. USDA Natural Resource Conservation Service. 2012. The PLANTS Database. National Plant Data Center, Baton Rouge, LA. <http://plants.usda.gov> Accessed September 25, 2012.
2. V. Thomas Parker, Michael C. Vasey, and Jon E. Keeley (2012). *Arctostaphylos patula* in Jepson Flora Project (eds.) *Jepson eFlora*, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=13965. Accessed September 25, 2012.
3. A. Hauser, A. Scott. 2007. *Arctostaphylos patula*. In: Fire Effects Information System (online). US Dept. of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis>. Accessed September 25, 2012.

Arctostaphylos patula species profile (Version 3; August 2012):

California Phenology Project:
species profile for
Greenleaf Manzanita
(*Arctostaphylos patula*)

CPP site(s) where this species is monitored: Lassen Volcanic National Park, Sequoia National Park




Photo credit: Bryant Olsen (Flickr)

What does this species look like?

This perennial evergreen shrub forms circular clones that are 1 to 2 meters tall and up to 3 meters in diameter. Clones form when the lower branches produce roots that penetrate the soil, promoting clonal growth. The smooth bright green leaves are 2.5 to 6 centimeters long and 1.5 to 4 centimeters wide. The glabrous pink or white, pendant, urn-shaped flowers form drooping clusters. Fruits are dark brown and 1 centimeter in diameter, each containing five hard seeds.

When monitoring this species, use the USA-NPN broadleaf evergreen trees and shrubs datasheet.




Photo credit: Brian Haggerty

Species facts!

- The CPP four letter code for this species is ARPA.
- The fruits of Greenleaf manzanita are eaten by bears and other animals.
- The seeds can stay dormant in the soil for many years, and require both fire and cold conditions to germinate.
- Pollinated by bees.
- Has a relationship with mycorrhizal fungi.




Photo credit: Ann Huber (SEKI/NPS)

Where is this species found?


- Arctostaphylos patula* is found in coniferous forests between 750 and 3350 meters in elevation.
- Adapted to hot, dry climates and to extreme temperatures.
- Found on well drained soils, from sandy to silky loam.

The photo at left shows the **immature** inflorescence structure (a panicle) that will develop into mature flower buds the following year (do not record these structures as "flowers or flower buds" during the first year they appear on the plant)


For more information about phenology and the California Phenology Project (CPP), please visit the CPP website (www.usanpn.org/cpp) and the USA-NPN website (www.usanpn.org)

Version 3, August 2012


CPP species profile for Greenleaf Manzanita (*Arctostaphylos patula*)




Breaking leaf buds
Leaf buds originate at the nodes of existing leaves, in the leaf "axils".
Note: The photo shows leaf buds right before they have broken to reveal the tips of young leaves.
Brian Haggerty



Young leaves
Young leaves tend to be thinner and brighter than mature leaves.
Brian Haggerty




Flowers or flower buds
When monitoring ARPA flower or flower bud abundance, count each inflorescence as a single flowering structure! For example, if there are 2 inflorescences with many flowers or buds each, then abundance should be recorded as < 3.
Brian Haggerty




Open flowers
Each flower has both male and female parts contained within the urn-shaped floral tube; this makes it difficult to see the anthers and the stigma. Proportion of open flowers should be recorded at the scale of individual flowers, not inflorescences (i.e. estimate the proportion of individual flowers that are open!)
Bryant Olsen

Note: USA-NPN flower and fruit phenophases are nested! If you record **Yes** for "open flowers" you should also record **Yes** for "flowers or flower buds" and if you record **Yes** for "ripe fruits" you should also record **Yes** for "fruits"



Fruits
The fruit is berry-like and changes from green to red, reddish-brown, purplish-brown, or chestnut brown; it drops from the plant when ripe.
Brian Haggerty



Ripe fruits
The fruit is considered ripe when it has changed color from green to red, reddish-brown or chestnut-brown. A ripe ARPA fruit will have very little green color on the surface (i.e., <10% will be green).
Bryant Olsen

Important note regarding sequence of ARPA phenophases: The phenological progression of ARPA can be confusing as its phenophases do not appear in the sequence presented on USA-NPN datasheets. Observers should look for the following progression: Inflorescence structures (i.e. panicles) begin to develop early in the growing season and are mostly, if not exclusively, terminal; the buds on these inflorescences do not open into flowers until the following spring (flower buds form one year prior to maturity). See a photo of this inflorescence structure on the front page. Flowering of last year's inflorescence begins after the flower buds for next year have developed. Following flowering, leaf buds break. Following leaf bud break, fruits set and ripen. Leaves are often fully developed before the fruits become ripe.

Phenophases not pictured: Recent fruit or seed drop

Version 3, August 2012

(4) Mountain pride (*Penstemon newberryi*)


- CPP four letter code: PENE
- Download the *Nature's Notebook* datasheet and the CPP profile for PENE here: <http://www.usanpn.org/cpp/PENE>
- Mountain pride is a lovely perennial with showy magenta flowers that give bright color to the granite and other rocky places in the montane coniferous forests of the western U.S. This species is found from southwest Oregon to the southern Sierra Nevada and western Nevada (1). In the Sierra Nevada, it is generally found from 5,000 to 9,000 ft in elevation (2).
- This species is cultivated in rock gardens. It does not tolerate very hot summers or cold winter temperatures without snow cover and may lose its leaves when stressed (2).

Literature Cited


1. Native Plant Database (2012) Ladybird Johnson Wildflower Center, University of Texas at Austin. http://www.wildflower.org/plants/result.php?id_plant=PENE3. Accessed September 27, 2012.
2. Las Pilitas Nursery website (no published date). Nature of California: *Penstemon newberryi*. <http://www.laspilitas.com/nature-of-california/plants/penstemon-newberryi>. Accessed September 27, 2012.

Penstemon newberryi species profile (Version 2; March 2012):

California Phenology Project:
species profile for
Pride of the Mountains
(*Penstemon newberryi*)



UCSB



CPP site(s) where this species is monitored: Lassen Volcanic National Park, Sequoia National Park




Photo credit: Dan Allison (Flickr)

What does this species look like?

This bushy perennial subshrub reaches a height of 12-30 centimeters. The leaves are covered with short hairs and are generally densely clustered at the base of plants. The leaf blades are 1 to 4 centimeters long and produce finely-toothed leaf margins. The glandular magenta flowers are 2-3 centimeters long, and the flowers are tubular or funnel shaped.

When monitoring this species, use the **USA-NPN broadleaf evergreen trees and shrubs (no buds)** datasheet.

Species facts!

- The CPP four letter code for this species is **PENE**.
- Penstemon newberryi* spends the winter underneath snow.
- The showy flowers are pollinated by both hummingbirds and insects.




Photo credit: Mr.Stobbe (Flickr)

Where is this species found?

- Penstemon newberryi* grows in high elevation in rocky habitat such as outcrops and talus.
- It is found at elevations between 700 and 3500 meters.
- Found in California, Nevada, and Oregon
- Occurs in the Siskiyou, Coast Range, Sierra Nevada Mtns and Mt. Lassen.




Photo credit: Gravitywave (Flickr)


For more information about phenology and the California Phenology Project (CPP), please visit the CPP website (www.usanpn.org/cpp) and the USA-NPN website (www.usanpn.org)

Version 2, March 2012

California Phenology Project:
species profile for
Pride of the Mountains
(*Penstemon newberryi*)



UCSB






Young leaves
Young leaves are generally thinner than mature leaves and may be a different color (note the red young leaves in the photo).




CPP *Penstemon newberryi* at Lassen Volcanic National Park.



Flowers or flower buds
A flower bud can be seen in the black box in the photo to the right.

Brian Haggerty




Open flowers
Can you see the anthers and stigma?
Note: flower phenophases are nested; if you say **Y** to "open flowers" you should also have said **Y** to "flowers or flower buds"

Brian Haggerty



Fruits
The fruit is a capsule that changes from green to tan, and then splits open when dry and ripe.

Brian Haggerty



Ripe fruits
The fruit is considered ripe when it splits open. The picture shows dried capsules that have split open and the ripe seeds found within.

Sylvia Hauptain

Note: fruit phenophases are nested; if you say **Y** to "ripe fruits" you should also have said **Y** to "fruits"

Phenophases not pictured: **Recent fruit or seed drop**

Version 2, March 2012

IV. SEKI Monitoring Locations and Maps

The CPP has established two monitoring locations at Sequoia and Kings Canyon National Parks: the Foothills Visitor Center and the Lower Kaweah Air Quality Monitoring site (Table 2; Figure 1). Maps of SEKI monitoring locations are available for download at <http://www.usanpn.org/cpp/SEKI/maps>.

Table 2. SEKI monitoring locations, target plant species at each location (with number of targeted individuals), and the approximate phenologically active season for each phenophase category at each location. Estimates of the phenologically active season at each location are based on observations recorded in 2012 and should be revised as additional years are represented in the dataset.

	Location (4-letter code)	Year monitoring initiated	Target Species (# of individuals)	Approximate Phenologically Active Season
(1)	Foothills Visitor Center (FHVC)	2011	<i>Aesculus californica</i> (7)	Leaves: January-August Flowers: March-June Fruit: June-December
			<i>Quercus douglasii</i> (14)	Leaves: year round Flowers: March-April Fruit: June- November
(2)	Lower Kaweah Air Quality Monitoring Site (LKAQ)	2011	<i>Penstemon newberryi</i> (10)	Leaves: April-June Flowers: May-July Fruit: year round
			<i>Arctostaphylos patula</i> (10)	Leaves: June-July Flowers: March-May Fruit: year round

Note that the timing of phenophases may vary with interannual variation in temperature and precipitation (e.g., in years where spring temperatures are warmer than average, phenophases may appear earlier than average). As such, the USA-NPN and the CPP recommend that monitoring should continue during the phenologically inactive season, although monitoring may continue at a lower frequency. In the 2-4 weeks before the phenologically active season, monitoring frequency may increase to catch the onset of the early phenophases.

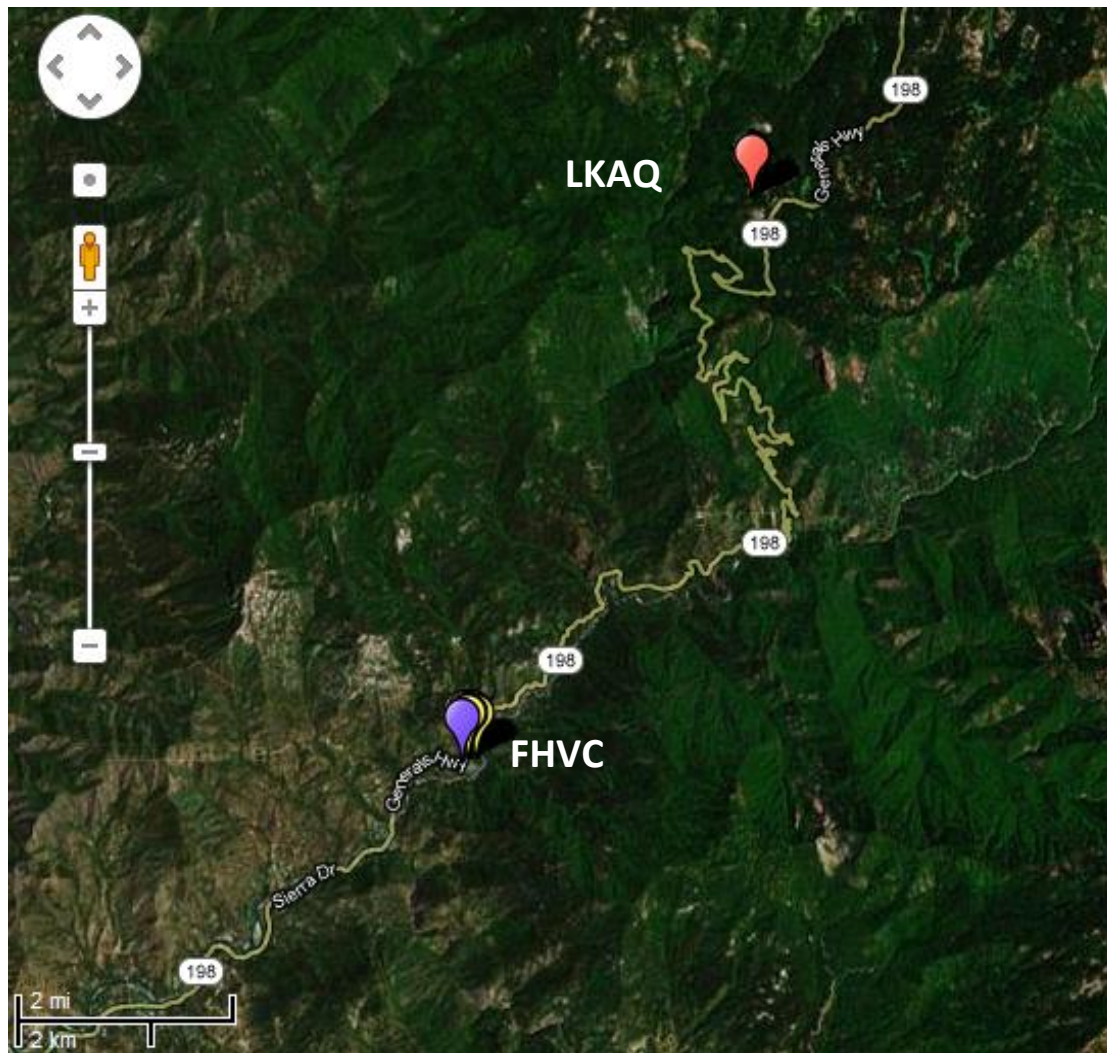


Figure 1. Google map of CPP monitoring locations at SEKI (as of January 2013).

A spreadsheet with GPS coordinates for each individual plant is available for download on the CPP website (<http://www.usanpn.org/cpp/SEKI/maps>). Coordinates are provided in three formats: UTM, latitude-longitude, and decimal degrees. The datum for all coordinates on the website is WGS84. The identifier code for each plant follows the same format:

CPP-PARK-LOCA#-GESP#.

LOCA# represents the location name in a four letter code (e.g., Lower Kaweah Air Quality= LKAQ) and the site at each location (e.g., site 2 at Lower Kaweah= LKAQ2).

GESP# represents the four letter code for each genus species combination (e.g., *Penstemon newberryi*= PENE) and the individual plant number at each site (e.g., the third *Penstemon newberryi*= PENE3).

The CPP plants at SEKI are marked with two metal tags. The first tag includes the 4-part code described above. The second tag includes a unique number identifier; this number is unique to

the individual plant. It is used in the tables below and in *Nature's Notebook*. See *Establishing Monitoring Sites SOP#5* for additional information about the tags used to mark CPP plants.

Photographs for each targeted individual are available on the SEKI sites' data entry pages of *Nature's Notebook* (<http://www.nn.usanpn.org>). To view plant photos, observers must have access to the SEKI sites in *Nature's Notebook*. All UTM coordinates presented in this monitoring guide are in Zone 11 and were recorded using the WGS84 datum.

(1) Foothills Visitor Center (FHVC)

FHVC monitoring sites are in Sequoia National Park near the visitor center. The Foothills Visitor Center is located shortly after the Ash Mountain entrance to the park via Highway 198.

Target plants are found in four general areas (sites 1-4) on gently sloping terrain and distributed around the visitor center and nearby administrative offices, picnic, and housing areas (Figure 2 and Figure 3). The dominant vegetation type is blue oak woodland, a common vegetation type found in the foothills of the southern Sierra Nevada. The elevation of the area is about 1,700 ft (520 m).

It takes about one hour for an experienced observer to monitor all of the plants at this site. Fourteen Blue oak (*Quercus douglasii*) and seven California buckeye (*Aesculus californica*) trees are monitored at FHVC.

Table 3. Plants monitored at the Foothills Visitor Center (FHVC) sites.

FHVC Site No.	Blue Oak Plant ID	California Buckeye Plant ID
1	QUDO 454	AECA 455
	QUDO 458	AECA 456
	QUDO 459	AECA 457
	QUDO 460	
	QUDO 461	
	QUDO 462	
	QUDO 463	
2	QUDO 448	AECA 450
	QUDO 449	
	QUDO 451	
	QUDO 452	
	QUDO 456	
3	QUDO 443	AECA 447
	QUDO 444	
4		AECA 445
		AECA 446
Total	14	7

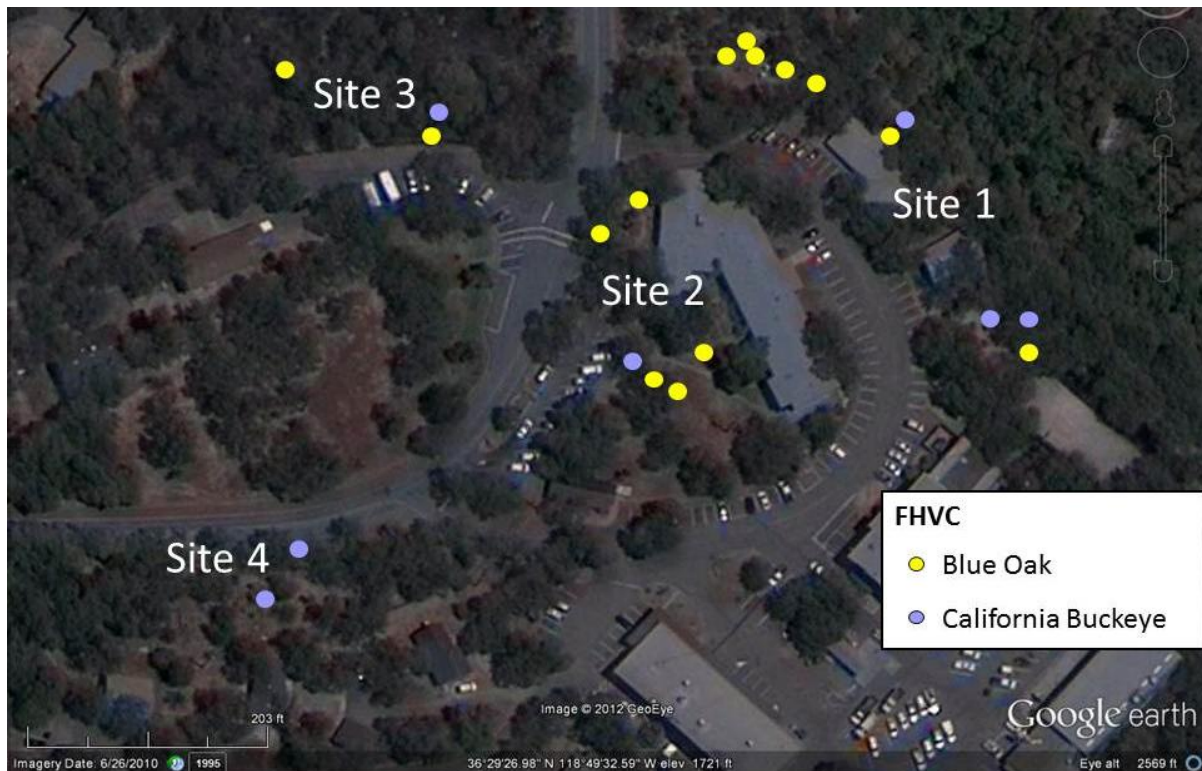


Figure 2. Foothills Visitor Center (FHVC) Monitoring Sites (as of January 2013).

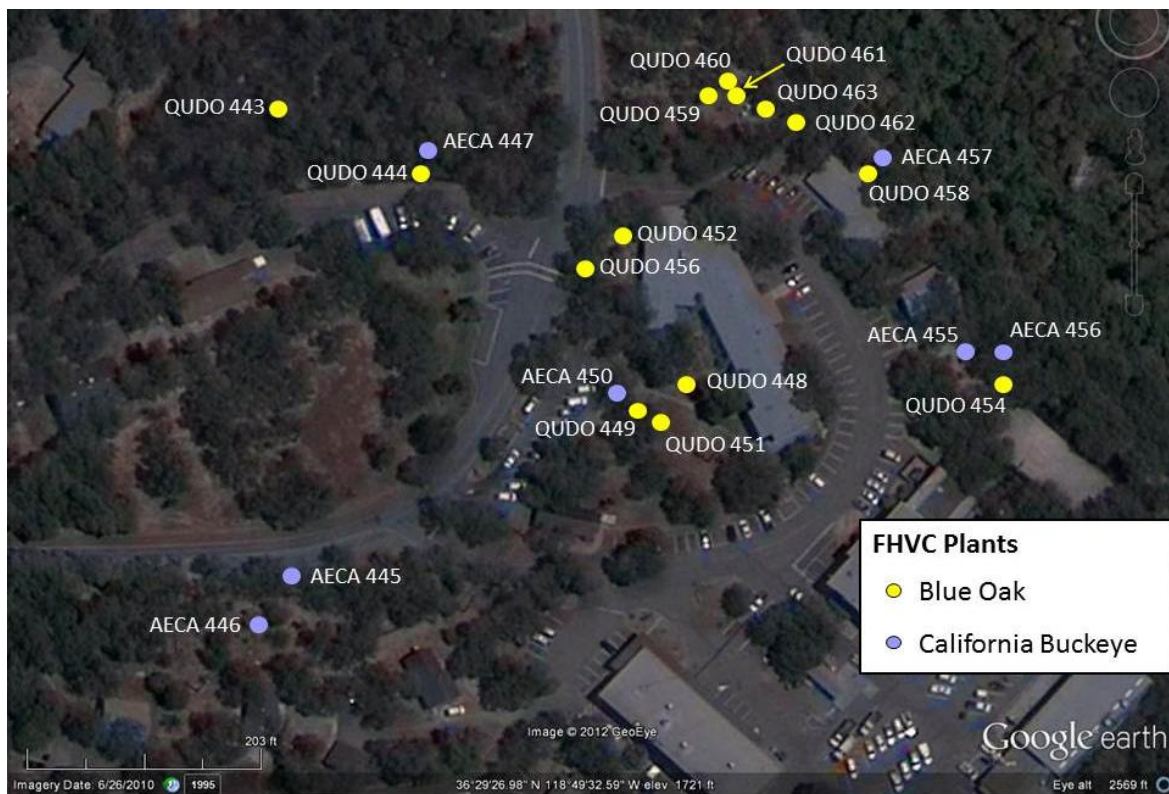


Figure 3. Foothills Visitor Center (FHVC) Monitoring Plants (as of January 2013).

FHVC site photos

Foothills Visitor Center Monitoring Site #1 (CPP-SEKI-FHVC1)

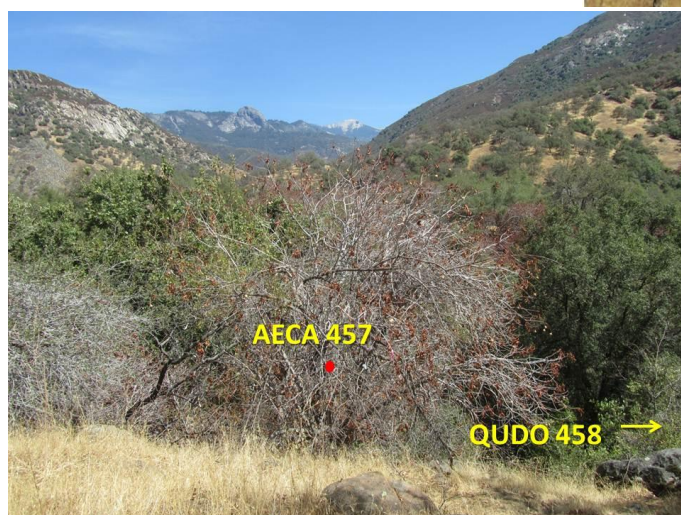
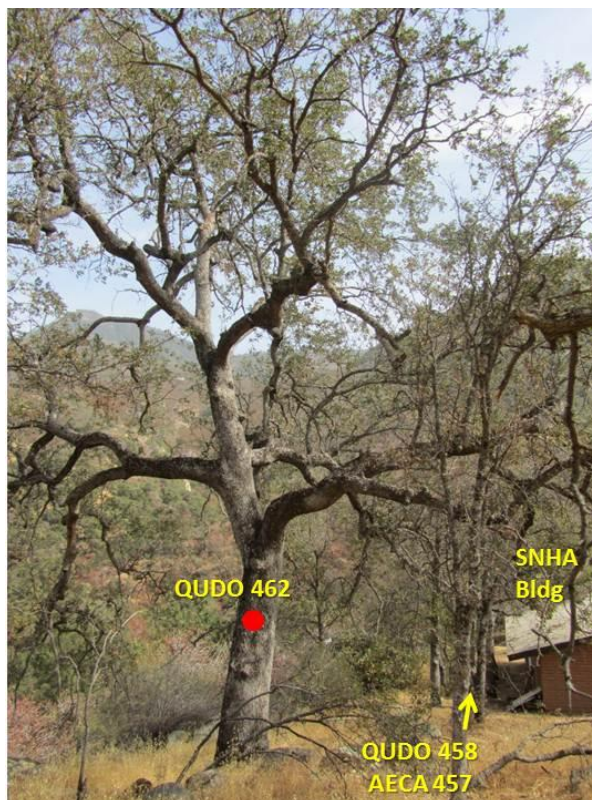
Site Notes: This site is approached from the parking lot and walking up to the meteorological station.



Site	Species Code	Unique ID*	Individual	Northing	Easting	Notes
1	QUDO	459	5	4040015	336498	Around Meteorological Station
1	QUDO	460	4	4040021	336501	Around Meteorological Station
1	QUDO	461	3	4040019	336503	Around Meteorological Station

*used on plant tag and in *Nature's Notebook*

Foothills Visitor Center Monitoring Site #1 (CPP-SEKI-FHVC1) (continued)



Site	Species Code	Unique ID	Individual	Northing	Easting	Notes
1	QUDO	462	1	4040007	336523	Around Meteorological Station
1	QUDO	463	2	4040011	336515	Around Meteorological Station
1	AECA	457	1	4040000	336546	Adjacent to webcam, behind SNHA building
1	QUDO	458	6	4039996	336540	Adjacent to webcam, behind SNHA building

*used on plant tag and in *Nature's Notebook*

Foothills Visitor Center Monitoring Site #1 (CPP-SEKI-FHVC1) (continued)



Notes: This picnic area is in between the USGS building and the tennis courts.



Site	Species Code	Unique ID*	Individual	Northing	Easting	Notes
1	AECA	455	2	4039949	336568	Behind blue oak
1	AECA	456	3	4039950	336579	Behind large, old blue oak
1	QUDO	454	7	4039942	336578	Next to trail and tennis courts fence

*used on plant tag and in *Nature's Notebook*

Foothills Visitor Center Monitoring Site #2 (CPP-SEKI-FHVC2)

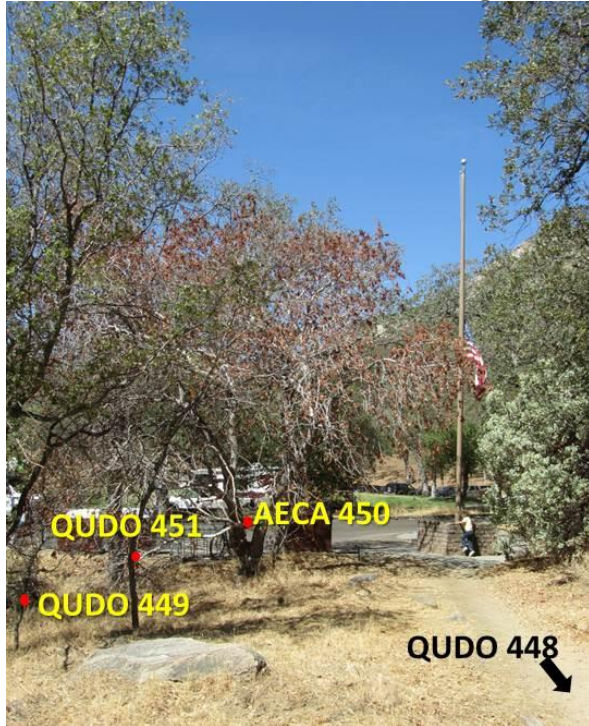
Site Notes: Site 2 includes monitoring plants located in the native plant demonstration garden (in front of the Foothill Visitor Center) and plants that are along a trail that runs along the back side of the Administration Building.



Site	Species Code	Unique ID	Individual	Northing	Easting	Notes
2	QUDO	452	2	4039978	336546	In front of visitor center in Native Plant Garden
2	QUDO	453	1	4039971	336467	In front of visitor center in Native Plant Garden

**used on plant tag and in Nature's Notebook*

Foothills Visitor Center Monitoring Site #2 (CPP-SEKI-FHVC2) (continued)



Site	Species Code	Unique ID*	Individual	Northing	Easting	Notes
2	AECA	450	1	4039939	336476	Near Flag Pole
2	QUDO	448	5	4039939	336493	Nickname Charlie Brown tree
2	QUDO	449	4	4039936	336479	
2	QUDO	451	3	4039935	336482	

*used on plant tag and in *Nature's Notebook*

Foothills Visitor Center Monitoring Site #3 (CPP-SEKI-FHVC3)

Site Notes: Site 3 is located northwest and across the street from the Foothills Visitor Center on the upper slope across from the picnic tables.



Site	Species Code	Unique ID*	Individual	Northing	Easting	Notes
3	AECA	447	1	4040002	336430	Large tree on open slope
3	QUDO	443	2	4040013	336389	Walk up the stone stairs
3	QUDO	444	1	4039995	336426	Closer to parking lot

*used on plant tag and in *Nature's Notebook*

Foothills Visitor Center Monitoring Site #4 (CPP-SEKI-FHVC3)

Site Notes: Site 4 is below the visitor center (west) and along Hwy 198 and can be reached from the road. Parking spaces are along the road here, and there is a dirt path along the road for walking.



Site	Species Code	Unique ID*	Individual	Northing	Easting	Notes
4	AECA	445	1	4039881	336382	Closer to the road
4	AECA	446	2	4039892	336391	Walk into grassland a bit. AECA 446 is next to a large shrub.

*used on plant tag and in *Nature's Notebook*

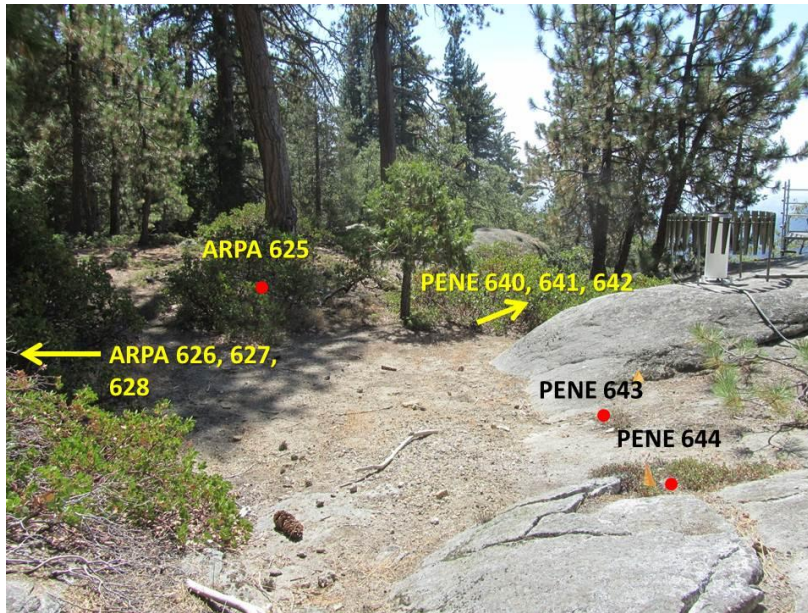
(2) Lower Kaweah Air Quality (LKAQ)

The LKAQ monitoring site is in Sequoia National Park, about 0.25 miles west of the Giant Forest Museum, on a generally west-facing slope at approximately 1800m (~6,000 ft) in elevation.. LKAQ is co-located with an air quality monitoring station and other long-term ecological studies that are associated with the station. A dirt road from the lower-most Giant Forest Museum parking lot leads to the air quality monitoring station and the LKAQ site. The short walk from the parking lot takes about 5 minutes. The monitoring plants at LKAQ are all considered to be part of the same monitoring site. It takes about 45 minutes for a seasoned monitor to conduct the monitoring at this site.

Table 4. Plants monitored at the Lower Kaweah Air Quality (LKAQ) monitoring site.

Greenleaf Manzanita Plant ID		Mountain Pride Plant ID	
	ARPA 625		PENE 635
	ARPA 626		PENE 636
	ARPA 627		PENE 637
	ARPA 628		PENE 638
	ARPA 629		PENE 639
	ARPA 630		PENE 640
	ARPA 631		PENE 641
	ARPA 632		PENE 642
	ARPA 633		PENE 643
	ARPA 634		PENE 644
<i>Total</i>	10		10

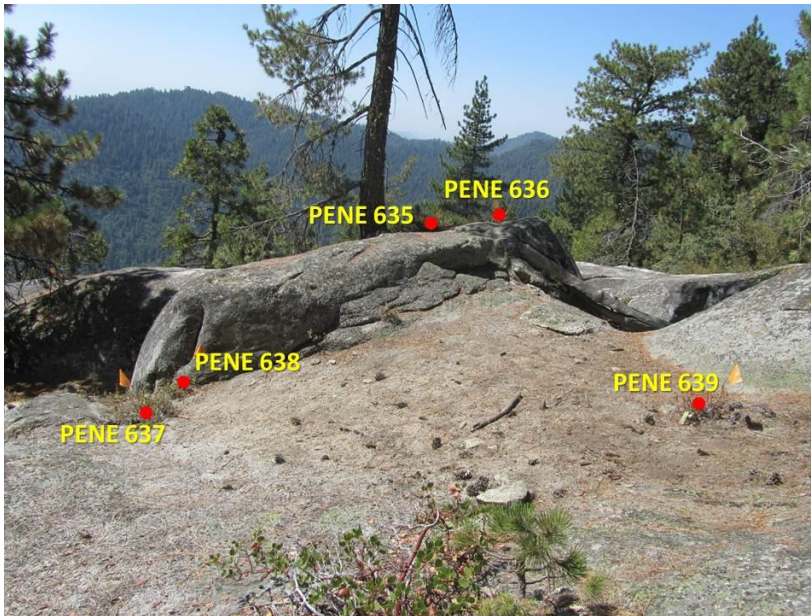
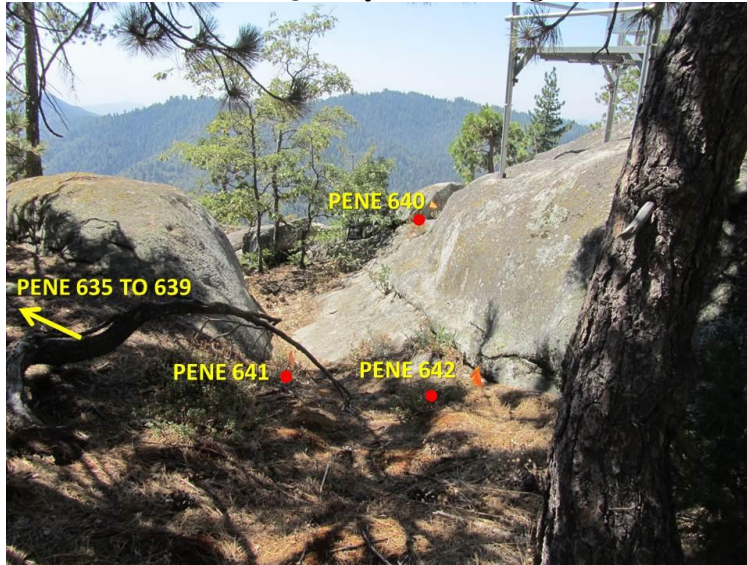
LKAQ site photos



Species Code	Unique ID*	Individual	Northing	Easting	Notes
ARPA	625	1	4048204	340936	Monitor entire patch
PENE	643	9	4048206	340927	West of PENE 644 #9
PENE	644	10	4048206	340927	
ARPA	626	2	4048200	340935	
ARPA	627	3	4048196	340935	Monitor entire patch
ARPA	628	4	4048199	340942	Bounded by 2 logs, plant tag is on branch closest to downed tree

*used on plant tag and in *Nature's Notebook*

Lower Kaweah Air Quality Monitoring Site (CPP-SEKI-LKAQ) continued



Species Code	Unique ID*	Individual	Northing	Easting	Notes
PENE	635	1	4048191	340903	South of PENE 636
PENE	636	2	4048191	340903	North of PENE 635
PENE	637	3	4048190	340909	Southeast of PENE 638
PENE	638	4	4048190	340909	
PENE	639	5	4048193	340913	
PENE	640	6	4048199	340911	
PENE	641	7	4048199	340914	
PENE	642	8	4048199	340914	Northeast and uphill of PENE 641

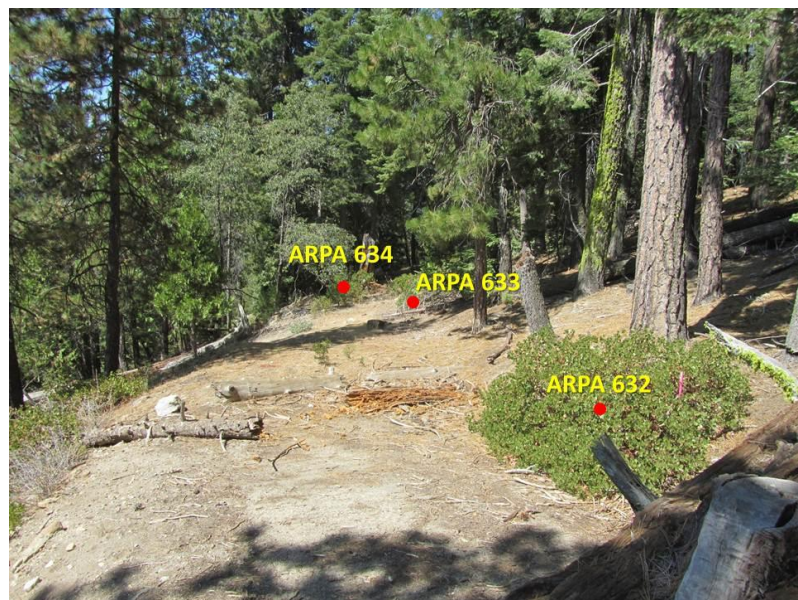
*used on plant tag and in *Nature's Notebook*

Lower Kaweah Air Quality Monitoring Site (CPP-SEKI-LKAQ) continued

ARPA 629 and 630 are behind a ponderosa pine and along the unpaved road leading to the air quality monitoring station. The sign in the picture below (left) is at the station.



ARPA 632, 633, and 634 are located along the end of the unpaved road, past the air quality monitoring station. The log in the foreground of the picture below blocks the road. ARPA 631 is on the other side of the log (not shown) and same side of the road as ARPA 632.



Species Code	Unique ID*	Individual	Northing	Easting	Notes
ARPA	629	5	4048206	340952	Monitor only the tagged stem
ARPA	630	6	4048209	340959	Closer to road than ARPA 629
ARPA	631	7	4048223	340931	
ARPA	632	8	4048229	340923	Monitor entire plant
ARPA	633	9	4048249	340916	Find meal tag on uphill stem
ARPA	634	10	4048252	340907	Next to snag

*used on plant tag and in *Nature's Notebook*

V. Frequency of Monitoring and Estimated Time Investment

As described in detail in the *CPP Plant Phenology Monitoring Protocol*, ideally plants should be monitored *at least* twice weekly to accurately detect changes in the onset and duration of phenophases. More frequent monitoring will maximize the ability to detect and to measure phenological change, although some CPP monitoring sites may be established primarily for interpretive purposes and monitored less frequently.

Although data entry is not time-sensitive, uploading observations to *Nature's Notebook* at least 4 times a year will minimize a back-log of data entry. Entering data more frequently (e.g., after each monitoring event or at the end of every week), however, is helpful in preventing confusion or correcting observation errors on the datasheets, since observers may remember the monitoring events well enough to correct errors during data-entry.

It is best to have only a small number of well-trained observers monitoring a site. Novices tend to interpret phenophase abundances or “quantities” differently, and if there are many observers with little experience recording abundance estimates, percentages and quantities may be estimated inconsistently on the datasheets.

VI. Datasheets and Data Entry

Datasheets for all CPP species can be downloaded from the CPP website on the individual species pages (direct links to the datasheets are provided below) or from two locations on the *Nature's Notebook* website (<http://www.nn.usanpn.org>). See *Phenology Site and Trail Monitoring SOP #6* for additional instructions for downloading and using *Nature's Notebook* datasheets.

Direct links to datasheets for SEKI species:

Aesculus californica (CA Buckeye): https://www.usanpn.org/files/shared/observationsheets/species_713.pdf

Quercus douglasii (Blue Oak): https://www.usanpn.org/files/shared/observationsheets/species_757.pdf

Penstemon newberryi (Mountain Pride): http://www.usanpn.org/files/shared/observationsheets/species_760.pdf

Arctostaphylos patula (Greenleaf Manzanita):

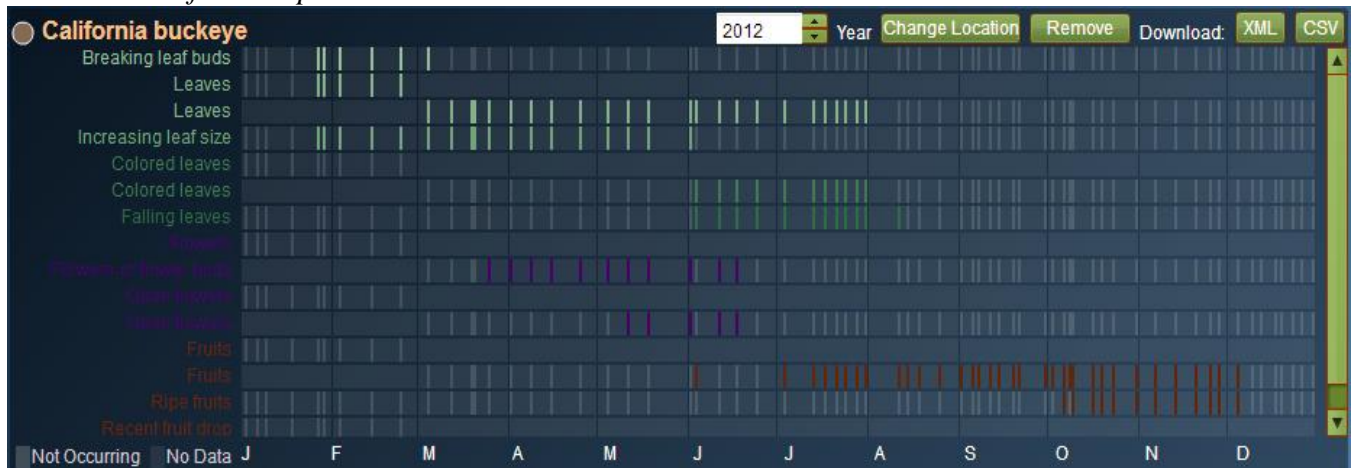
http://www.usanpn.org/files/shared/observationsheets/species_761.pdf

Step-by-step instructions for data entry into the National Phenology Database (NPDb) curated by the USA-NPN are provided in *Data Entry and Data Management SOP # 7*.

VII. Preliminary Phenological Calendars for SEKI focal taxa: estimates of phenophase onset and duration

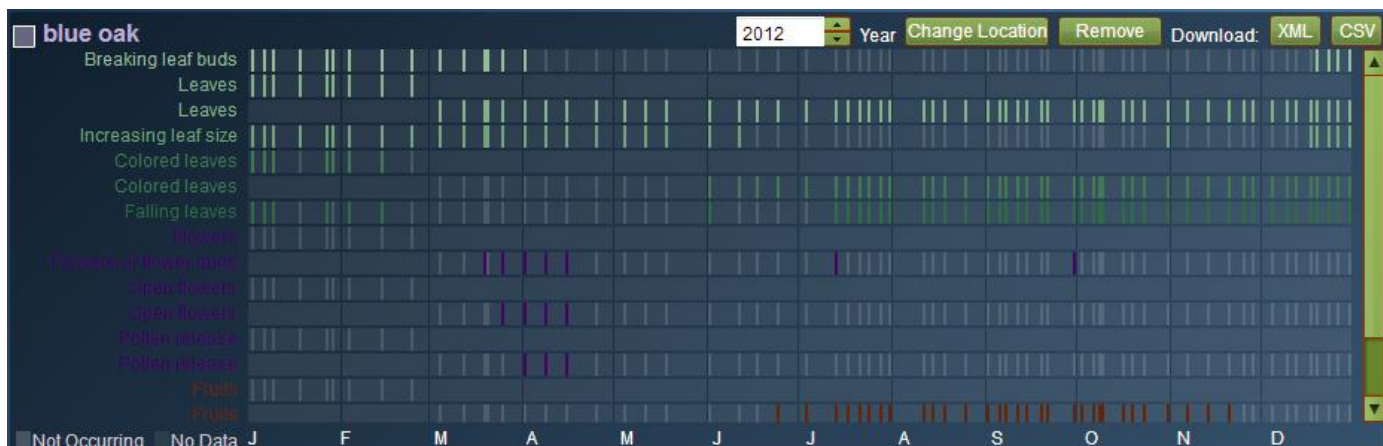
(1) **California Buckeye:** 2012 observations at SEKI are summarized in the USA-NPN visualization tool below. Based on these preliminary summaries, estimates the phenologically active season (at SEKI) for Buckeye phenophases are:

- *breaking leaf buds*: January-March
- *leaves*: January-August
- *increasing leaf size*: January- June
- *colored leaves*: June-August
- *falling leaves*: June-August
- *flowers*: March-June
- *open flowers*: May-June
- *fruits*: June-December
- *ripe fruits*: October-December
- *recent fruit drop*: TBA



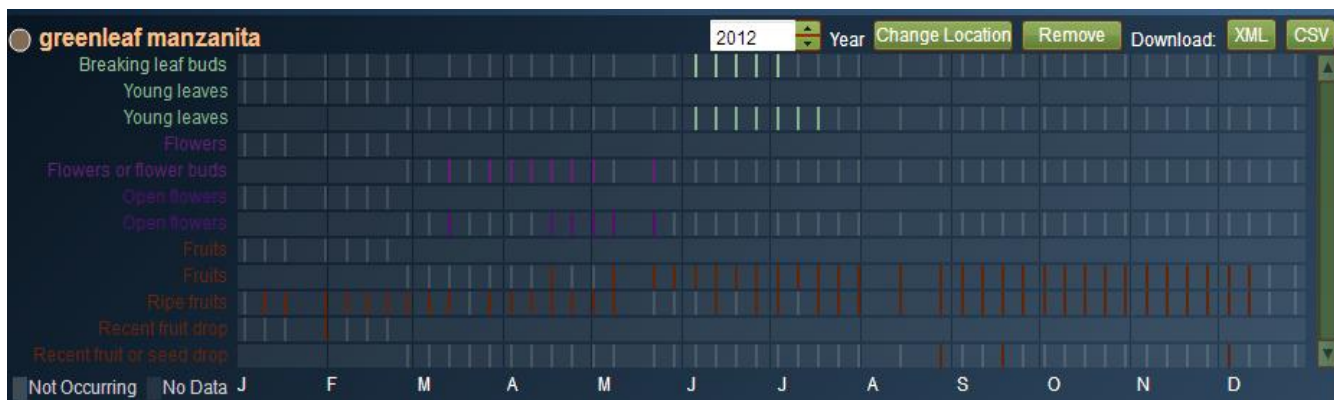
(2) **Blue Oak:** 2012 observations recorded at SEKI are summarized in screen shot of the USA-NPN visualization tool below. Based on these preliminary summaries, estimates the phenologically active season (at SEKI) for Blue Oak phenophases are:

- *breaking leaf buds*: December-April
- *leaves*: year round
- *increasing leaf size*: December-June
- *colored leaves*: May-February
- *falling leaves*: May-February
- *flowers*: March-April
- *open flowers*: March-April
- *pollen release*: March-April
- *fruits*: June-November
- *ripe fruits*: October-December
- *recent fruit drop*: November-December



(3) **Greenleaf Manzanita:** 2012 observations recorded at SEKI are summarized in screen shot of the USA-NPN visualization tool below. Based on these preliminary summaries, estimates the phenologically active season (at SEKI) for Greenleaf Manzanita phenophases are:

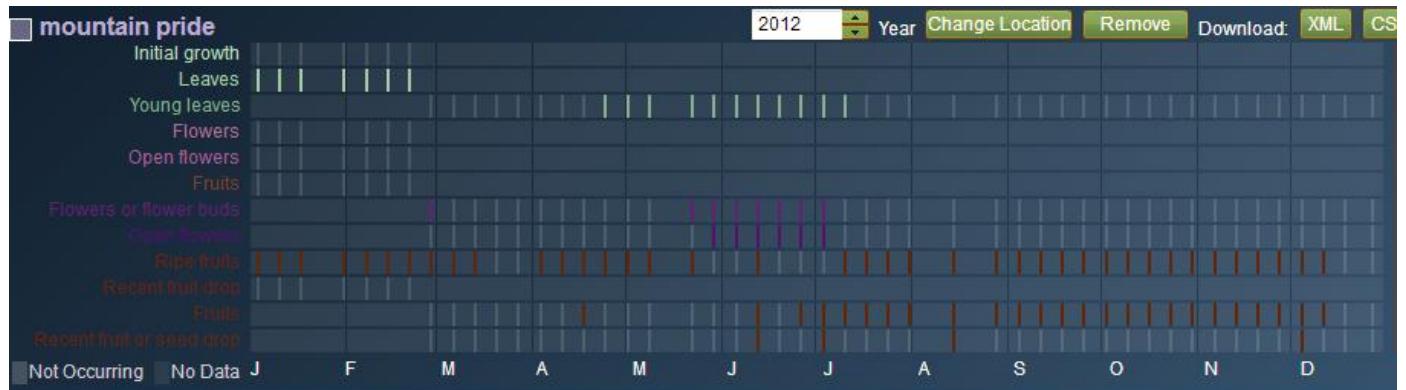
- *breaking leaf buds*: June-July
- *young leaves*: June-July
- *flowers*: March-May
- *open flowers*: March-May
- *fruits*: year round
- *ripe fruits*: year round
- *recent fruit or seed drop*: sporadic



(4) **Mountain Pride:** 2012 data are summarized in visualization below. Based on these preliminary data summaries, we have estimated the phenologically active season (at SEKI) for selected Mountain Pride phenophases:

- *young leaves*: April-June
- *flowers or flower buds*: (February) May-July
- *open flowers*: May-July
- *fruits*: April-December

- *ripe fruits*: year round
- *recent fruit or seed drop*: TBD



VIII. Suggestions for Interpretative Programs for the Public

The CPP has developed a variety of educational and interpretive programs that can be downloaded from the *Education* page on the CPP website (<http://www.usanpn.org/cpp/education>). Whether you're looking for a simple hands-on activity for the backyard or schoolyard, or you're in need of a guide to plan, install, and use a phenology garden for year-round scientific and educational activities, you'll find over 25 phenology-focused resources on the *Education* page. These resources are designed by CPP scientists and educators for a variety of ages and scientific abilities.

The CPP Interpretive Guide is also available for download on the website on the *Resources* page (<http://www.usanpn.org/cpp/resources>). We expect this guide will help park interpreters and educators to introduce the CPP to park visitors. This guide also provides suggestions for ways in which — through hands-on activities — park staff can help visitors to learn how park scientists and volunteers are detecting the effects of environmental variation and climate change on the seasonal cycles of plants and animals.

Appendix A. Monitoring tips from SEKI observers

General

- When estimating, it can help to use process of elimination. Start by ruling out an estimate range that clearly does not apply to the current condition then keep trying ranges until you narrow it down to the best estimate.
- Previous visit fruit abundance estimates are often necessary to answer fruit drop question.

Foothill Visitor Center Site 2

- If the watering system is turned on in the native plant garden, the properties in *Nature's Notebook* for this site need to be recorded as irrigated.

California buckeye (*Aesculus californica*)

- Buckeye can abort fruits, causing the abundance metric (i.e., the estimate of total fruit) to first increase, then decrease.
- After the leaves are completely brown and dead, they often do not fall off the tree right away. Be careful not to count these as colored leaves at that point.

Blue oak (*Quercus douglasii*)

- Colored Leaves: Be careful to know the difference between insect damage and seasonal leaf color. Insects can cause small brown patches on the leaves that look a lot like seasonal leaf color change.
- Colored Leaves: A small number of leaves can become mottled with brown spots (unrelated to insect damage) fairly early in the growing season, although the majority of leaves will not begin turning until fall. Thus, % canopy of colored leaves may be especially useful to detect the onset of seasonal color change for blue oak.
- Falling Leaves: Pay attention to the amount of leaves on the ground before you reach the season where they start to fall, that way you are able to discern this year's falling leaves from last year's. If you just look for just any fallen leaves, then you will always be marking yes to that category with the blue oak, because they lay on the ground under the tree for years after they fall.
- Fruits: When there are a lot of acorns, it can help to frame a section of the canopy with your hands to take a subsample then extrapolate to get an estimate for the whole tree.

Greenleaf manzanita (*Arctostaphylos patula*)

- Flowers or flower buds: Do not count the inflorescence structure (panicle) that forms during the summer the year before flowering occurs (*see the ARPA species profile for a photo of this structure*). For flower buds, count them as present when they become visible without a hand lens and develop into flowers that same year. (Remember to count the number of inflorescences, not individual flowers.)
- At LKAQ, the manzanita fruits are often brown when mature and never turn red. Count a fruit as mature when most of it (>75%) has turned a darker rusty brown to red color.

- Small old leaves can be mistaken for new leaves, so be careful with that one. Look for other clues to determine which leaves are young-- lighter color, softer texture, etc.
- Greenleaf manzanita can hold on to old shriveled up fruit from the previous year. Any fruit that is obviously from the previous year should not be counted.