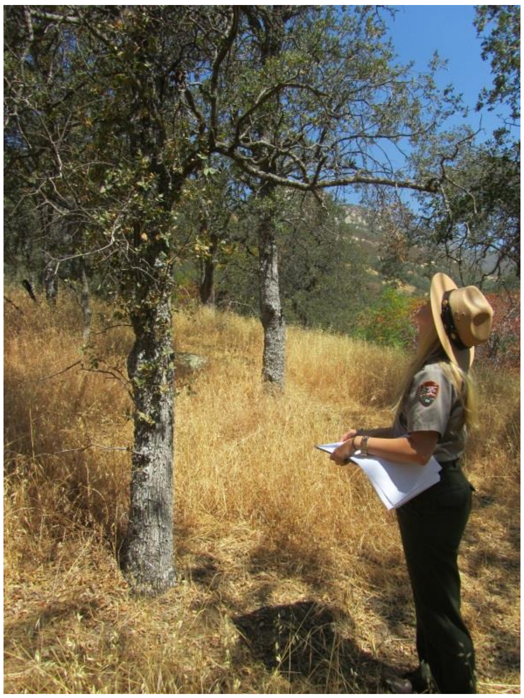
National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Sequoia and Kings Canyon National Parks' (SEKI) California Phenology Project DRAFT Annual Report 2012



ON THE COVER
Photos: Upper left: Hannah Schwalbe, 2012 Phenology Intern at FHV; Upper right: Dani Cessna, Interpretation Ranger monitoring a blue oak at FHVC; Lower left: Frank Klein, Air Quality Biological Technician standing behind a greenleaf manzanita at LKAQ; Lower right: *Penstemon newberryi*
All photographs were taken by Ann Huber in 2012 except the photo of *Penstemon newberryi* taken by Jeff Abbas in 2001.

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Overview

Phenology is the study of seasonal changes or events in plants and animals such as flowering, leaf drop, insect emergence, and animal migration. Long-term studies have shown that phenological phases are sensitive to changes in environmental variation and climate. Climate-driven changes in the timing of plant and animal seasonal events can have far-reaching ecological effects such as changes in primary productivity, species interactions, resource availability, and population growth.

Sequoia and Kings Canyon National Parks (SEKI) is currently one of seven national parks in California that participate in the California Phenology Project (CPP). With funding from the National Park Service (NPS) Climate Change Response Program, the CPP was formed in 2010 to provide tools and protocols to be used for long-term plant phenology monitoring with an emphasis on public participation and education across parks in California. SEKI participates in the CPP effort to advance public understanding of phenology and its relationship with climate with a variety of outreach efforts, and also in scientific understanding of current phenological events by monitoring plants in the field. The scope of this annual report is limited to the activities and results of the monitoring component of the California Phenology Project in SEKI.

The main objectives of this annual report are to provide general information on the amount of data collected (effort) and general patterns in phenological activity observed at SEKI from November 2011 to December 2012, lessons learned, and recommendations for the future. A post-season field summary is also included in this report. The post-field season summary provides additional documentation about monitoring effort; file and equipment locations; changes in protocols and any other monitoring-related changes. Trend analyses and other analyses investigating links between changes in phenology and changes in climate are generally not included in park-specific annual reports.

Methods

A brief overview of methods is summarized here. For a complete account of methods and materials please refer to the California Phenological Monitoring Guide: Sequoia and Kings Canyon National Parks. Information on CPP-wide protocols, including site selection, field methods, data management, and data analysis are described in the California Phenology Project (CPP) Plant Phenology Monitoring Protocol. A collection of phenological monitoring resources that provide additional information about methods, including phenophase definition sheets, species accounts, and sample datasheets are available from the California Phenology Project at www.usanpn.org/cpp/.

Monitoring Locations, Sites, and Frequency

There are two plant phenology monitoring locations at Sequoia National Park: the Foothills Visitor Center (FHVC) and the Lower Kaweah Air Quality Monitoring site (LKAQ). These locations were chosen primarily because the target plants are easily accessible; they are co-located with weather stations; and they occur at two different elevation zones in the park. FHVC is located in blue oak woodlands at 1,700 ft and LKAQ is located in an opening in mixed conifer forest at about 6,000 ft.

Fourteen blue oak (*Quercus douglasii*) and seven California buckeye (*Aesculus californica*) trees are monitored at the Foothills Visitor Center location, and are divided among four sites (Sites 1-4) located near the visitor center. Phenological monitoring at FHVC began in December 2011 and is conducted year-round by NPS Interpretive Ranger staff or interns. The sampling interval goal at LKAQ is 2x/week.

Ten greenleaf manzanitas *(Arctostaphylos patula)* and ten mountain pride plants *(Penstemon newberryi)* are monitored at the Lower Kaweah Air Quality Monitoring location (LKAQ). This location is not subdivided into sites. Phenological monitoring at LKAQ began in November 2011 and is conducted 1x/week throughout the year except when plants are completely buried in snow. (So far complete snow cover has only occurred during a the second half of March 2012 for *Penstemon* plants only.) Monitoring at this site is conducted by NPS Air Quality Monitoring technicians.

Data Summaries

Step-by-step methods for annual data summaries are described in the CPP Protocol's SOP 10: Data Summary, Analysis and Reporting. For climate summaries, additional data sources not referenced in SOP 10 were utilized, and thus are described here.

For the FHVC monitoring location, temperature and precipitation data were obtained from the Ash Mountain weather station located near the Foothills Visitor Center. Precipitation summaries since 1927 are available from www.wrh.noaa.gov/hnx/coop/ashmtn.htm. Temperatures in 2012 and 30 year normals (1981-2010) for this station were obtained from NOAA's National Climatic Data Center at www.ncdc.noaa.gov/cdo-web/. The NOAA Satellite and Information Service site at www.ncdc.noaa.gov/IPS/cd/cd.html, which is referenced in SOP 10, also provides this information, but had several months of missing data for all stations.

The Lower Kaweah Air Resources station provided 2012 weather data for LKAQ. These records were obtained from ard-request.air-resource.com/DataProducts.aspx by selecting the "products for pre-selected parameters" option. This station has precipitation records since 1996 and temperature since 1988; which is not long enough for 30 year normal calculations. Thus, 30 year normals (1981-2010) from the Grant Grove meterological station were used to give an approximate idea of how conditions at LKAQ in 2012 compared to long-term averages in the area. Although the station at Lodgepole is geographically closer to LKAQ, because Lodgepole is a cold-sink Grant Grove is a better surrogate for conditions at the Lower Kaweah / Giant Forest area. Thirty year normals for temperature came from the Western Regional Climate Center's website www.wrcc.dri.edu.

Results

Annual Climate Summary

The tables below show temperature and precipitation averages from weather stations located at and/or near phenological monitoring locations.

Table 1. Temperature summary table for the Foothills Visitor Center (FHVC) monitoring location at Ash Mountain, Sequoia National Park.

	2012 Average Temperature (^{o}F) **FHVC**	Departure from 30 Year Normal (1981-2010)
Jan	48.8	1.9
Feb	49.3	-0.4
Mar	51.1	-2.0
Apr	56.0	-1.2
May	66.9	0.8
Jun	77.2*	2.4
Jul	81.2	-0.8
Aug	85.5	4.3
Sep	79.9	4.6
Oct	66.3	1.1
Nov	56.4	2.8
Dec	47.6	0.9
Annual	**62.6**	**-0.1**

*Missing data estimated using the RAWS weather station located adjacent to the Ash Mountain station (www.raws.dri.edu/cgi-bin/rawMAIN.pl?caCASM).

Overall 2012 monthly average temperatures at FHVC were fairly typical compared to the 30 year normal record, with the exception of August and September which were warmer on average by about 4-5^{o}F. The average annual temperature was nearly identical to the 1981-2010 average.

Table 2. Precipitation summary table for the Foothills Visitor Center (FHVC) monitoring location at Ash Mountain, Sequoia National Park.

	2012 Total Precipitation (in) **FHVC**	Departure from 30 Year Normal (1981-2010)	Departure from 85 Year Normal (1927-2011)	Percent of 85 Year Normal (1927-2011)
Jan	4.39	-0.51	-0.34	93%
Feb	1.55	-3.28	-3.11	33%
Mar	2.98	-1.35	-1.30	70%
Apr	4.97	2.36	2.32	188%
May	0.07	-1.05	-1.02	6%
Jun	0.00	-0.40	-0.34	0%
Jul	0.00	-0.11	-0.10	0%
Aug	0.00	-0.03	-0.10	0%
Sep	0.00	-0.44	-0.45	0%
Oct	1.94	0.50	0.72	160%
Nov	1.46	-1.45	-1.31	53%
Dec	6.98	2.99	2.72	165%
Annual	**24.28**	**-2.77**	**-1.41**	**95%**

At the elevation of FHVC, precipitation is predominately in the form of rain that falls in the winter and spring.

In 2012, the FHVC area at Ash Mountain accumulated about 2.77 inches of precipitation less than the 30 year normal record. This amount is slightly drier than normal, at 90% of the previous 30 year average and 95% of the previous 85 years average (25.69 inches). From a water year perspective, the 2011-2012 water year (October 2011 to September 2012) was only 75% of the 85 year average (19.19 inches compared to water years 1928-2011 average of 25.74 inches, water year data not shown in table). Although summers are typically dry, the summer of 2012 was drier than normal compared to the last 85 years, which shows some precipitation in June, July, August and September.

2011 was overall also slightly dry (23.3 inches); however, the 2010-2011 water year, with 40.7 inches of accumulation, was about 160% of normal compared to the long-term record (water years 1928-2010). This was due in large part to an unusually wet November 2010, December 2010, and March 2011, with other months slightly wetter or drier than normal (data not shown).

Table 3. Temperature summary table for the Lower Kaweah Air Quality (LKAQ) monitoring location, Sequoia National Park, and Grant Grove, Kings Canyon National Park.

	2012 Average Temperature (^{o}F) **LKAQ**	2012 Average Temperature (^{o}F) **Grant Grove***	Departure from 30 Year Normal (1981-2010) **Grant Grove**
Jan	40.46	40.6	5.2
Feb	34.70	35.4	0.3
Mar	37.04	36.9	0.0
Apr	42.44	43.4	2.7
May	51.44	50.9	2.3
Jun	57.92	57.7	0.3
Jul	65.48	64.6	-0.1
Aug	69.26	68.9	4.6
Sep	64.76	63.6	5.0
Oct	52.34	20.5	0.6
Nov	45.14	43.2	2.4
Dec	34.16	31.7	-3.7
Annual	**49.60**	**49.0**	**1.6**

*Monthly average temperatures at Grant Grove in 2012 are shown simply as an example of the similarity with LKAQ. Departures from normal calculations used data from Grant Grove only.

The average temperature in 2012 was about 1.6^{o}F warmer than the 30 year normal record, using data from Grant Grove as an estimate for long-term conditions at LKAQ. January, August, and September stand out as having the warmest departures from normal, on average about 5^{o}F higher than the 30 year normal. December was the only month that was colder than normal (not counting July which was only 0.1^{o}F colder).

Table 4. Precipitation summary table for the Lower Kaweah Air Quality (LKAQ) monitoring location, Sequoia National Park, and Grant Grove, Kings Canyon National Park.

	2012 Total Precipitation* (in) **LKAQ**	2012 Total Precipitation (in) **Grant Grove****	Departure from 30 Year Normal (1981-2010) **Grant Grove**	Percent of Long-Term Average (1981-2010) **Grant Grove**
Jan	6.8	2.75	-5.07	35%
Feb	2.5	1.56	-5.67	22%
Mar	5.7	6.88	-0.08	99%
Apr	5.8	6.37	2.42	161%
May	0.3	0.26	-1.42	15%
Jun	0.1	0.25	-0.28	47%
Jul	0.0	trace	-0.23	0%
Aug	0.1	0.04	-0.08	33%
Sep	0.0	0.03	-0.87	3%
Oct	0.7	1.23	-1.21	50%
Nov	4.1	3.97	-0.39	91%
Dec	9.2	12.52	5.95	191%
Annual	**35.2**	**35.86**	**-6.93**	**84%**

*Precipitation amount includes rainfall and melted frozen precipitation (snow and sleet). **2012 Grant Grove values shown simply to provide an example of the similarity with LKAQ. Departures from normal and percent of long-term averages were calculated with data from Grant Grove only.

Overall, LKAQ had 35.2 inches of precipitation in 2012. 2012 was a drier than normal year, with about 84% of the long-term average for precipitation (1981-2010), using data from Grant Grove as an estimate for long-term conditions at LKAQ.

Monitoring Effort

The tables below provide a summary of monitoring effort from November to December 2011 and for the entire year of 2012. See the Post-field Season Summary for information on individual participant efforts.

Table 5. Data monitoring effort in **2011** for each monitoring location and total for Sequoia and Kings Canyon National Parks (SEKI). Monitoring for LKAQ began in November 2011 and for FHVC in December 2011.

	FHVC	LKAQ	SEKI Total
Observation Records	1,049	784	1,833
Observers	1	2	3
Days Observed	5	6	11
Species Observed	2	2	4
Sites Monitored	4	1	5
Individuals Monitored	21	20	41

Table 6. Data monitoring effort **in 2012** for each monitoring location and total for Sequoia and Kings Canyon National Parks (SEKI).

	FHVC	LKAQ	SEKI Total
Observation Records	13,654	6,549	20,203
Observers	8	2	10
Days Observed	63	49	112
Species Observed	2	2	4
Sites Monitored	4	1	5
Individuals Monitored	21	20	41

Table 7. Sampling interval at each monitoring location in 2012.

	FHVC		LKAQ	
	Maximum # days between visits	Mean # days between visits	Maximum # days between visits	Mean # days between visits
January	9	5	14	9
February	11	9	7	7
March	9	6	7	7
April	10	8	7	7
May	14	9	7	7
June	10	8	7	7
July	10	5	7	7
August	11	6	14	9
September	9	4	7	7
October	8	4	7	7
November	7	6	7	7
December	6	4	10	8

Plants at FHVC were monitored at varying intervals in 2012, ranging from 4 to 9 days on average. At least one missed week occurred in every month in 2012 except December. Monitoring at LKAQ consistently took place every 7 days, with the exception of a missed week in January and August (Table 7). A list of observation dates for each species is included in Appendix B.

Phenophase Activity

The USA-NPN visualization tool provides a simple overview of observed phenological activity at a site, park, or region. Figures 1-4 show observation results for all species monitored at SEKI in 2011 and 2012. Different species are monitored at FHVC and LKAQ, so it is not possible to combine results from more than one location. In the visualization figures, light grey bars indicate a negative observation (phenophase not occurring). Colored bars represent positive observations (phenophase occurring).

Phenophase activity dates and duration times are shown in the tables that follow each visualization figure. "First" or "first observed" and "last" or "last observed" dates are the first and last dates with a positive observation for the corresponding phenophase. "Duration" or "days" is simply a count of the number of days between the first and last observation dates. Specific dates of activity are from the raw data downloaded from the National Phenology Database (NPDb). Both raw data and visualization figures were utilized for depicting general patterns of activity.

It is important to point out that phenophases may have actually begun or ended during gaps in monitoring visits, and not specifically on the date they were observed. Sampling interval can vary with date. Monitoring dates are shown in Appendix B in part to provide a record of the range of potential variation in time associated with reported activity periods. Since monitoring at LKAQ usually occurred every 7 days, the range of potential variation for reported activity periods of *Penstemon newberryi and Arctostaphylos patula* is typically 6 days before the first positive observation date and 6 days after the last positive observation date. In 2012, there was considerably more variation in sampling interval at the FHVC (Table 7) monitoring location. Thus the potential variation in reported activity periods for *Quercus douglasii* and *Aesculus californica* is less consistent, and would need to be determined from Appendix B for every date that is reported for phenophase activity. Table 7 can be used for general estimates. The USA-NPN is currently developing methods to generate onset and duration dates for phenophases from the raw data archived in the NPDb. The CPP will be adopting these methods when they become available in 2014.

Note regarding USA-NPN visualization figures: Following an assessment of the phenological records contributed to *Nature's Notebook* in 2011, some of the USA-NPN phenophase definitions and/or names were modified in early 2012. One result of these changes is that many phenophases for a given individual plant or species are listed twice in the visualization tool or database, with the phenophase for each year associated with a slightly different definition and name (e.g. "Flowers" in 2011 was changed to "Flowers and flower buds" in 2012). The USA-NPN is currently preparing a document that will document phenophase equivalence, which will be made available on their website.

Blue oak *(Quercus douglasii)*

The visualization figure below shows the combined results for all 14 *Quercus douglasii* trees monitored at Foothills Visitor Center (FHVC). Monitoring began on December 5, 2011. Breaking leaf buds, leaves, increasing leaf size, colored leaves, and falling leaves were active at the time of the first monitoring visit in December and continued into 2012.

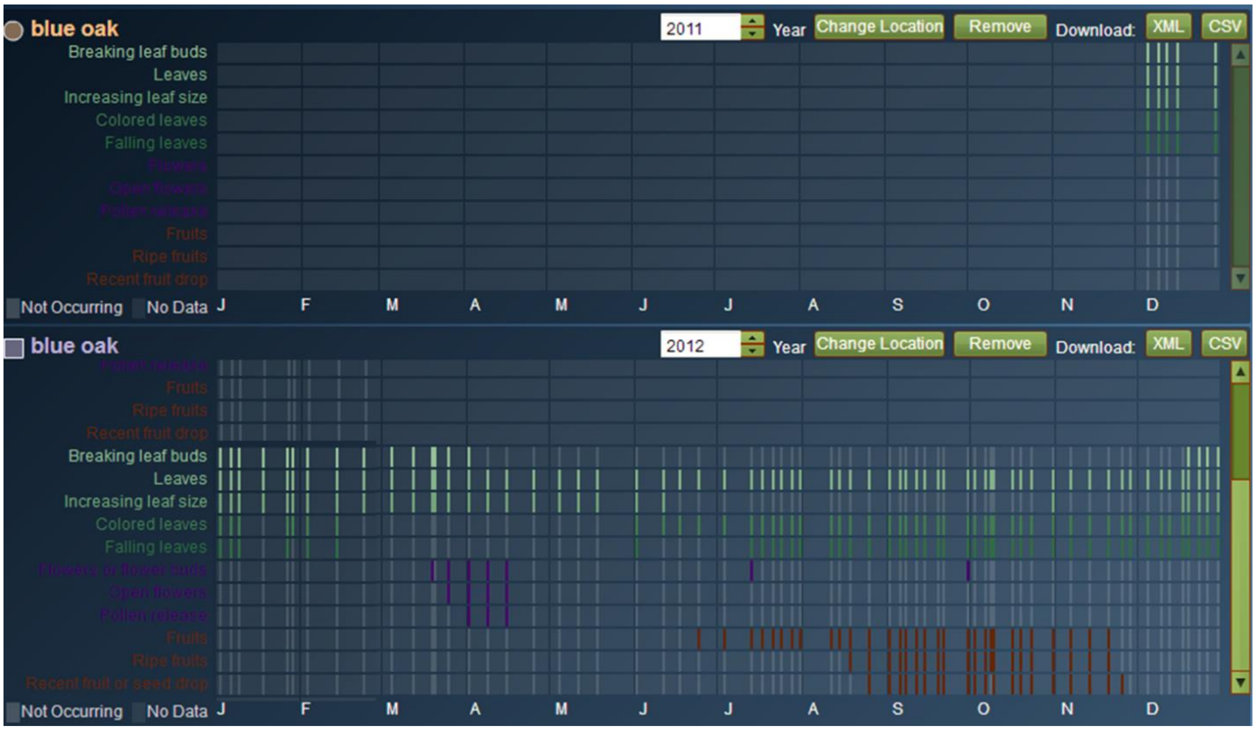

Figure 1. *Quercus douglasii* phenophase activity in 2011 (top) and 2012 (bottom) at the Foothills Visitor Center (FHVC) monitoring location in SEKI (n=14).

Figure Notes: Several data entry errors are shown in Figure 1. These include the following entries accidentally entered as positive observations: July and September flowers or flower buds; June falling leaves; and October increasing leaf size. These phenophases had negative observations on datasheets in those months. (For data security reasons, Nature's Notebook only allows past entries to be changed under the account that entered them. Therefore, at this time we are not able to directly access these data on Nature's Notebook and have sent them to NPN to make the corrections in the database.)

Specific phenophase activity dates are shown in Table 8.

Phenophases that were active on the first visit for the project on December 5, 2011 may have initiated much earlier than the first observed date in Table 8. Thus, duration estimates are likely underestimates but are reported in case they may be helpful for future comparisons. First positive observation dates for these phenophases were captured in 2012. We will be able to more completely report activity periods for these phenophases in the 2013 annual report as a continuous monitoring record will be available.

Table 8. *Quercus douglasii* phenophase activity (n=14). All dates are 2012 unless indicated as 2011.

Park = SEKI Year = 2012 Species = blue oak (*Quercus douglasii)*				
Phenophase	**First Observed**	**Last Observed**	**Duration (Days)**	**Notable Patterns of Activity**
Breaking leaf buds	December 5, 2011*	April 1	>119	Activity period spans calendar years
	December 19	December 30**	>21	
Leaves	Year-round	Year-round	Year-round	
Increasing leaf size	December 5, 2011*	June 12	>191	Activity period spans calendar years
	December 17	December 30**	>13	
Colored leaves	December 5, 2011*	February 14	>71	Activity period spans calendar years
	June 1	December 30**	>199	
Falling leaves	December 5, 2011*	February 14	>71	Feb 14 date is blue oak 448
	July 13	December 30**	>170	First dates July 13 – July 24 for all but blue oak 448
Flowers or flower buds	March 19	April 15	27	
Open flowers	March 25	April 15	22	
Pollen release	April 1	April 15	15	
Fruits	June 24	November 20	150	
Ripe fruits	August 18	November 20	95	Duration range 87-95 days
Recent fruit or seed drop	August 25	November 20	95	

Table notes: *Phenophase active during first monitoring visit of the project at FHVC on December 5, 2011. **Phenophase active during last monitoring visit for the year on December 30, 2012.

Reproduction: blue oak

A closer look at flower and fruit observations reveals that only about half (6 out of 14) of the oaks were seen with flowers in 2012, and of these only 4 were observed with fruits (Table 9). The first day that flowers or flower buds were observed varied among trees between March 19 and April 8; the last day that flowers were seen was the same for all trees (April 15).

Table 9. *Quercus douglasii* reproductive phenophase activity of individual trees in 2012.

			Flowers or Flower Buds			**Open Flowers**			**Fruits**		
Plant ID No.	**Site No.**	**Area**	**First**	**Last**	**#Days**	**First**	**Last**	**#Days**	**First**	**Last**	**#Days**
443	3	housing	Mar-25	Apr-15	21	Mar-25	Apr-15	21	Jun-24	Aug-25	62
444	3	road									
448	2	admin sapling									
449	2	admin									
451	2	admin									
452	2	garden	Mar-25	Apr-15	21	Apr-08	Apr-15	7	Jul-13	Nov-13	123
453	2	garden	Apr-08	Apr-15	7	Apr-08	Apr-15	7			
454	1	tennis courts	Apr-01	Apr-15	14	Apr-08	Apr-15	7			
458	1	behind SNHA	Mar-25	Apr-15	21	Mar-25	Apr-15	21	Jul-03	Nov-20	140
459	1	weather sta									
460	1	weather sta									
461	1	weather sta									
462	1	weather sta	Mar-19	Apr-15	27	Mar-25	Apr-15	21	Jul-03	Nov-20	140
463	1	weather sta									

Table notes: Blank cells are negative observations (phenophase status = 0; no activity).

Two of the trees with flowers did not appear to produce fruits (acorns) (Table 9). Of the 4 trees with acorns, one tree's acorns did not appear to ripen (blue oak 443). No clear differences between sites were seen for reproductive-type phenophase activity periods shown in Table 8.

Leaves: blue oak

Although *Quercus douglasii* is a deciduous species, leaves were seen year-round (Fig. 1, Table 8). This is because at least one tree had at least some leaves throughout the monitoring period. However, 9 of the 14 trees were completely leafless during all or a portion of the monitoring period from December 30, 2011 to March 12, 2012. The other trees dropped to as low as <5% canopy in January and February (Fig. 2).

Canopies were fully replenished over a short period between mid-Feb to mid-March and trees retained leaves throughout the summer months (Fig. 2). Leaf drop was first observed for all trees between mid to late July (Table 8) except blue oak 448 which had was not observed to begin leaf drop until September 1. The greatest declines in canopy for many trees occurred in November.

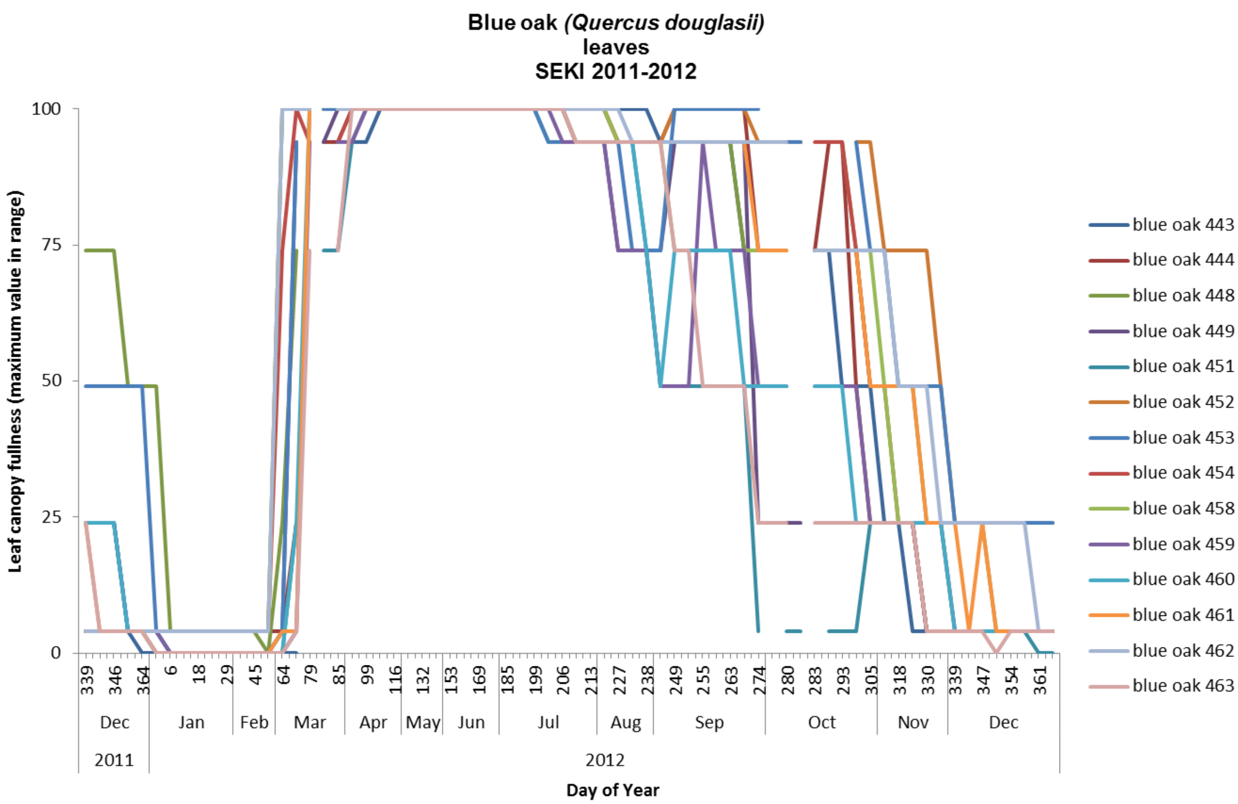

Figure 2. *Quercus douglasii* leaves phenophase activity of individual trees (n=14).

Figure Notes: The upper limit of abundance categories recorded for the "Leaves" phenophase were used to chart leaf canopy fullness. Also note that observations were not binned into equal time intervals. Breaks in the lines are caused when no observations were made on a day of the year that is included on the x-axis.

The last observation date for falling leaves on February 14, 2012 was observed for one tree, blue oak 448 (Table 8). Falling leaves were last observed for all other trees for the 2011-2012 activity period between December 5, 2011 to January 2, 2012.

Table 10 shows the estimated total number of days that trees were observed to have leaves, and are sorted by number of days so that trees that retained leaves the longest are at the top. Blue oak 448, a sapling that likely has an underdeveloped root system, had the fewest estimated days with leaves (i.e., the longest leafless period). Blue oak 444, 452, 454, 458, and 462 had considerably more estimated days with leaves than the other target trees.

Table 10. *Quercus douglasii* duration estimates of the leaves phenophase for each tree monitored in 2012.

Unique Plant ID No.	Site No.	Area	Total # Days with Leaves
444	3	road	391
452	2	VC garden	391
454	1	tennis courts	391
458	1	behind SNHA	391
462	1	weather station	391
453	2	VC garden	329
449	2	admin	326
461	1	weather station	326
459	1	weather station	321
460	1	weather station	318
463	1	weather station	318
451	2	admin	314
443	3	housing	292
448	2	admin sapling	132

California buckeye *(Aesculus californica)*

The figure below shows the combined results for all 7 *Aesculus californica* that are monitored at Foothills Visitor Center (FHVC). Monitoring began on December 5, 2011. The only phenophase active at that time was recent fruit drop. Overall, activity periods for all phenophases were continuous (not sporadic) in 2012 when positive observations for all individuals are combined. All phenophases began and ended within 2012 (i.e., none spanned calendar years).

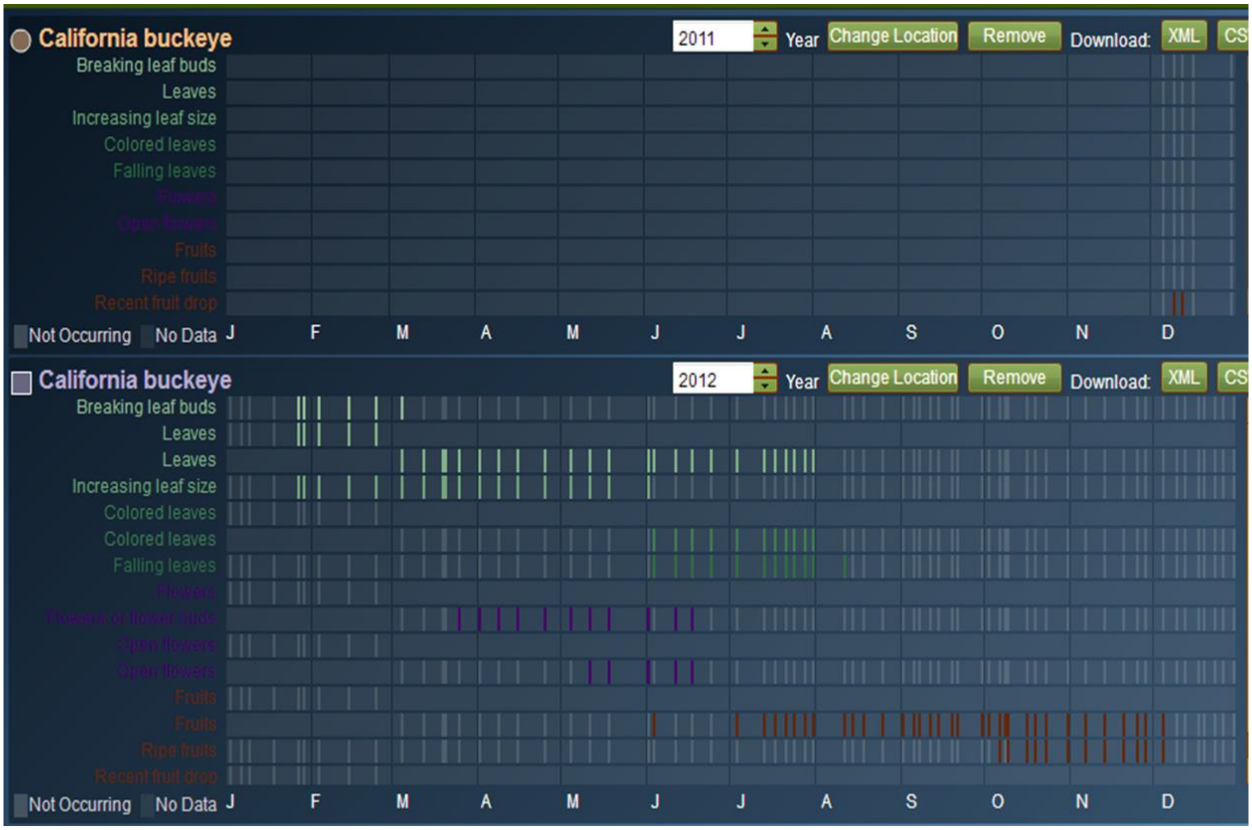

Figure 3. *Aesculus californica* phenophase activity in 2011 (top) and 2012 (bottom) at the FHVC monitoring location in SEKI (n=7).

Figure notes: The first observation in December should have a colored bar for recent fruit drop – it is unknown why it is not since it is not a data entry error. Data entry errors in this figure include a positive observation for fruits in June and all entries for June 3 (correct date July 3). These errors will be corrected in the database as soon as possible. Recent fruit drop results after March 2012 are not visible Figure 3. After March, the recent fruit drop category was changed to “recent fruit or seed drop”. Because of this change the “recent fruit or seed drop” observations are shown in the row below recent fruit drop when the visualization is viewed on the USA-NPN website, using the scroll bar to scroll down.

The end of the 2011 recent fruit drop phenophase was captured in December 2011 (Fig. 3). At this time only two trees were seen with noticeable recent fruit drop. Monitors observed the recent fruit drop phenophase to begin again on November 13, 2012 and continue to December 4 (Table 11).

Table 11. *Aesculus californica* phenophase activity (n=7). All dates are 2012 unless indicated as 2011.

Park = SEKI **Year = 2012** **Species = California buckeye (*Aesculus californica*)**				
Phenophase	**First observed**	**Last observed**	**Duration (days)**	**Notable Patterns of Activity**
Breaking leaf buds	January 27	March 4	38	
Leaves	January 27	July 31	187	
Increasing leaf size	January 27	June 1	127	
Colored leaves	June 3	July 31	59	
Falling leaves	June 3	August 11	70	
Flowers or flower buds	March 25	June 16	85	April 1 first observation date for most trees
Open flowers	May 11	June 17	37	
Fruits	July 3	December 4	155	First date for all trees was July 3, some >100 fruits
Ripe fruits	October 6	December 4	59	First date for most trees after November 6
Recent fruit drop	December 5, 2011*	December 12, 2011	8	Only 2 trees with positive observations
	November 13	December 4	21	Last date for most trees November 28

Table notes: *Phenophase active during first monitoring visit of the project at FHVC on December 5, 2011.

Breaking leaf buds: California buckeye

The breaking leaf bud phenophase for *Aesculus californica* was restricted to the first three months of 2012 (Table 11, Fig. 4).

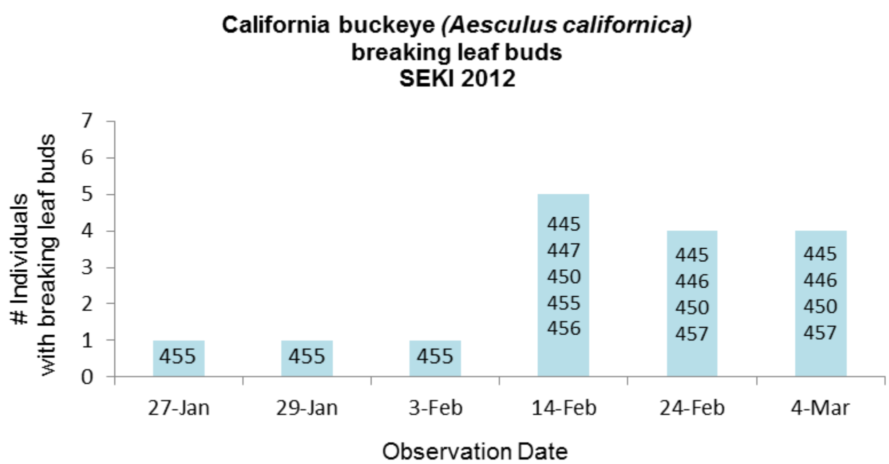

Figure 4. *Aesculus californica* breaking leaf buds positive observations in 2012 (n=7). Numbers within bars are unique plant ID numbers.

Although the first positive observation date is January 27, most of the target buckeyes had mid-February first positive observation dates for breaking leaf buds (Fig. 4). The end of this phenophase occurred sometime between the March 4th and March 12th monitoring visits.

Fruits and ripe fruits: California buckeye

Fruiting phenophase activity periods were remarkably uniform among target trees (Fig.5). The first positive observation date for fruits was the same for all (July 3). The last positive observation date varied among trees from late November to early December (November 25, November 28, and December 4).

Figure 6 shows that the peak monitoring date for ripe fruit occurred within the 10-day period of days of year #320-329 (charted as point 320 in the figure). Note that there was only monitoring date within this period (November 20), when 6 out of 7 trees were seen with ripe fruits (86%). Because of the distribution of monitoring dates, the figure does not show that all trees had ripe fruits on the following monitoring visit (November 25). This was the only date when 100% of trees were observed with ripe fruits.

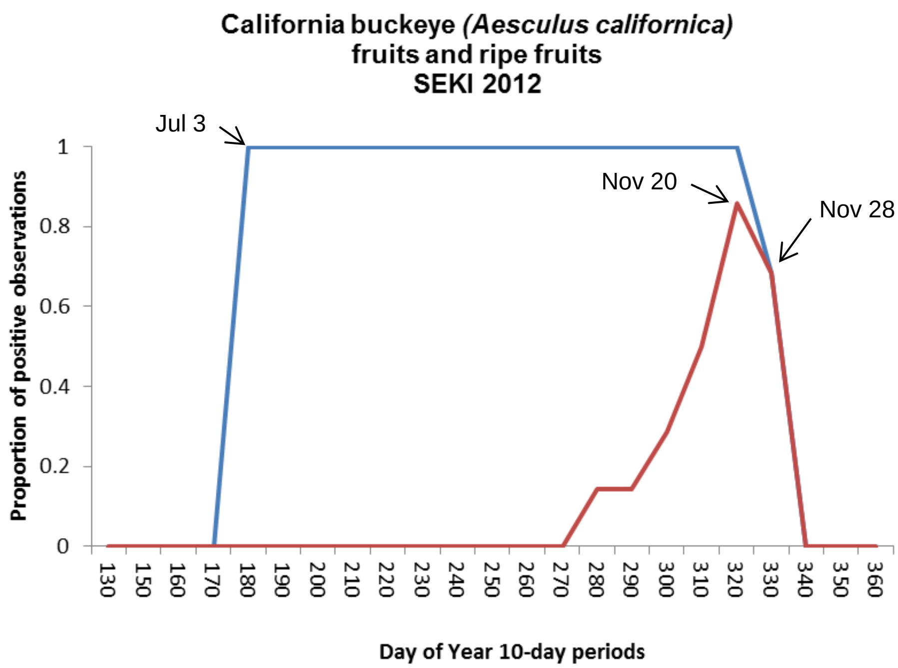

Figure 5. *Aesculus californica* summary of positive observations for fruit and ripe fruit phenophases over an 8-month period (May-Dec 2012; n=7 individuals; blue line=fruits; red line=ripe fruits).

Figure notes: Observations are pooled within successive 10-day periods, with the proportion of observations reporting the presence of phenophase calculated for each 10-day period. 10-day periods correspond to Day of Year. The first day of each 10-day period is indicated on the x-axis. This figure includes the entire time period of positive observations for fruit and ripe fruit phenophases in 2012.

The distribution of fruit intensity estimates during the first month of the fruit phenophase is shown in Figure 6. Observation results suggest that once fruit development has begun in buckeye trees, it does not take long to observe large changes in abundance (less than 10 days). On the first positive observation date for fruits (July 3), two trees already had an estimated 101-1,000 fruits

(Fig. 6). The change from no fruits seen to over 100 fruits occurred in less than 8 days (the previous monitoring visit took place on June 24). Over a 10 day gap between monitoring visits, fruit intensity estimates for California buckeye 457 increased from 11-100 on July 3 to 1,001-10,000 on July 13. (California buckeye 457 is represented by the blue bars in Figure 6.)

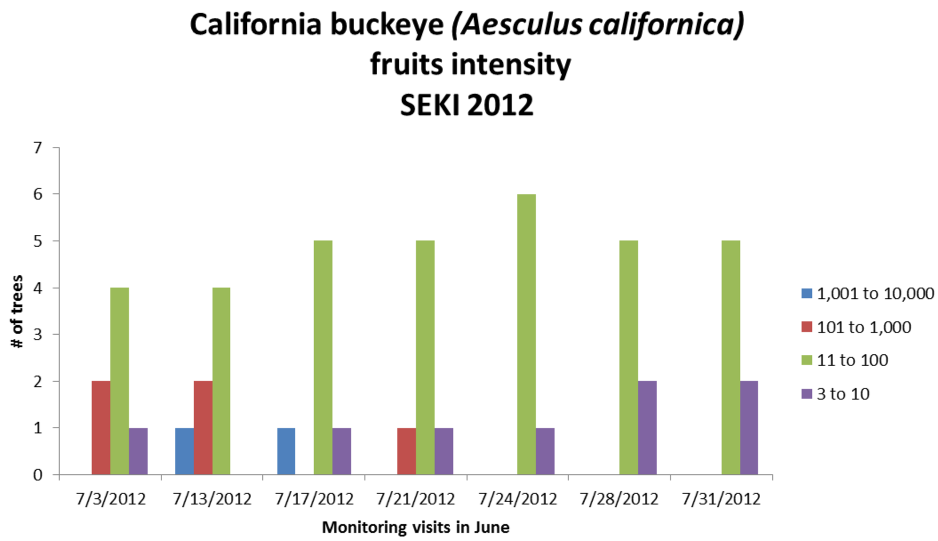

Figure 6. *Aesculus californica* frequency distribution of fruit intensity observations on each monitoring visit in June 2012 (n=7 individuals).

Greenleaf manzanita (*Arctostaphylos patula*)

Results for all 10 *Arctostaphylos patula* shrubs monitored at Lower Kaweah Air Quality Monitoring Site (LKAQ) are shown in the figure below. Monitoring began on November 8, 2011. The visualization figure shows the consistent 7-day sampling interval at LKAQ; monitoring at this site takes place every Tuesday. Phenophase results are shown split into different rows when the "flowers" phenophase was changed to "flowers or flower buds".

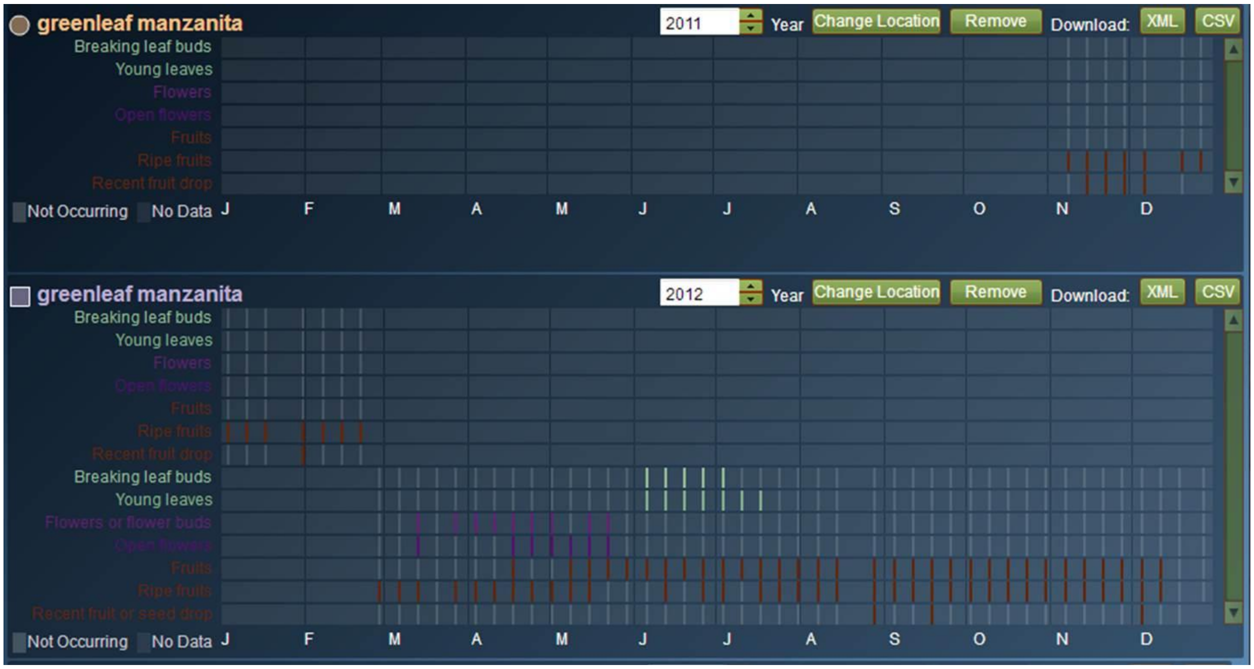

Figure 7. *Arctostaphylos patula* phenophase activity in 2011 (top) and 2012 (bottom) at the LKAQ monitoring location in SEKI.

Ripe fruits was the only phenophase that spanned calendar years (2011-2012), with nearly continuous positive observations until mid-December 2012. Recent fruit and recent fruit or seed drop observations were sporadically and rarely observed to occur throughout the monitoring period.

All plants were completely buried under snow on the last two monitoring dates in December 2012. Therefore, the gray bars in the visualization figure in December 2012 do not indicate "not occurring", but rather that monitors were uncertain that they were occurring (shown as -1 in the database).

A subset of plants was buried in snow on March 20 and March 27. These monitoring visits appear in the visualization figure as the last two bars in March. The gap in positive observations on March 20 might be because the only plants with positive observations the previous week were all buried in snow on March 20. On March 27, the only plant that was previously seen with open flowers was still buried in snow. The following visit on April 3, some plants were half buried with snow but monitors were able to record positive or negative observations on all plants.

Specific first and last positive observation dates for all phenophases are shown in Table 12.

Table 12. *Arctostaphylos patula* phenophase activity (n=10). All dates are 2012 unless specified as 2011.

Park = SEKI Year = 2012 Species = Greenleaf manzanita *(Arctostaphylos patula)*				
Phenophase	**First observed**	**Last observed**	**Duration (days)**	**Notes**
Breaking leaf buds	June 5	July 3	28	
Young Leaves	June 5*	July 17	42[†]	
Flowers	--	--	0	Monitored from Nov 8 2011 to Feb 21 2012.
Flowers or flower buds	March 13*	May 22**	70[†]	Monitored beginning Feb 28 2012.
Open flowers	March 13*	May 22**	70[†]	
Fruits	April 17*	December 11**	238[†]	
Ripe fruits	November 8, 2011*	December 11**	400[†]	Duration in 2012 alone: 346 days[†]
Recent fruit drop	November 15, 2011*	December 27, 2011**	42[†]	
	January 31*	January 31**	1[†]	
Recent fruit or seed drop	August 28*	December 24**	98[†]	

*First positive observation date may not be accurate. **Last positive observation date may not be accurate. [†]Duration estimate may not be accurate.

Breaking leaf buds and the flowers phenophases are the only phenophase categories that have no known interpretation issues throughout the monitoring period for *Arctostaphylos patula* at Sequoia National Park.

The “young leaves” phenophase observations in 2011 and 2012 may not be accurate. The lead phenology monitor at LKAQ in 2012, Erik Meyer, warned that prior to May, small mature leaves may have at times been mistaken as young leaves.

Flowers were not seen during monitoring for the “flowers” phenophase (November 8 2011 to February 21 2012) (Table 12). This phenophase was replaced with “flowers or flower buds” on datasheets after February 21.

The first positive observation date for flowers or flower buds reported in Table 12 is later than it should be by an unknown amount of time. Monitors commented on the March 13 datasheet that flower buds had been present on several individuals previously, although “N” had been recorded until this date. In 2013, after tracking early flower bud development with photographs, monitors were able to confirm with the phenology coordinator at SEKI that they had not captured the beginning of this phenophase in 2012 simply because of uncertainty about what a very young flower bud looked like for *Arctostaphylos patula*.

Intensity estimates for flower or flower buds were inconsistently sampled in 2012. Prior to July 10th, individual flowers were often but possibly not always counted instead of number of inflorescences. Beginning July 10 only the number of inflorescences was counted.

Monitors reported to the SEKI phenology coordinator that observations in 2012 for open flowers may not be accurate.

Fruits were recorded as occurring beginning on April 17 although ripe fruits, a phenophase category nested within fruits, were observed as present year-round (Fig. 7, Table 12). Monitors commented on the April 17th datasheet that they were not sure if ripe fruits should be counted in the fruit phenophase category, but it seems that a decision was made on that day that it should. Fruits were not recorded as present again until this question was resolved by May 8, when the first of continuous positive observations for fruits began.

However, prior to October 2012, it is unknown to what extent fruit presence and intensity observations were affected by including dried shriveled fruits that remained on the plants from the previous year. Prior to October 2012, monitors had sometimes but possibly not always counted all fruits, including old shriveled fruits, in their observations. Beginning late October and into 2013, monitors excluded last year's fruits from observations; however, all old fruits were excluded and not necessarily only the shriveled ones.

Ripe fruits observations are also suspect because prior to August 2012, fruit was considered ripe when it had any trace of color change (in this case from green to brown). Also, prior to October 2012 shriveled fruits were included in ripe fruit observations, and like fruits, afterwards all old fruits were excluded and not necessarily only the shriveled ones.

After sorting through all the confusion in 2012, we concluded that *Arctostaphylos patula* shrubs probably had fruits year-round because many fruits from the previous year remain on the plants and still appear fresh. Another year of monitoring is needed to determine how long the previous year's fruits stay fresh-looking.

Observations for recent fruit and recent fruit or seed drop are also questionable. Although there were sporadic negative (not occurring) and positive (occurring) observations in 2011 and 2012, by and large monitors circled the question mark for these phenophases on datasheets throughout the monitoring period, including dates in between positive and negative observations.

Mountain pride (*Penstemon newberryi*)
Results for all 10 *Penstemon newberryi* plants monitored at Lower Kaweah Air Quality Monitoring Site (LKAQ) are shown in the figure below. Monitoring began on November 8, 2011. The visualization figure shows the consistent 7-day sampling interval at LKAQ since monitoring occurs every Tuesday. Phenophase results are shown split into different rows when the *Penstemon newberryi* datasheets were changed from a forbs form to a trees and shrubs form that included a different combination of phenophases.

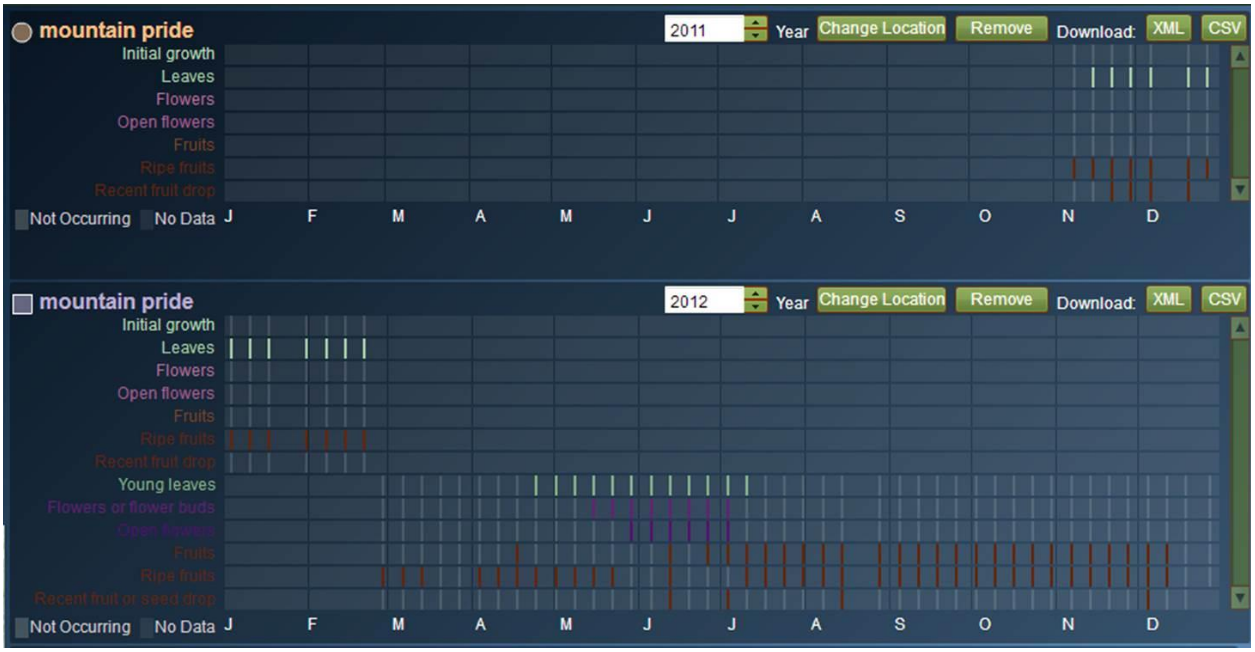

Figure 8. *Penstemon newberryi* phenophase activity in 2011 (top) and 2012 (bottom) at the LKAQ monitoring location in SEKI.

Figure notes: The April positive observation for fruits is a data entry error; there were no positive observations for fruits in April. For some reason this date could not be accessed in Nature's Notebook for editing; it will be corrected as soon as possible. Also, the November 8 negative observation for leaves is probably a data entry error; however, the datasheet from that monitoring date is missing.

Both leaves and ripe fruits calendar years (2011-2012), with nearly continuous positive observations for ripe fruits until all plants were buried under snow on the last two monitoring visits of December 2012. Again, when plants were buried under snow phenophases were recorded as uncertain whether they were occurring.

All plants were again buried in snow on March 20 and March 27, shown as the last two bars in March on the visualization figure). Only one plant was sampled on February 14 (mountain pride #635) because the rest were covered in snow. On the following dates, all or a subset of plants were partially covered in snow: January 31, February 7, February 21, February 28, and March 6. However, enough of the plants were visible that observations were still recorded on these dates.

Specific first and last positive observation dates for all phenophases are shown in Table 13.

Table 13. *Penstemon newberryi* phenophase activity (n=10). All dates are 2012 unless indicated as 2011.

Park = SEKI Year = 2012 Species = Greenleaf manzanita *(Arctostaphylos patula)*				
Phenophase	**First observed**	**Last observed**	**Duration (days)**	**Notes**
Initial growth	--	--	0	Monitored until Apr 17
Leaves	November 15, 2011*	February 21	>98	Monitored until Apr 17
Young leaves	April 24*	July 10	77	Monitored beginning Mar 13
Flowers	--	--	0	Monitored until Apr 17
Flowers or flower buds	May 15	July 3	49	Monitored beginning Mar 13
Open flowers	May 29	July 3	35	
Fruits	June 12	December 11**	182†	
Ripe fruits	November 8, 2011*	December 11**	400†	
Recent fruit drop	November 22, 2011*	December 27, 2011**	35†	
Recent fruit or seed drop	June 12*	December 4**	175†	

*First positive observation date may not be accurate. **Last positive observation date may not be accurate. †Duration estimate may not be accurate.

Monitors did not record any positive observations for initial growth or flowers during the time that these phenophases were monitored (November 5 2011-February 21 2012); a period of the year that one would not expect growth or flowers, especially at this location which is typically cold enough to accumulate snow in the winter. It should be noted however that monitors commented that clarification was needed on how to interpret initial growth, and some snowless dates were recorded as uncertain whether initial growth was occurring.

Penstemon newberryi is a perennial, evergreen subshrub. Thus it is not surprising that leaves were nearly always seen while the "leaves" phenophase was monitored. It is likely that the first positive observation date was actually November 8, 2011, the first monitoring visit at LKAQ, and not November 15, 2011 (Table 13). As stated in the notes below Figure 8, the negative observation for leaves on November 8 is probably a data entry error, but this cannot be confirmed because the datasheet is missing. (This is the only missing datasheet so far for all plants and monitoring dates at SEKI).

The first observation date for young leaves may not be accurate because monitors commented that prior to May, mature small leaves may have been mistaken for new leaves, as with *Arctostaphylos patula*.

Flowers or flower buds were first seen on May 15, and open flowers two weeks later (Table 13, Fig. 9). All 10 plants were sampled every 7 days, with no uncertain observations (-1) reported (thus binning into date categories and calculating proportions was not necessary in Figure 9). All 10 plants were in flower during monitoring visits on May 29 to June 12. It appears that second burst of flowers or flower buds development was seen on July 3 (Fig. 9 spike in blue line caused by positive observations of flower or flower buds for four plants that were previously recorded with no flowers or flower buds on June 26). All *Penstemon* plants had finished flowering by the time of the July 10 monitoring visit.

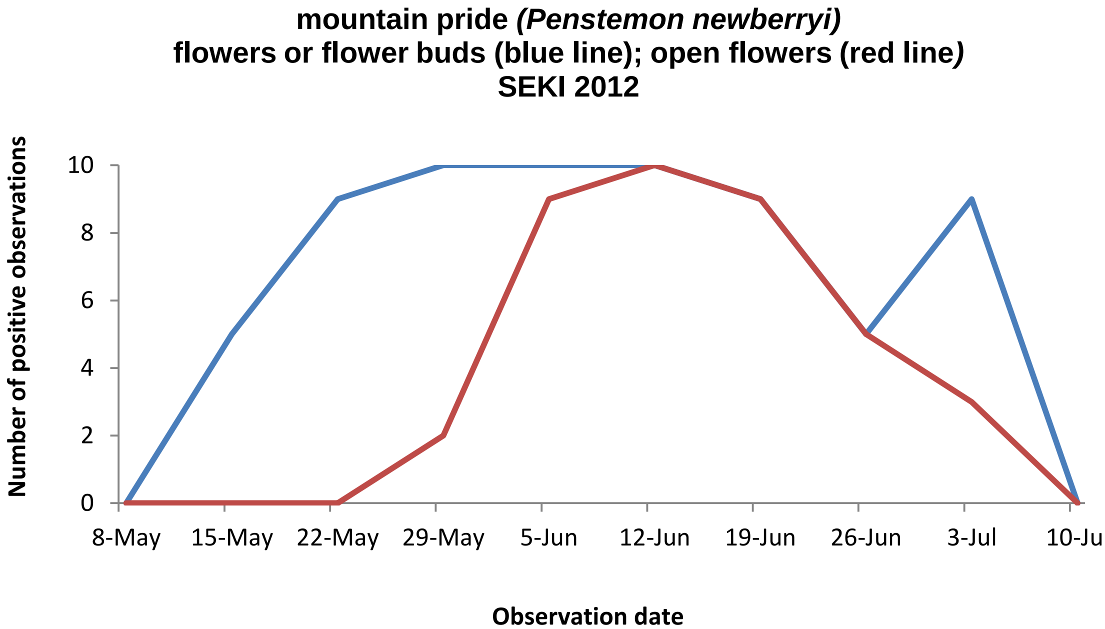

Figure 9. *Penstemon newberryi* summary of positive observations for flowers or flower buds and open flowers phenophases (May-July 2012; n=10 plants; blue line=flowers or flower buds; red line=open flowers).

Fruits were first recorded as present on June 5, approximately mid-way through the flower or flower bud activity period (Fig. 9), on 6 out of the 10 plants. The remaining four plants were not seen with new fruits until June 26 (data not shown). The last positive observation dates recorded for the fruits and ripe fruits phenophases was December 11, 2012 (Table 13). This date may not be accurate because monitors reported that an unknown number of plants had fruit capsules that may have retained seeds into 2013 (this conclusion based on interpretation of the end of the fruit and ripe fruit phenophases as the point in time when capsules have dropped all seeds, i.e., no longer contain ripe seeds).

The first positive observation date for ripe fruits (Table 13) may also be inaccurate. Monitors correctly interpreted the ripe fruit category to apply to opened capsules but did not check to make sure that they were not including empty capsules in their observations.

Ripe fruit intensity estimates do not appear in the database prior to July 17 because monitors estimated intensity with number of ripe fruits instead of percent. Observations for number of ripe fruits were entered in the comments field. Ripe fruit intensity was estimated with percent ripe beginning July 17.

The first and last observation dates for recent fruit drop and recent fruit or seed drop phenophases shown in Table 11 are not reliable because of significant uncertainty monitors had with this phenophase in *Penstemon newberryi* plants. Except for periods in which it was obvious that seeds were not dropped, such as months prior to the presence of new fruits, observations were generally reported as uncertain whether these phenophases were occurring.

Discussion

Results Interpretation and Conclusions

Because 2012 was the first full year of phenological monitoring, conclusions cannot be made yet regarding species specific sensitivity to climate. Also, because different species are monitored at the two phenological monitoring locations in SEKI, data from SEKI alone cannot be used to draw conclusions about responses to geographic variation. At the Foothills Visitor Center (FHVC) monitoring location, target plants are divided into four sites that are concentrically located around the visitor center. Differences among sites were not fully explored in this annual report; this may be of interest for future data exploration. (Flower and fruit phenophases did not show differences by site in Table 9).

Weather in 2012 was not highly unusual compared to long-term records of average temperature and precipitation. At FHVC, weather station records within the monitoring location indicate that 2012 was fairly normal with regard to average annual temperature and slightly drier than normal (95% of the 85 year normal). However, the 2011-2012 water year was 75% of normal at FHVC. (Water years are useful at SEKI since they do not divide rainfall amounts between winter months, which can contribute a significant amount of precipitation in a year). At LKAQ, 2012 was also close to normal in average monthly and annual temperature and 85% of normal in total precipitation (water year data not readily available for this location).

Blue oak (Quercus douglasii)

Blue oaks are fall and drought-deciduous trees that may retain leaves year-round on moist sites (Pavlik et al. 1991). During extremely dry years, blue oaks may respond to soil moisture stress by dropping its leaves in the summer. Tracking leaf canopy fullness for this species can be used as a potential indicator of soil moisture stress or availability. In 2012, the target blue oak trees retained canopies during summer months. Also, trees began to drop their leaves in July2012 (Table 8) and reached lowest canopy fullness levels in December (Fig. 2). It will be interesting to compare these patterns with additional years of data to see how closely activity patterns in the leaves-related phenophases track year-to-year changes in weather, and over the longer-term, changes in climate.

Blue oak 448, a sapling that likely has an underdeveloped root system, had the fewest estimated days with leaves (i.e., the longest leafless period). Blue oak 444, 452, 454, 458, and 462 had considerably more estimated days with leaves than the other target trees. Blue oak 452 is large oak in a low point in the FHVC native plant garden, next to a retaining wall. Blue oak 454 is growing next to a seasonal drainage ditch next to the tennis courts. Blue oak 454 is a very large oak behind and slightly downhill of the SNHA building. Because of their locations, these trees are probably receiving more runoff and higher soil moisture during wet months. It is not clear why blue oak 444 or 462 might also be in moister sites than the other trees.

Blue oak 228 did not flower or produce fruits, most likely because this tree is a sapling and does not have a root system extensive enough to allow resources to be allocated to reproduction. There are no other obvious reasons why so many other target trees were not observed to flower or produce acorns in 2012 (Table 9), unless the flowering response is due to the 75% of normal

2011-2012 water year. Flowers (catkins) on blue oaks are formed the year before they develop into fruits, so weather conditions in 2011 may be more indicative of the link between fruit response to precipitation and temperature patterns than those of 2012. However, weather station records do not appear to explain the low number of target trees observed with fruits. Total precipitation in 2011 was only slightly drier than normal and the 2010-2011 water year was unusually wet.

California buckeye (Aesculus californica)

The general seasonal patterns in phenophase activity observed for monitored California buckeye trees observed in 2012 are typical for this species. Like the other species monitored at SEKI, additional years of monitoring will be helpful to discern relationships between phenophase activity and weather conditions (and, over the long-term, climate). Since the leaves, flowers, and fruit phenophases for this species stand out over the year in distinct periods, this may be an ideal species to track responses to temperature and moisture conditions. Its breaking leaf buds, flowers, and fruits are also showy, which makes it an ideal plant for phenology education programs when a California buckeye is available.

With regard to 2012 results, fruit phenophase observations were examined more closely than other phenophase results because it seemed a little strange that the fruit and ripe fruit activity periods were so uniform among individuals. All trees were observed to begin the fruiting phase on the same monitoring date. This result may be due to the gap in time between monitoring visits (8 days), or possibly because, by the time fruit buds had grown enough to stand out from flower buds the eye was trained to suddenly see fruit buds on all the trees. (I only state this because this was my personal experience in monitoring the beginning of this phenophase in 2013). Fruits, when very small, are quite difficult to distinguish from flower buds, which can be present at the same time on a buckeye tree. If hypothesis is true, future monitoring years may show more variation in first observation dates among trees as monitors become more experienced in what to look for. Variation among individuals was also examined for the breaking leaf buds phenophase, but no clear patterns arose. California buckeye 455 was seen with breaking leaf buds much earlier than other trees, but its location, size, nor condition stand out from the other buckeyes as possible explanations for this result.

Greenleaf manzanita (Arctostaphylos patula)

Phenophase patterns of this species were not explored since there were significant issues with first and last observation dates, and in some cases intensity estimates (as in fruits). However, 2012 was a valuable year for learning how to monitor this species, which can be especially tricky with regard to flowering and fruit phenophases. Almost all questions that arose with regard to interpretation of phenophases have been addressed, and monitors report that they are feeling much more comfortable with the protocol in 2013. Turnover of new monitors has decreased and monitors have easier access to species accounts and phenophase definitions (laminated in monitor binders and shown on custom datasheets).

Mountain pride (Penstemon newberryi)

Penstemon newberryi was overall easier for monitors to confidently observe, but there were still significant difficulties estimating activity periods of ripe fruits (and intensity) and recent fruit or seed drop phenophases. The flowering phenophases were explored as there were not any reported problems observing flowers or flower buds or open flowers. Very little information could be found in scientific literature or other online sources about the phenology of this species. Additional years of monitoring will be of value to phenological investigations as well as the scientific community in general (as long as these results are made available outside of SEKI).

Lessons Learned

Recent fruit or seed drop was a very difficult phenophase to reliably monitor for *Penstemon newberryi* and *Arctostaphylos patula*. It is recommended that these phenophases be dropped from the protocol for these species. If fruit presence in 2013 is confirmed to be year-round for *Arctostaphylos patula*, it will be difficult to capture first positive observation dates in the data for new fruits, except in the comments section. If true, it is recommended that the protocol for this species is changed to address this issue.

In 2012, there were frequent large (>7 days) gaps in sampling intervals at FHVC (Table 7). This location is often monitored more than once per week, but because the gaps occur so frequently (10 out of 12 months) it may indicate that there are not enough monitors at this site to meet the twice per week monitoring goal. This needs to be discussed with the FHVC phenology monitors to explore potential solutions.

If additional monitors is not possible, one approach that could be explored is to reduce sampling to once per week as long as the reduced time in monitoring effort will help to eliminate the large gaps, and whenever possible monitoring increased to twice per week. More frequent sampling is especially recommended just before a phenophase is expected to begin (two weeks before), during peak activity periods, and during the last two weeks when phenophases are expected to end. Blue oak first positive observation dates in 2012 shown in Table 7 can be used to predict when sampling frequency should increase to more closely capture onset and ending dates. There are not many periods in the year when blue oak was not observed to enter or complete a phenophase (Table 7), and with only one year of data it may be premature to identify periods when monitoring could be reduced in frequency to less than once per week.

On the other hand, California buckeye has a distinct dormant period with no observable phenological activity that occurs after all leaves have fallen and before breaking leaf buds emerge. So it may be safe to not monitor this species for a 3-week period after all leaves have dropped (in 2012 this occurred in early December and breaking leaf buds were first seen in late January). Additional years of monitoring will allow more precise recommendations for monitoring frequency of both species at FHVC.

Because monitoring at LKAQ is tied to the Air Quality monitors' weekly visits to the Lower Kaweah Air Quality monitoring station, it is not possible to increase sampling frequency at this location under the current agreement. Because sampling at this site is so regular and consistent in time, and consistent in trained staff, there are no strong recommendations for a change in monitoring frequency at this site. If volunteers or other park resources could be found, it would be ideal if monitoring frequency could increase at this station during times that phenophases were expected to begin or end to more closely capture onset or ending dates. However, results from 2012 alone are not enough to predict these periods because of the issues with data collection this year (described in the results section).

Future Recommendations for Data Collection

Frequent communication between monitors and SEKI phenology project manager (coordinator or park ecologist) is recommended for 2013, including regular check-ins with monitors and review of data. As data collection questions continue to be addressed and clearly documented, the level of frequency with which check-ins and troubleshooting needed to maintain data quality will be able to be reduced, except during periods of observer turnover.

In 2013, we plan to take pictures of each stage in phenological development for all target species to supplement those provided by the species accounts. These "photo diaries" and a regularly updated version of the "Tips for monitors" section in the SEKI Monitoring Guide will be placed in the monitor binders for reference in the field. The pre-season monitoring preparations recommended in the CPP Monitoring Protocol will be carried out by the coordinator in the spring. We also plan to experiment with collecting data on a tablet to reduce data entry time and data entry errors.

Post-Field Season Summary

1. Location of CPP working documents, tools and equipment: Where are the working documents, tools and equipment stored? Include updated monitoring guide, datasheets, clipboards, training materials etc.

Working documents specific to phenology monitoring at SEKI and their locations are listed below. All SEKI Phenology project files are stored on Ann Huber's computer and backed up to a Phenology folder on Google drive that has shared access with Sylvia Haultain. All files and datasheets will be transferred to Sylvia Haultain at the end of Ann Huber's term as coordinator in 2013.

- Current and archived versions of SEKI Phenology Monitoring Guide
- LKAQ_customdatasheets.xlsx
- CPP SEKI plants.xls – GPS coordinates of all target plants
- MonitorsLog.xlsx - list of SEKI CPP phenology participants contact information
- Photographs of target plants at LKAQ and FHVC, and photographs of phenological stages taken by SEKI monitors
- LKAQ datasheets are stored at Ann Huber's office.
- FHVC datasheets are stored at the Foothills Visitor Center.

A monitoring binder is stored at each monitoring location. Monitoring binders contain:

- Datasheets
- Phenophase definition sheets and species accounts
- SEKI Monitoring Guide

2. Location of archives: Where are project archives stored? List both electronic and physical storage locations.

Paper datasheets that have been entered are stored at Ann Huber's office, and will be transferred to Sylvia Haultain's care in 2013. All data is entered online via Nature's Notebook and is stored in the USA-NPN's National Phenology Database. See question 1 for location of SEKI phenology project files.

3. CPP participants: Who has participated in CPP activities this year, in what capacity and how many hours have they contributed? (Groups may be listed on one line; this table may be reformatted to meet park-specific needs.) Who maintains the CPP participant contact information? (Personally Identifiable Information (PII) must be kept in a secure location.)

See tables below. Data collection estimates include approximately 60 minutes of training per person. Ann Huber maintains participant contact information.

Table 14. CPP participants at SEKI in 2011. Hours values are approximate time contributed to monitoring-related activities and do not include phenology public outreach or education efforts.

Location	Name	Is contact information documented in a secure location?	Type (staff, intern, public volunteer, etc.)	Role (data collection, data entry, management, etc.) List all that apply.	Hours*	Participation Range of Dates
FHVC	Dani Cessna	yes	NPS staff	Data collection, data entry	5.5	Nov-Dec
LKAQ	Michael Turner	yes	NPS staff	Data collection	2	Dec
LKAQ	Alysia Schmidt	yes	NPS staff	Data collection	2	Nov-Dec
				2011 Total hours:	**9.5**	

Table 15. CPP participants at SEKI in 2012. Hours values are approximate time contributed to monitoring-related activities and do not include phenology public outreach or education efforts.

Location	Name	Is contact information documented in a secure location?	Type (staff, intern, public volunteer, etc.)	Role (data collection, data entry, management, etc.) List all that apply.	Hours*	Participation Range of Dates
FHVC	Dani Cessna	yes	NPS staff	Data collection, data entry	67.5	Jan-Dec
FHVC	Hannah Schwalbe	yes	NPS intern	Data collection	Not reported	
FHVC	Alysia Schmidt	yes	NPS staff	Data collection	0.17	Feb
FHVC	Stephanie Sutton	yes	NPS staff	Data collection	1	May-Jun
FHVC, LKAQ	Suzanne Blake	yes	NPS staff	CPP coordinator at SEKI	unknkown	Mar-Jul
FHVC, LKAQ	Ann Huber	yes	NPS contractor	CPP coordinator at SEKI and data entry	130	Jul-Dec
LKAQ	Michael Turner	yes	NPS staff	Data collection	5	Jan-May; Dec
LKAQ	Frank Klein	yes	NPS staff	Data collection	9	Feb-Nov
LKAQ	Danielle Knapp	yes	NPS staff	Data collection	3.25	Mar-May
LKAQ	Ariane Sarzotti	yes	NPS staff	Data collection	1.5	Apr-Jul
LKAQ	Erik Meyer	yes	NPS staff	Data collection	7.5	Apr-Dec
LKAQ	Analisa Skeen	yes	NPS staff	Data collection	2	May-Jul
				2012 Total hours:	**>226**	

Notes for Tables 1 and 2: Hours were not recorded by monitors and thus are rough estimates. Estimates were calculated by number of visits recorded per person over the year, and multiplying by the approximate time it takes to monitor that location (FHVC takes about 1 hour for one person and 30 minutes for two persons; LKAQ takes 30 minutes for one person and 15 minutes for two persons). Data entry time was estimated by multiplying the number of visits by the approximate time it takes to enter data for the location. A complete set of observations for FHVC takes about 5 minutes to enter in Nature's Notebook; LKAQ data takes between 3-5 minutes to enter. Five minutes was used for LKAQ calculations. Other observers participated at FHVC but did not record their names on datasheets. All FHVC datasheets had Dani Cessna pre-printed on them, so Dani's time is an overestimate for her personally, but takes into account time spent monitoring at LKAQ not tracked by participants that did not record their names.

4. Document changes to a) monitoring protocols, b) sites or targeted plants and c) updates to monitoring tools. Which documents have been updated to reflect these changes (park monitoring guide, phenophase sheets, maps etc)? If documents have not been updated, explain why.

4a. Changes to monitoring protocols

Arctostaphylos patula: The "flowers or flower buds" phenophase was added to the suite of phenophases for greenleaf manzanita on February 28, 2012. "Recent fruit drop" was changed to "recent fruit or seed drop" on this date as well.

Penstemon newberryi: Monitoring began with the Forbs datasheet form and switched to the Trees and Shrubs form beginning March 13, 2012 and then permanently on April 24, 2012. These forms differed slightly in the set of phenophases. After March 13, the Forbs form was used by monitors again on March 20, March 27, April 3, and April 17. Data fields in the NPN database were changed to match those on the Trees and Shrubs form on February 28. The end result is some data loss for observations dates on or after Februrary 28 when the Forbs form was still being used in the field. The loss in data applies to phenophases on the Tree and Shrubs form that were not active during this part of the year ("flowers or flower buds" and "new leaves").

No other protocol changes were made; however, some phenophases were misinterpreted at LKAQ in 2011 and 2012. These are described in the results section of this report.

4b. Changes to monitoring sites or targeted plants

There were no changes to monitoring sites or targeted plants. Tags of all plants were checked for wear and did not need to be replaced.

4c. Updates to monitoring tools

- Updated versions of species accounts with phenophase definition sheets (version 6, March 2012) were laminated and placed in the monitor binders at each monitoring location.
- The draft SEKI CPP Monitoring Guide was developed in 2012.
- An error was found in the identification number of a target tree in Nature's Notebook, GPS coordinate files, and the public Google Map of CPP sites at SEKI. All sources were updated except the Google Map. This error will be fixed in 2013.
- Custom datasheets were created for both monitoring locations. It turned out that monitors at FHVC preferred the standard datasheets.

In October 2012, monitors at LKAQ switched from a route-based method of data recording (e.g., one datasheet per monitoring visit) to the one datasheet per plant ID#, with multiple observation dates for that specific plant ID recorded on the same datasheet. This method allowed previous observations to be seen, which increased data quality and ease in reporting.

5. Have all observations from this year been entered into the USA-NPN online database? If not, explain why and describe what steps are necessary to accomplish this.
Yes, all observations taken in 2011 and 2012 have been entered into the NPN database.

6. Have hard copy datasheets, and electronic files such as photos been archived in a secure location? If so, where? If not, where are they currently stored and is there a plan for archiving them?
Datasheets will be scanned for archival in 2013. Paper datasheets are stored at Ann Huber's office and will be transferred to Sylvia Haultain in 2013.

7. Summary of accomplishments and challenges – please summarize the highlights, accomplishments and challenges of the CPP program this year. Include start and end dates of monitoring, whether all sites were monitored regularly, if any problems came up and how they were resolved and anything else of note.
Monitoring began in late 2011, and has been continuing on a regular basis. Getting the program going, keeping it going, and fine-tuning the data collection methods are arguably the most significant accomplishments during this time period. Although it is not covered in this report, SEKI is also very fortunate to have interpretive rangers that implemented an array of phenology outreach programs to the public and to schools in 2012.

The greatest challenge was the learning curve involved in completing the first year of data collection. Some of the metrics for *Arctostaphylos patula* and *Penstemon newberryi* were misinterpreted, especially in the first half of 2012. (Detailed accounts are described in the results section of this report.) Prior to July 2012, turnover in monitors at LKAQ and lack of a CPP coordinator resulted in incomplete training. When Ann Huber arrived as CPP coordinator in July 2012, LKAQ monitors were not aware of the species accounts or phenophase definition sheets for the species that they were monitoring, so monitors had done their best to interpret the phenophases on their own. The CPP workshop given at SEKI on July 6 was a turning point, as it was then that LKAQ monitors acquired the CPP species accounts and phenophase definition sheets. Frequent communication between monitors and the CPP coordinator in the second half of 2012 helped to discover additional questions monitors had with regard to data collection and address new questions that arose as plants entered into new phases of development. Ann documented these questions and answers in easy to find places for monitors (on datasheets, in Monitors Binders, and in the SEKI Monitoring Guide) to help guide future monitors.

8. Summary of communication with the USA-NPN National Coordinating Office (NCO)
Sylvia Haultain had an active role on the CPP Core Team, which communicated on a regular basis with the USA-NPN National Coordinating Office in 2011 and 2012.

9. Recommendations for the future
See Recommendations for the Future subsection in the Discussion portion of this annual report.

Literature Cited

Pavlik, Bruce M.; Muick, Pamela C.; Johnson, Sharon G.; Popper, Marjorie. 1991. Oaks of California. Los Olivos, CA: Cachuma Press, Inc. 184 p.

Appendix A. Sample Data Used to Create Data Summary Tables and Figures

Below is a sample of the raw data used to create the tables and figures in this report. There are over 22,000 observation records over the 2011-2012 monitoring period. Please refer to CPP Monitoring Protocol SOP 10 for a description of the variables contained in the database.

Observation_ID	Observation_Date	Day_Of_Year	Latitude	Longitude	Phenophase_Status	Elevation	Genus	Species	Individual_ID	Phenophase_Name	Plant_Nickname	Site_Name
1574867	2011-11-08	312	36.56599	-118.7776	0	1920	Arctostaphylos	patula	30908	Breaking leaf buds	greenleaf manzanita 631	LKAQ
1574868	2011-11-08	312	36.56599	-118.7776	0	1920	Arctostaphylos	patula	30908	Young leaves	greenleaf manzanita 631	LKAQ
1574869	2011-11-08	312	36.56599	-118.7776	0	1920	Arctostaphylos	patula	30908	Flowers	greenleaf manzanita 631	LKAQ
1574870	2011-11-08	312	36.56599	-118.7776	0	1920	Arctostaphylos	patula	30908	Open flowers	greenleaf manzanita 631	LKAQ
1574871	2011-11-08	312	36.56599	-118.7776	0	1920	Arctostaphylos	patula	30908	Fruits	greenleaf manzanita 631	LKAQ
1574872	2011-11-08	312	36.56599	-118.7776	1	1920	Arctostaphylos	patula	30908	Ripe fruits	greenleaf manzanita 631	LKAQ
1574873	2011-11-08	312	36.56599	-118.7776	-1	1920	Arctostaphylos	patula	30908	Recent fruit drop	greenleaf manzanita 631	LKAQ
1574874	2011-11-08	312	36.56599	-118.7776	0	1920	Arctostaphylos	patula	30909	Breaking leaf buds	greenleaf manzanita 632	LKAQ
1574875	2011-11-08	312	36.56599	-118.7776	0	1920	Arctostaphylos	patula	30909	Young leaves	greenleaf manzanita 632	LKAQ
1574876	2011-11-08	312	36.56599	-118.7776	0	1920	Arctostaphylos	patula	30909	Flowers	greenleaf manzanita 632	LKAQ
1574877	2011-11-08	312	36.56599	-118.7776	0	1920	Arctostaphylos	patula	30909	Open flowers	greenleaf manzanita 632	LKAQ

Appendix B. Monitoring Dates

Foothills Visitor Center (FHVC)		
Monitoring Date	# Observations *Quercus douglasii*	# Observations *Aesculus californica*
2011-12-05	143	50
2011-12-09	154	60
2011-12-12	154	60
2011-12-16	154	60
2011-12-30	154	60
2012-01-02	154	60
2012-01-06	154	60
2012-01-09	154	60
2012-01-18	154	70
2012-01-27	154	70
2012-01-29	154	70
2012-02-03	154	70
2012-02-14	154	70
2012-02-24	154	70
2012-03-04	154	70
2012-03-12	154	70
2012-03-19	77	30
2012-03-20	77	40
2012-03-25	154	70
2012-04-01	154	70
2012-04-08	154	70
2012-04-15	153	70
2012-04-25	110	40
2012-05-04	77	30
2012-05-11	132	70
2012-05-18	132	70
2012-06-01	143	70
2012-06-11	154	70
2012-06-17	154	70
2012-06-24	154	70
2012-07-03	132	70
2012-07-13	154	70
2012-07-17	154	70
2012-07-21	154	70
2012-07-24	154	70
2012-07-28	154	70
2012-07-31	154	70
2012-08-11	154	70
2012-08-14	154	70

Foothills Visitor Center (FHVC) continued		
Monitoring Date	# Observations *Quercus douglasii*	# Observations *Aesculus californica*
2012-08-18	154	70
2012-08-25	154	70
2012-09-01	154	70
2012-09-05	154	70
2012-09-07	154	70
2012-09-11	154	70
2012-09-21	154	70
2012-09-30	154	70
2012-10-02	77	30
2012-10-06	154	70
2012-10-08	55	10
2012-10-09	99	60
2012-10-16	154	70
2012-10-19	132	70
2012-10-23	154	70
2012-10-31	154	70
2012-11-06	154	70
2012-11-13	154	70
2012-11-20	154	70
2012-11-25	154	70
2012-11-28	154	70
2012-12-04	154	50
2012-12-09	154	70
2012-12-12	154	70
2012-12-17	154	70
2012-12-19	154	70
2012-12-23	154	70
2012-12-26	154	70
2012-12-30	154	70

Lower Kaweah Air Quality (LKAQ)		
Monitoring Date	# Observations *Arctostaphylos patula*	# Observations *Penstemon newberryi*
2011-11-08	14	14
2011-11-15	49	56
2011-11-22	49	42
2011-11-29	70	70
2011-12-06	70	70
2011-12-20	70	70
2011-12-27	70	70
2012-01-03	70	70
2012-01-10	70	70
2012-01-17	70	70
2012-01-31	70	70
2012-02-07	70	70
2012-02-14	70	70
2012-02-21	70	70
2012-02-28	70	60
2012-03-06	60	60
2012-03-13	70	54
2012-03-20	70	60
2012-03-27	70	60
2012-04-03	70	60
2012-04-10	70	60
2012-04-17	70	58
2012-04-24	67	60
2012-05-01	70	60
2012-05-08	70	60
2012-05-15	70	60
2012-05-22	70	60
2012-05-29	70	60
2012-06-05	70	60
2012-06-12	70	60
2012-06-19	70	60
2012-06-26	70	60
2012-07-03	70	60
2012-07-10	70	60
2012-07-17	70	60
2012-07-24	70	60
2012-07-31	70	60
2012-08-07	70	60
2012-08-14	70	60

Lower Kaweah Air Quality (LKAQ) Location (continued)		
Monitoring Date	# Observations *Arctostaphylos patula*	# Observations *Penestemon newberryi*
2012-08-28	70	60
2012-09-04	70	60
2012-09-11	70	60
2012-09-18	70	60
2012-09-25	70	60
2012-10-02	70	60
2012-10-09	70	60
2012-10-16	70	60
2012-10-23	70	60
2012-10-30	70	60
2012-11-06	70	60
2012-11-13	70	60
2012-11-20	70	60
2012-11-27	70	60
2012-12-04	70	60
2012-12-11	70	60
2012-12-18	70	60
2012-12-27	70	60