Appendix C: Joshua Tree National Park CPP Monitoring Guide

Version 1

Revision History Log:

Version #	Revision Date	Author	Changes Made	Reason for Change
1.00				

Phenological monitoring guide: Joshua Tree National Park

A designated monitoring site of
The California Phenology Project

Yucca brevifolia

Coleogyne ramosissima

Prosopis glandulosa

Larrea tridentata

Contents

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 ***Joshua Tree National Park*** **(JOTR)**. It identifies and describes all of the CPP and USA-NPN resources that observers will need to start monitoring plants at JOTR (e.g., USA-NPN 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 USA-NPN's *How to Observe* webpage (http://www.usanpn.org/how-observe). 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. JOTR Points of Contact

CPP contacts at JOTR:

Josh Hoines
Vegetation Branch Chief
Joshua Tree National Park
josh_hoines@nps.gov

George Land
Joshua Tree NP Volunteer Coordinator
george_land@nps.gov

Other CPP contacts:

Dr. Angie Evenden
Pacific West Region, Californian Cooperative Ecosystem Studies Unit
angela_evenden@nps.gov

Dr. Susan Mazer
Professor of Ecology and Evolution
Department of Ecology, Evolution and Marine Biology
University of California, Santa Barbara
mazer@lifesci.ucsb.edu
phone: 805-893-8011

Dr. Liz Matthews
Postdoctoral Associate
Department of Ecology, Evolution and Marine Biology
University of California, Santa Barbara
lizmatthews03@gmail.com

III. CPP Species Monitored at JOTR

There are **7** species targeted for monitoring at Joshua Tree NP, including: *Acacia greggii, Coleogyne ramosissima, Eriogonum fasciculatum, Larrea tridentata, Prosopis glandulosa, Yucca brevifolia,* and *Yucca schidigera.*

The 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. The CPP species profiles include a brief description of each species, as well as photos of most phenophases. Please note that some profiles are missing phenophase photos -- *we encourage CPP participants to continue collecting photos and updating the species profiles.*

Table 1. CPP species targeted for monitoring in JOTR and the other NPS units where they are monitored.

Common Name	**Scientific Name**	**Parks**
Blackbrush	*Coleogyne ramosissima*	JOTR
California buckwheat	*Eriogonum fasciculatum*	JOTR, SAMO
Catclaw acacia	*Acacia greggii*	JOTR
Creosote	*Larrea tridentata*	JOTR
Honey mesquite	*Prosopis glandulosa*	JOTR, DEVA
Joshua tree	*Yucca brevifolia*	JOTR
Mojave yucca	*Yucca schidigera*	JOTR

Abbreviations used: SAMO= Santa Monica Mountains NRA; DEVA= Death Valley National Park)

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

A brief description of the species targeted for monitoring at JOTR is provided below:

3.1 *Acacia greggii* (ACGR; Catclaw Acacia) is a deciduous shrub or small tree common in washes and scrub habitat. It is an important species for wildlife, providing food, shelter, nesting sites, and nesting materials for many species. Dispersal of ACGR seeds can result from animal movements and abiotic disturbances; cactus wrens, for example, are known to include the seeds in their nests and may contribute to seed dispersal. Compared to other CPP taxa, ACGR has relatively late phenology and may be a useful plant for late-season phenological interpretation programs. Native Americans used ACGR in several ways; for example, the leaves and pods were ground into a powder to stop minor bleeding and to treat diaper rash, and the flowers and leaves were used to make a tea that could treat nausea and vomiting.

Download the USA-NPN datasheet and the CPP profile for ACGR here: http://www.usanpn.org/cpp/ACGR

3.2 *Coleogyne ramosissima* (CORA; Blackbrush) is a drought-deciduous shrub in the Rosaceae family. It occurs primarily in the transition zone between the Mojave and Great Basin deserts and on the western border of the Sonoran Desert, forming a band from southeastern California to southwestern Colorado. In California, it is indicator of the upper Mojave transition. It is very long-lived and sensitive to increased fire frequency and other environmental change (e.g., climate). Blackbrush is mast-fruiting and only produces fruit and seed in years of abundant

resources. However, there is little or no seed production observed in the southern portion of its range (i.e., Joshua Tree NP). CORA is wind-pollinated, so climate change may not negatively impact pollination success (at least due to the disruption of plant-insect relationships). CORA appears to be animal dispersed, as rodents cache their seeds.

Download the USA-NPN datasheet and the CPP profile for CORA here:
http://www.usanpn.org/cpp/CORA

3.3 *Eriogonum fasciculatum* (ERFA; California buckwheat) is a widespread perennial shrub in the Polygonaceae, common to sagebrush scrub, desert scrub, and coastal sage scrub vegetation. The species hosts a wide diversity of arthropod species, including specialized feeders such as moth larvae of the Electra buckmoth (*Hemileuca electra*) and the larvae of a variety of butterfly species (e.g., *Apodemia mormo*). Several rare vertebrate species are known to rely on or are associated with ERFA, including California gnatcatchers (*Polioptila californica californica*), mountain sheep (*Ovis candadensis nelsoni*) and the orange-throated whiptail lizard (*Aspidoscelis hyperythra beldingi)*. Four varieties or subspecies of ERRA have been described (*fasciculatum*, *foliolosum*, *polifolium*, and *flavoride*); they overlap somewhat in their geographic distribution and elevation range but each tends to be associated with distinct climatic zones, degree of pubescence, leaf shape, and flower color (white to light pink). The subspecies also vary in chromosome number. The species is relatively deep-rooted (1.5 m or more below the surface) and drought-resistant, but does not generally resprout following fires. Populations rely on regeneration from the seed bank, so frequent fires can lead to local extinction where the seed bank has been depleted. This widespread species is currently monitored at Joshua Tree National Park and Santa Monica Mountains NRA.

Download the USA-NPN datasheet and the CPP profile for ERFA here:
http://www.usanpn.org/cpp/ERFA

3.4 *Larrea tridentata* (LATR; Creosote) is among the most common and widespread native shrubs in the Mojave and an indicator of warm deserts. Because it occurs throughout the Chihuahuan, Sonoran, and Mojave Deserts, it is a species that could be tied to phenological studies in other desert regions. Creosote's phenological events respond to precipitation events, leafing out in response to spring, summer, or fall rains and flowering both in mid-spring and after sporadic summer rains in the Mojave. Creosote interacts with many desert animals, providing cover for small mammals and birds; it is the host plant for the Creosote gall midge (a group of 15 closely related species of gall-inducing flies) and the Lac Scale insect, *Tachardiella larreae,* which produces lac and deposits it on the stems of the shrub. Lac is plastic when heated, but hardens when cool, and has been used by desert peoples for many applications. Creosote

Download the USA-NPN datasheet and the CPP profile for LATR here:
http://www.usanpn.org/cpp/LATR

3.5 *Prosopis glandulosa* (PRGL; Honey Mesquite) is a deciduous shrub or small tree in the Fabaceae. PRGL has a long taproot, but may be sensitive to changes in the water table. Honey mesquite is an important wildlife plant. It is insect-pollinated (primarily by bees), and its flowers are high in nectar and strongly scented. It is long-flowering and potentially a resource for pollinators over a long period. Many neo-tropical migratory bird species nest in honey mesquite patches along their migration route. The pods and seeds are eaten and dispersed by wildlife.

Native Americans ground the pods and seeds into meal to make bread, mush, and alcohol. Other plant parts were used to make black dye, rope, cement for pottery, and candy.

Download the USA-NPN datasheet and the CPP profile for PRGL here:
http://www.usanpn.org/cpp/PRGL

3.6 *Yucca brevifolia* (YUBR; Joshua Tree) is an iconic Mojave Desert species that is believed to be at risk from the effects of climate change. It is at its extreme southern limit in JOTR and occurs across elevational gradients within the park. The Joshua tree is coevolved with a moth pollinator, *Tegeticula synthetica.* The temporal decoupling (or increasing asynchrony) of plant hosts from their pollinators is an emerging problem related to climate change, which is a major concern resource managers have for the Joshua tree and its pollinator. After pollinating the receptive, open flowers of the Joshua Tree, the Yucca moth lays its eggs in the ovary located at the base of the flowers; the moth larvae then feed on the young ovules after they hatch. This prevents a small portion of an individual plant's seeds from maturing, but produces another generation of moths that will pollinate Joshua Trees when the adult moths emerge the following year. Joshua tree provides important habitat, nesting sites, and food for a wide variety of small mammals, birds, reptiles, insects, and spiders. Its seeds are dispersed by mammals and wind.

Download the USA-NPN datasheet and the CPP profile for YUBR here:
http://www.usanpn.org/cpp/YUBR

3.7 *Yucca schidigera* (YUSC; Mojave Yucca) is a common shrub across large areas of the Mojave desert and an indicator of mid- and upper- elevation Mojave Ecoregion. Mojave Yucca is more widely distributed than Joshua Trees and likely more resilient to climate change. It is long lived and tolerant of many disturbance regimes. Similar to *Yucca brevifolia,* the Mojave Yucca is pollinated by a moth (*Tegeticula mojavella*, a part of the *Tegeticula yuccasella* species complex), which specializes on its flowers., In addition, Martin's Giant Skipper butterfly (Megathymus coloradensis) lay eggs on YUSC sucker shoots. Another moth species, *T. corruptrix*, has been observed to lay its eggs in developing ovaries of Mojave Yucca without pollinating its flowers; apparently, this moth species has evolved the ability to parasitize Mojave Yucca. Some climate models suggest that the YUSC bioclimatic range will contract under climate change, and its survival may depend on ability to adapt phenologically.

Download the USA-NPN datasheet and the CPP profile for YUSC here:
http://www.usanpn.org/cpp/YUSC

Acacia greggii (Catclaw acacia) CPP species profile (Version 2, Apr 2013):

California Phenology Project: species profile for Catclaw Acacia (*Acacia greggii*)

USA-NPN National Phenology Network | UCSB | National Park Service

CPP site(s) where this species is monitored: Joshua Tree National Park

Photo credit: Stan Shebs

What does this species look like?

This deciduous shrub or small tree has curved thorns on its stems. The grey-green leaves are made up of many small leaflets. The flowers are arranged in inflorescences made up of many small light yellow flowers. Inflorescences tend to be longer than the leaves and clustered with leaves on short-shoots. The fruit is a brown pod between 5 and 15 centimeters long. It can be curved, twisted, or flat in shape, narrowing between the seeds.

*When monitoring this species, use the USA-NPN **semi-deciduous trees and shrubs** datasheet.*

Species facts!

- The CPP four letter code for this species is **ACGR.**
- This species got its common name from hooked thorns that are the size and shape of a cats claw and tend to hook unsuspecting wanderers.
- The seeds require scarification to germinate. This often occurs when seeds travel across a landscape due to flash flooding.
- This species has extrafloral nectaries that provide a food and water source for ants.
- Native americans avoided mature fruit of this species because the tissue contains a potentially poisonous compound called prunasin. However, the young unripe fruit was eaten and the stems were used for making tools.

Photo credit: Stan Shebs

Photo credit: Stan Shebs

Where is this species found?

- Found at elevations between 100 and 1400 meters.
- Occurs along flats and washes
- Found in desert regions from California to Texas and into Mexico.

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 April 2013

California Phenology Project: species profile for Catclaw Acacia (*Acacia greggii*)

Young leaves
Young leaves are generally thinner and lighter colored than mature leaves.

Leaves

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.*

ACGR flowers and flower buds grow on inflorescence stalks. Before the flowers open they are stalks with many small buds on them (~2-3" long)

Open flowers
*You can see the pollen-producing anthers emerging from the flower in the photo to the left. **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)!*

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

Fruits
The fruit is a pod that changes from green to tan, red-brown or brown and splits open to expose the seeds. Do not include empty pods that have already dropped all of their seeds.

***Note**: fruit phenophases are nested; if you record **Y** for "ripe fruits" you should also record **Y** to "fruits"*

Ripe fruits
A fruit is considered ripe when it has turned tan, red-brown or brown. Do not include empty pods that have already dropped all of their seeds.

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

Version 2 April 2013

Coleogyne ramosissima (Blackbrush) CPP species profile (Version 3, April 2013)

California Phenology Project: species profile for Blackbrush *(Coleogyne ramosissima)*

CPP site(s) where this species is monitored: Joshua Tree National Park

Photo credit: Stan Shebs

What does this species look like?

This perennial desert shrub grows up to 2 meters tall with short, stiff, branched stems that are spine-like at the tip. The grey bark turns black with age or when wet and the small leaves are aromatic. The flowers lack petals but the thick sepals remain when flowers open. The sepals are yellow on the inside and reddish on the outside.

*When monitoring this species, use the USA-NPN **semi-deciduous trees and shrubs** datasheet.*

Species facts!

- The CPP four letter code for this species is **CORA.**
- Member of the rose family.
- *Coleogyne* is Greek for "sheathed fruit" and *ramosissima* is Latin for "many branched".
- Spiny stems protect it from browsing herbivores.
- Depends on rodents for seed dispersal.
- Drought deciduous; it loses its leaves when water is highly limited.
- Primarily wind pollinated.
- Blackbrush is mast-fruiting and only produces fruit and seed in years of abundant resources.

Photo credit: Brewbooks (Flickr)

Photo credit: Brewbooks (Flickr)

Where is this species found?

- Mojave desert scrub and Pinyon-Juniper Woodland in the Upper Sonoran life zone.
- Associated with Joshua Tree and Mojave Yucca.
- Dry well-drained sandy, or rocky soil.
- Mesas, open plains, and foothills.
- Elevations between 750 and 2100 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 3, April 2013

California Phenology Project: species profile for Blackbrush *(Coleogyne ramosissima)*

Young leaves
Young leaves appear hairier and thinner than mature leaves. ***Note:*** *There is no petiole on CORA leaves! This may make this phenophase difficult to distinguish on this species.*

Leaves
Leaves are small, longer than wide and roughly oval and come to a shallow point

Similar to other species in Mediterranean and desert ecosystems, Blackbrush may respond to precipitation events with a flush of new leaf production. If water becomes unavailable after growth is initiated, however, then leaf expansion may be arrested, resulting in many small leaves on the plant. These responses to water availability (initiation of growth followed by arrested growth when resources give out) can be confusing for observers. If you are unsure of what you are seeing, do not hesitate to circle ? on the NPN datasheets. With more experience, observers may be able to distinguish between newly produced young leaves vs. old, small leaves. Throughout the year, take note of the differences between new and old leaves– color, texture, and size may all be used to identify young leaves!

Flowers and flower buds
Be aware that this species does not produce flowers every year!

Open flowers
These flowers appear singly and have both male and female parts.
Note: *flower phenophases are nested; if you say **Y** to "open flowers" you should also say **Y** to "flowers or flower buds".*

Fruits
The fruit is a crescent shaped tiny capsule that changes from green to reddish brown; it drops from the plant when ripe.

Ripe fruits
The fruit is ripe when it is reddish brown.
Note: *fruit phenophases are nested; if you say **Y** to "ripe fruits" you should also say **Y** to "fruits".*

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

Version 3, April 2013

Eriogonum fasciculatum (Mojave buckwheat) CPP species profile (Version 2, March 2012):

California Phenology Project: species profile for Eastern Mojave Buckwheat (*Eriogonum fasciculatum*)

CPP site(s) where this species is monitored: Santa Monica Mountains National Recreation Area, Joshua Tree National Park

Photo credit: Stan Shebs

What does this species look like?

This perennial shrub can be up to 2 meters tall and 3 meters wide. The leaves are clustered at branch nodes and are leathery in texture; some varieties have white fuzz below, whereas others are glaborous. Leaves are a grey-green color, and rolled along the edges. The small flowers are 2.5 to 3 millimeters diameter, white to pinkish in color, and arranged in a dense clusters.

*When monitoring this species, use the USA-NPN **semi-deciduous trees and shrubs** datasheet.*

Species facts!

- The CPP four letter code for this species is **ERFA.**
- This species was used by Native American groups to treat headaches, diarrhea, and wounds.
- This species is visited by a variety of butterflies, and is an important source of nectar for honeybees in dry areas.
- Can form associations with mycorrhizal fungi to aid in seedling survival and the colonization of new sites.

Photo credit: Brian Haggerty

Photo credit: wanderingnome (Flickr)

Where is this species found?

- Found in dry slopes, washes, and canyons.
- A member of sagebrush scrub, desert scrub and coastal sage scrub plant communities.
- Found at elevations less than 2300 meters.
- In California, it is distributed in the Southern Sierra Nevada, Central West CA, Southwestern CA, East of Sierra Nevada, and Deserts.

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 Eastern Mojave Buckwheat (*Eriogonum fasciculatum*)

Cait McHugh and Anjanette Garcia

Young leaves
Young leaves are generally thinner and lighter colored than mature leaves.

Similar to other species in Mediterranean and desert ecosystems, Buckwheat may respond to precipitation events with a flush of new leaf production. If water becomes unavailable after growth is initiated, however, then leaf expansion may be arrested, resulting in many small leaves on the plant. These responses to water availability (initiation of growth followed by arrested growth when the resources give out) can be confusing for observers. If you are unsure of what you are seeing, do not hesitate to circle ? on the NPN datasheets. With more experience, you may be able to distinguish between newly produced young leaves vs. old, small leaves. As you observe this species throughout the year, take note of the differences between new and old leaves– color, texture, and size can all be used to identify young leaves!

Brian Haggerty

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.*

Brian Haggerty

Open flowers
*You can see the pollen-producing anthers emerging from the flower in the photo to the left. **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)!*

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

Steve Berardi

Fruits
The fruit is tiny and capsule-like, partially enclosed in a spent flower base (calyx), with many such spent flower bases tightly clustered together. The spent flower base changes from green to light brown or rusty brown as it dries out.

Arnold Zane

Ripe fruits
A fruit is considered ripe when the spent flower base enclosing it has turned light brown or rusty brown.
***Note**: fruit phenophases are nested; if you record **Y** for "ripe fruits" you should also record **Y** to "fruits"*

The green, pre-ripe fruit phenophase may be difficult to identify on this species. Remember you can circle ? if you are unsure of what you are seeing!

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

Version 2, March 2012

Larrea tridentata species profile (Version 2, March 2012):

California Phenology Project: species profile for Creosote Bush (*Larrea tridentata*)

CPP site(s) where this species is monitored: Joshua Tree National Park

Photo credit: R.A. Howard, Smithsonian Institute

What does this species look like?

Creosote bush is a drought tolerant evergreen shrub growing up to 4 meters tall. The stems are generally flexible. The waxy small leaves are dark green and very resinous. After rainfall, these leaves emit a characteristic strong odor. Its yellow flowers have five petals and are bisexual, having both male and female parts. Under particularly dry conditions, the foliage appears greenish-orange from a distance.

*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 **LATR.**
- The oldest living plant is a Creosote bush in the Mojave Desert, estimated to be between 9,400 and 11,000 years old.
- The flowers are visited by over 120 bee species; 22 of these exclusively use Creosote pollen as their food source.
- Native Americans used a dry powder prepared from the leaves as an antibacterial treatment for wounds and burns.

Photo credit: Sue in AZ (Wikipedia)

King Clone, the oldest known plant
Photo credit: Klokied (Wikipedia)

Where is this species found?

- Grows in gravelly and sandy soils that are well drained.
- Can tolerate a wide range of water availability and temperatures (5 to 120°F).
- Found in valley plains, mesas, arroyos, alluvial fans, and gentle slopes within the three Southwest deserts (Mojave, Sonoran and Chihuahuan).

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 Creosote Bush (*Larrea tridentata*)

Young leaves
In this species, young leaves are thin, bright green in color, and appear in pairs, usually at the stem tips.

Similar to other species in Mediterranean and desert ecosystems, Creosote may respond to precipitation events with a flush of new leaf production. If water becomes unavailable after growth is initiated, however, then leaf expansion may be arrested, resulting in many small leaves on the plant. These responses to water availability (initiation of growth followed by arrested growth when the resources give out) can be confusing for observers. If you are unsure of what you are seeing, do not hesitate to circle ? on the NPN datasheets. With more experience, you may be able to distinguish between newly produced young leaves vs. small, old leaves. As you observe this species throughout the year, take note of the differences between new and old leaves– color, texture, and size can all be used to identify young leaves!

Flowers or flower buds
The flowers appear singly and have both male and female parts. A flower bud (or unopened flower) can be seen in the background of this photo.

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

Fruits
The fruit is capsule-like and fuzzy with white hairs; it changes from green to dark brown, and splits apart into 5 sections.

Ripe fruits
The fruit is ripe when it is dark brown; it usually splits into five sections when ripe.
***Note:** fruit phenophases are nested; if you record **Y** for "ripe fruits" you should also record **Y** to "fruits"*

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

Version 2, March 2012

Prosopis glandulosa (Honey mesquite) species profile (Version 3, August 2012):

California Phenology Project: species profile for Honey Mesquite (*Prosopis glandulosa*)

CPP site(s) where this species is monitored: Joshua Tree National Park

Photo credit: Homer Price (Flickr)

What does this species look like?

This deciduous species is a thorny, nitrogen-fixing large shrub or medium-sized tree that reaches 0.5 – 12 meters in height. The greenish-white to yellowish-white flowers develop simultaneously with the leaves. These flowers are grouped tightly on elongated spikes that are showy and droopy. Flowers are high in nectar and pollinated primarily by bees.

*When monitoring this species, use the USA-NPN **semi-deciduous trees and shrubs** datasheet.*

Species facts!

- The CPP four letter code for this species is **PRGL.**
- Honey mesquite wood is used for fuel, furniture, flooring, utensils, and posts.
- The pods and seeds are eaten by wildlife.
- Native Americans ground the pods and seeds into meal to make bread, mush, and alcohol. Other plant parts were used to make black dye, rope, cement for pottery, and candy.

Photo credit: Melody Lytle

Photo credit: Thomas Muller

Where is this species found?

- Grows in warm desert shrub communities and grasslands.
- On plains, terraces, washes, and riparian sites.
- Grows in sites where plants have access to permanent underground water.
- In California, this species occurs at elevations between 60 and 1090 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 3, August 2012

California Phenology Project: species profile for Honey Mesquite (*Prosopis glandulosa*)

Brian Haggerty

Young leaves
In the photo, the leaves have unfolded to reveal their leaf stalk, but they are not yet full size!

Brian Haggerty

Leaves
In this species, each leaf is made up of many smaller leaflets.

Mitzi Harding

Open flowers

Flower buds

Flowers or flower buds** and **Open flowers
Greenish flower buds (in the green box) and whitish open flowers (in the red box) can both be seen in this photo.
*For **open flowers,** you must be able to see anthers or stigma.*
*When monitoring **flower or flower bud abundance**, count each inflorescence as a single flowering structure. When monitoring the **proportion of open flowers**, estimate the number of individual flowers that are open, not inflorescences!*

Mitzi Harding

Fruits
The fruit is a pod that changes from green to tan, sometimes tinged with violet.

Mitzi Harding

Ripe fruits
The fruit is ripe when it is tan, sometimes tinged with violet, and dry.

***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: **Pollen release, Recent fruit or seed drop***

Version 3, August 2012

Yucca brevifolia (Joshua tree) species profile (Version 3, April 2012):

California Phenology Project: species profile for Joshua Tree *(Yucca brevifolia)*

USA-NPN National Phenology Network | UCSB | National Park Service

CPP site(s) where this species is monitored: Joshua Tree National Park

Photo credit: Brian Haggerty

What does this species look like?

This species is tree-like with a thick, often-branched trunk, growing up to 40 feet tall. The leaves are evergreen and linear, tapering to a sharp point. The creamy flowers are bell-shaped and found in tight clusters at the end of stalks. Most flowers are bisexual.

*When monitoring this species, use the USA-NPN **broadleaf evergreen (no leaves)** datasheet.*

Species facts!

- The CPP four letter code for this species is **YUBR.**
- A monocot in the plant family Agavaceae .
- It has been proposed that the Shasta ground sloth was the main fruit disperser of Joshua Tree before these mammals became extinct.
- Joshua Tree is pollinated by the Yucca moth, which pollinates the flowers while laying its eggs inside the flowers. The larvae then hatch and feed on the seeds.
- Native Americans used the leaves for baskets and the seeds and flower buds for food.
- Joshua Tree got its name from Mormon pioneers.

Photo credit: Jack11_Poland (Wikipedia)

Photo credit: David Scriven

Where is this species found?

- Joshua Tree is an indicator species of the Mojave desert.
- It is found at elevations between 400 and 1800 meters.
- It is found on flat sites, mesas, bajadas, and gentle slopes.
- Prefers well-drained sandy and gravelly soil in alluvial fans adjacent to desert mountain ranges.

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, April 2012

California Phenology Project: species profile for Joshua Tree *(Yucca brevifolia)*

USA-NPN National Phenology Network | UCSB | National Park Service

Flowers or flower buds
*When monitoring **flower or flower bud abundance** for this species, count each inflorescence as a single flowering structure!*

Open flowers
Can you see anthers and/or stigma? Most Joshua Tree flowers are bisexual, producing both anthers and pistil.

For example, if there are 2 inflorescences with many flowers each, abundance should be recorded as <3.

***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)!*

Young YUBR flower bud

YUBR flower bud, which will open soon to reveal an inflorescence (pictured in the upper left photo)

***Important Note:** USA-NPN flower phenophases are nested; if you say **"Y"** to "open flowers" you should also have said **"Y"** to "flowers or flower buds"*

Fruits
The fruit is a capsule that changes from fleshy green to leathery tan, grayish-brown or brown. Sometimes the skin cracks, and the fruit drops from the plant.

Ripe fruits
A fruit is ripe when it is leathery tan, grayish-brown or brown.

***Important Note:** USA-NPN 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 3, April 2012

Yucca schidigera (Mojave yucca) species profile (Version 2, March 2012):

California Phenology Project: species profile for Mojave Yucca (*Yucca schidigera*)

CPP site(s) where this species is monitored: Joshua Tree National Park

Photo credit: Stan Shebs

What does this species look like?

This is a small evergreen plant that grows up to 5 meters tall with a grayish-brown trunk. Its leaves are long, pointy, and very rigid. The leaves are arranged in a spiral on top of the basal trunk. They have coarse fibers that peel away from the leaf margins. The flowers are 3 to 5 centimeters long, white, and bell-shaped. They are arranged in dense clusters at the tip of a central stalk. The flowers are bisexual; meaning that each flower produces both male and female reproductive parts.

*When monitoring this species, use the USA-NPN **broadleaf evergreen (no leaves)** datasheet.*

Species facts!

- The CPP four letter code for this species is **YUSC**
- A monocot in the plant family Agavaceae
- Mojave Yucca was used extensively by Native Americans who prepared flour from the seeds, used the leaf fibers for rope and cloth, and prepared soap from the roots.
- This species is pollinated by the Yucca moth, which polinates the flowers while laying its eggs inside the flowers. The larvae then hatch and feed on the seeds.
- Occasionally hybridizes with Banana Yucca.

Photo credit: Nyenyec (Wikipedia)

Photo credit: Comrogues (Flickr)

Where is this species found?

- Distributed within the Mojave and Sonoran deserts.
- Typically found on well drained soil on rocky slopes and on Creosote flats.
- Found at elevations between 300 and 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 Mojave Yucca (*Yucca schidigera*)

Flowers or flower buds

Open flowers *Yucca flowers are bisexual. Can you see anthers or stigma?*

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

***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)!*

***Important Note**: USA-NPN flower phenophases are nested; if you say "**Y**" to "open flowers" you should also have said "**Y**" to "flowers or flower buds"*

Fruits *The fruit is a capsule, sometimes constricted, that changes from fleshy green to leathery tan, grayish-brown or brown, and drops from the plant when ripe.*

Ripe fruits *The fruit is considered ripe when it is leathery tan, grayish-brown or brown.*

***Important Note**: USA-NPN 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. JOTR Monitoring Locations and Maps

The CPP has established four monitoring locations at Joshua Tree National Park: High View trail, the Oasis Visitor Center, Ryan Mountain trail and Park Boulevard. Maps for each monitoring site are available for download at http://www.usanpn.org/cpp/JOTR/maps.

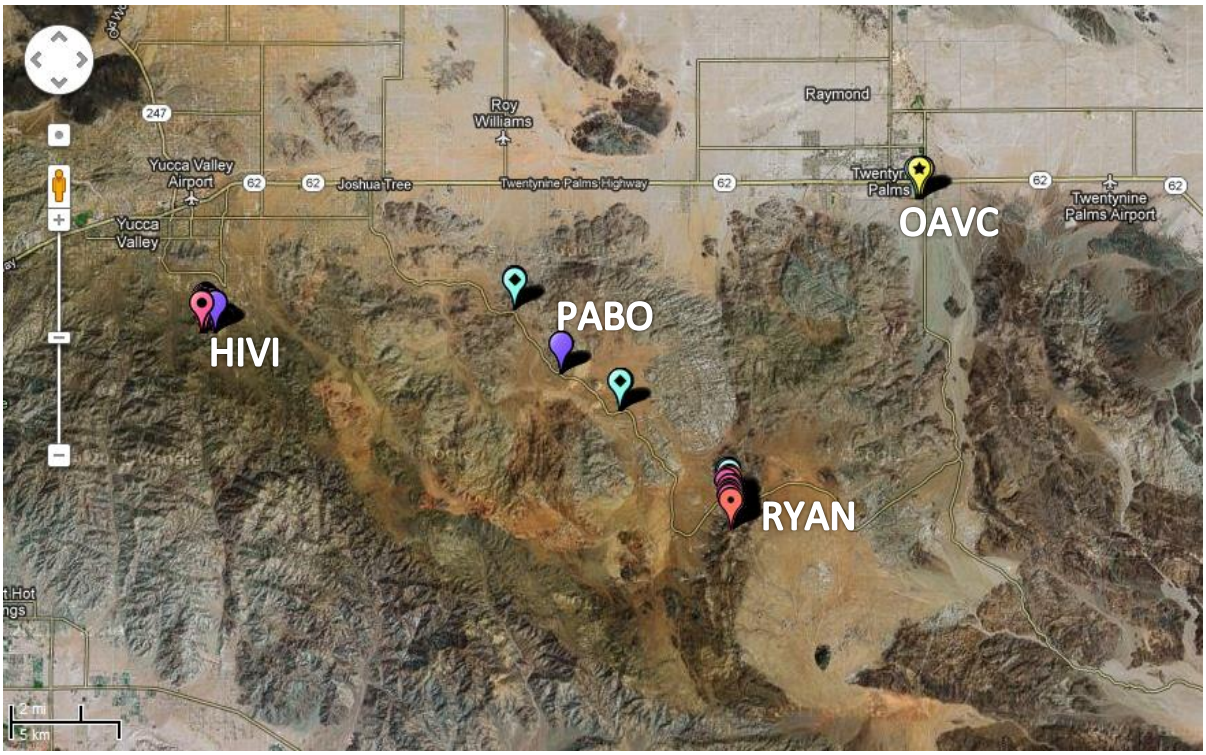


Figure 1. The four CPP monitoring locations at JOTR (as of January 2013). Locations are labeled with their four letter codes, described below.

Table 2. JOTR monitoring locations, target plant species at each location (with number of targetted 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)	Target Species (# of individuals)	Year monitoring initiated	Approximate Phenologically Active Season
(1)	High View Trail (HIVI) **** no records for this site entered in NPDb after August 2012.**	*Coleogyne ramosissima* (24)	2011	Leaves: March-August** Flowers: TBD Fruit: August**
		Eriogonum fasciculatum (13)	2011	Leaves: March-August** Flowers: March-August** Fruit: January-August**
		Yucca brevifolia (17)	2011	Flowers: April Fruit: March-August**
		Yucca schidigera (14)	2011	Flowers: TBD Fruit: June
(2)	Oasis Visitor Center (OAVC)	*Larrea tridentata* (5)		Leaves: year-round Flowers: February-September Fruits: April-December

	Location (4-letter code)	Target Species (# of individuals)	Year monitoring initiated	Approximate Phenologically Active Season
		Prosopis glandulosa (5)		Leaves: year-round Flowers: April-May Fruits: May-July
(3)	Ryan Mountain Trail (RYAN) **** no records for this site entered in NPDb after August 2012.**	*Coleogyne ramosissima* (22)		Leaves: January-August** Flowers: May Fruit: June-August**
		Eriogonum fasciculatum (14)		Leaves: March-August** Flowers: May-July Fruit: January-August**
		Larrea tridentata (10)		Leaves: year-round Flowers: March-June Fruit: year-round
		Yucca schidgera (26)		Flowers: TBD Fruit: TBD
(4)	Park Boulevard (PABO) **** no records for this site entered in NPDb after early October 2012.**	*Acacia greggii* (11)		Leaves: February, May-Oct** Flowers: May-August Fruit: July-August
		Larrea tridentata (12)		Leaves: January-October ** Flowers: April-June, Aug-Sept Fruit: January-October**
		Yucca brevifolia (12)		Flowers: February-April Fruit: April-July

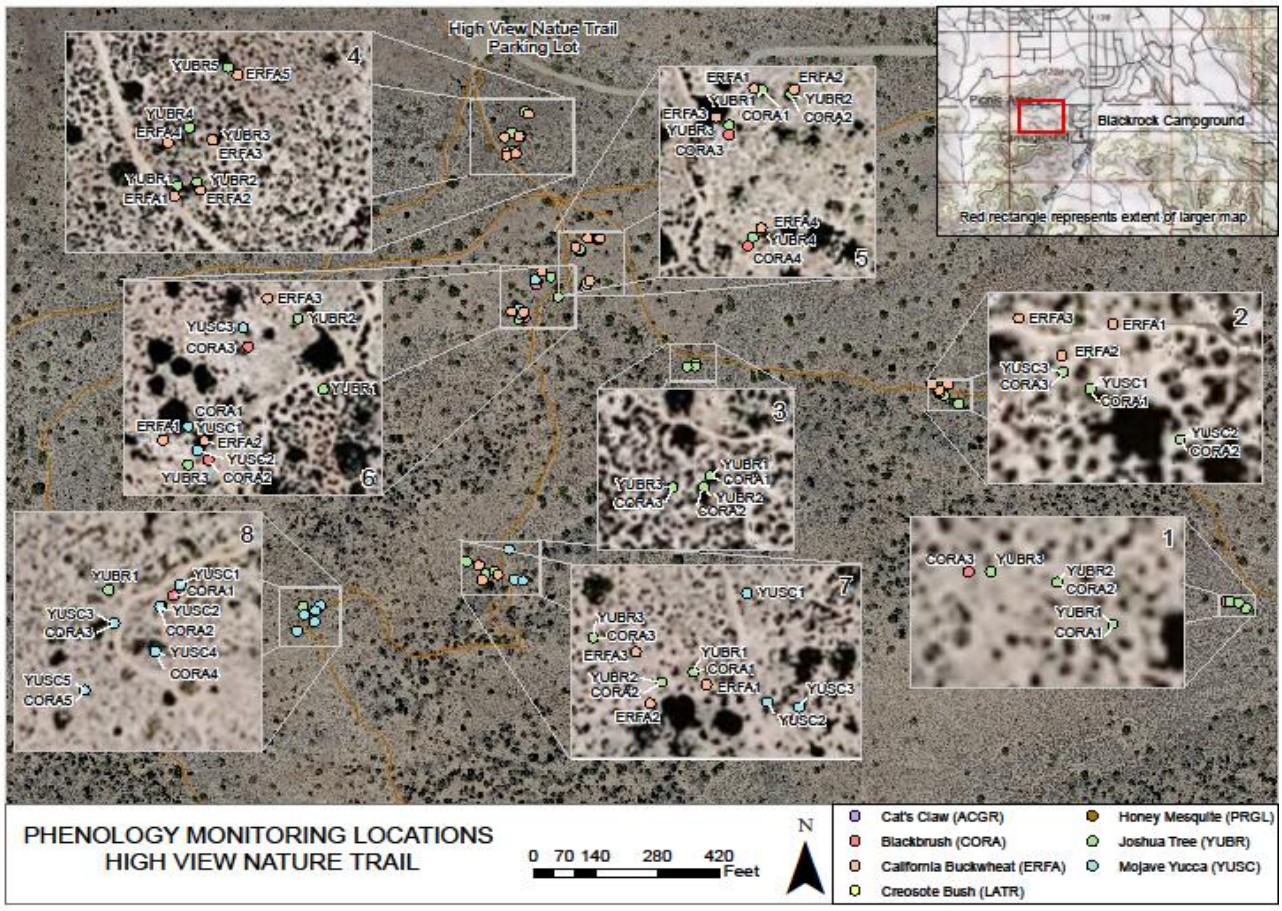
A spreadsheet with GPS coordinates for each individual plant is available for download on the CPP website (http://www.usanpn.org/cpp/JOTR/maps). Coordinates are provided in three formats: UTMs, latitude-longitude, and decimal degrees. The datum for all coordinates is WGS84. The identifier code for each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

CPP-PARK-LOCA#-GESP#.

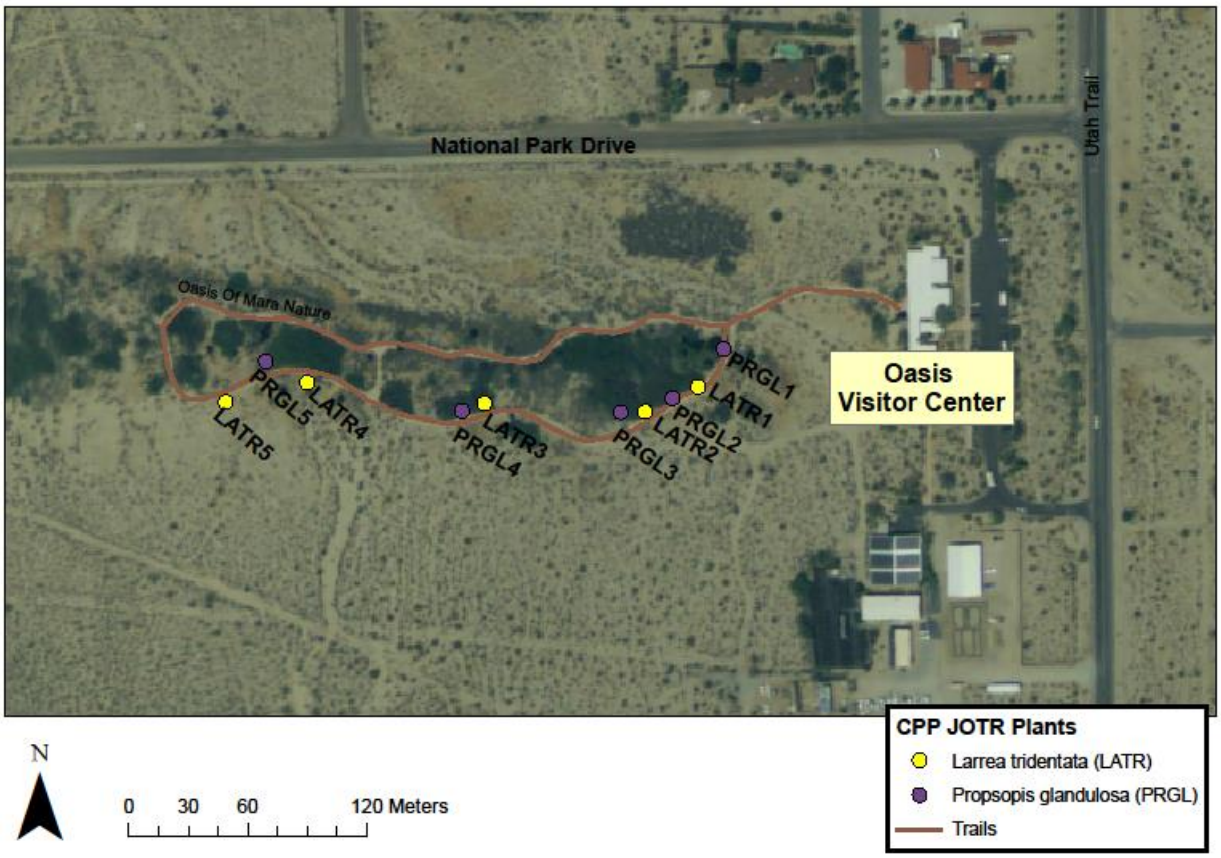
LOCA# represents the location name in a four letter code (e.g., Ryan Mountain= RYAN) and the site at each location (e.g., site 3 at Ryan Mountain= RYAN3).
GESP# represents the four letter code for each genus species combination (e.g. Yucca brevifolia=YUBR) and the individual plant number at each site (e.g. the third Yucca brevifolia= YUBR3).

The CPP plants at JOTR are marked with a metal tag that includes the 4-part code described above. See *Establishing Monitoring Sites SOP#5* for additional information about the tags used to mark CPP plants.

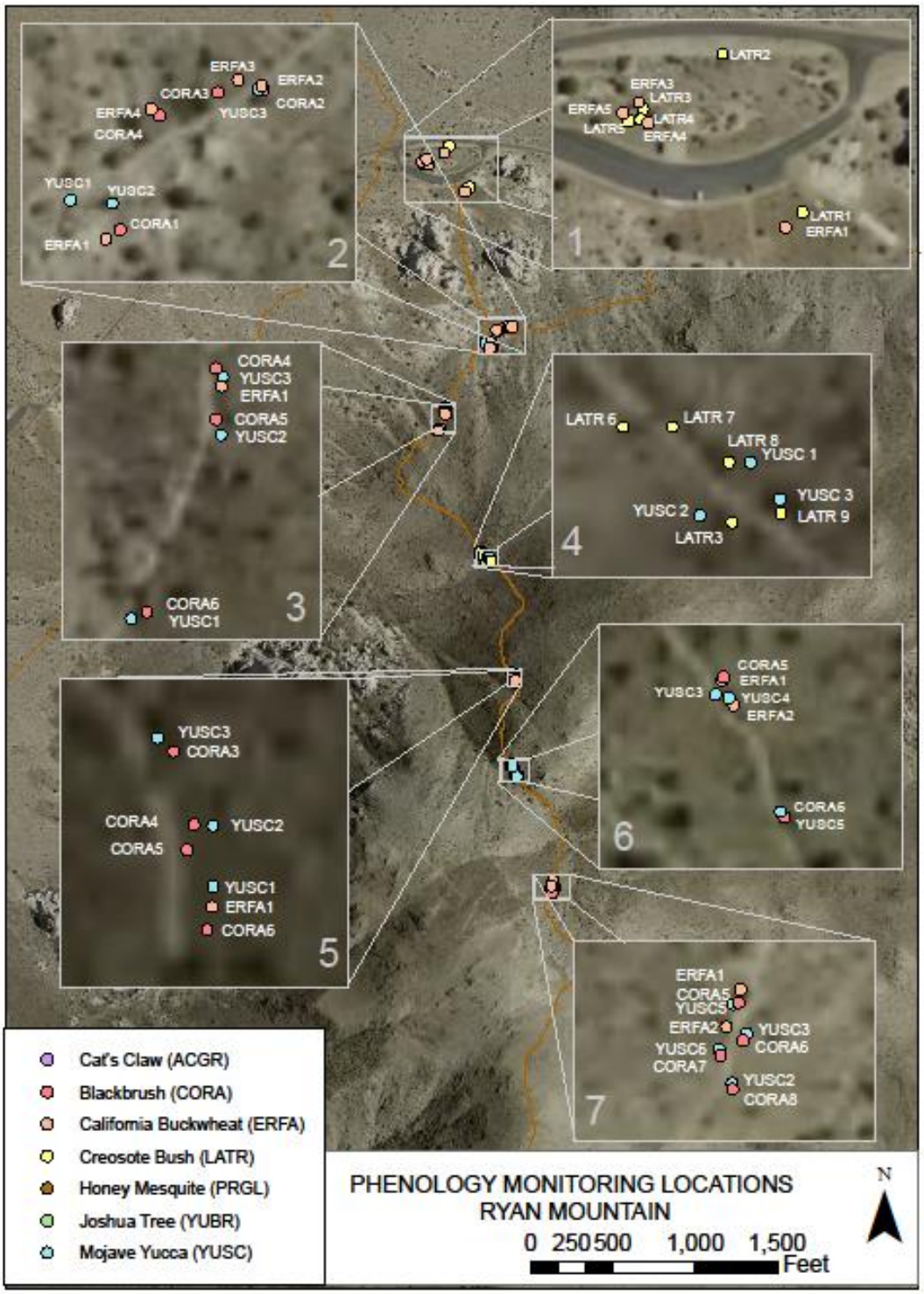
4.1 The ***High View (HIVI)*** monitoring sites are also located along the first mile of the High View Nature trail, which gains approximately 250ft of elevation from the first to the final sites. There are 8 monitoring sites at HIVI.



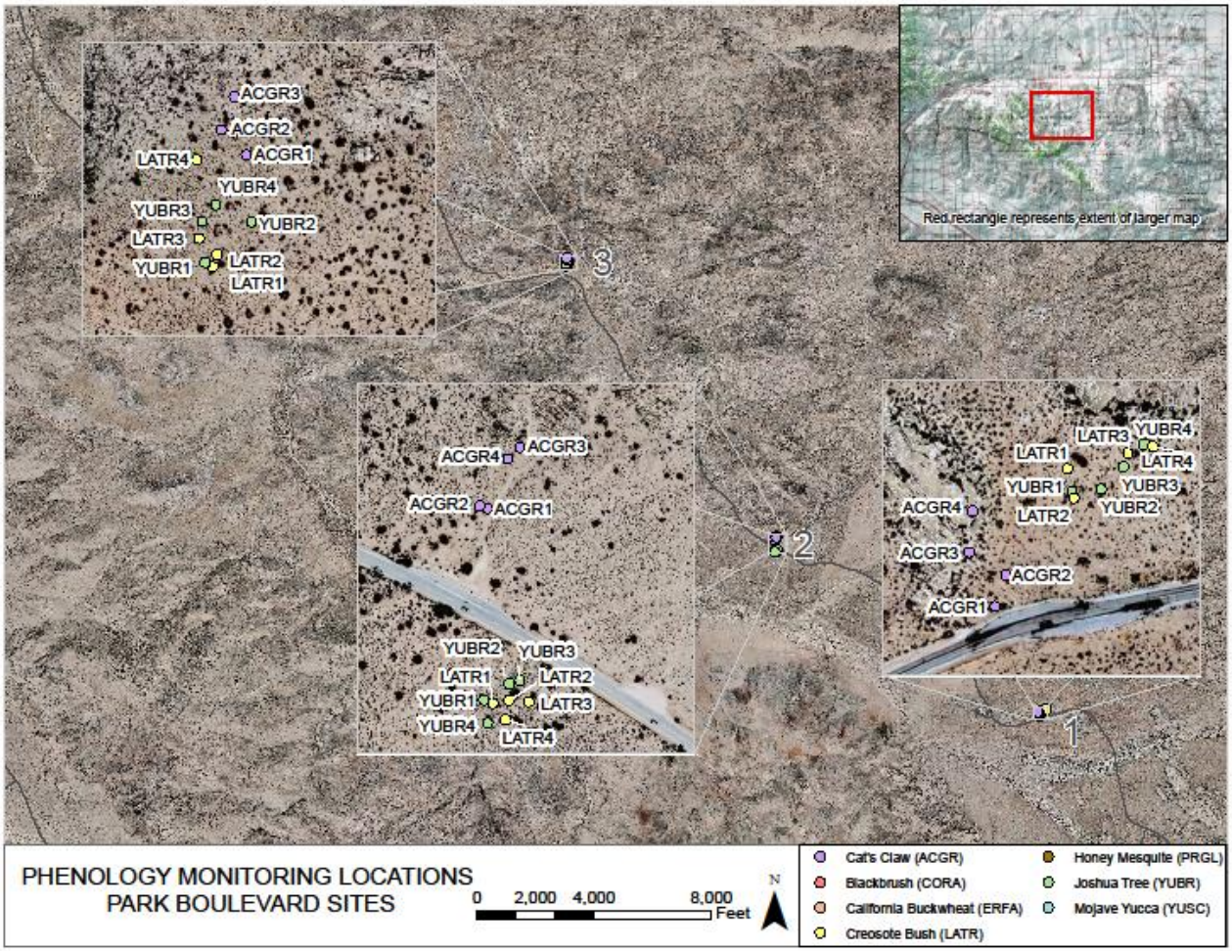
4.2 The ***Oasis Visitor Center (OAVC)*** monitoring sites are located directly behind the visitor center, along the Oasis of Mara loop trail. This is a short, paved trail that is easily accessible from the visitor center.



4.3 The ***Ryan Mountain (RYAN)*** monitoring sites are located along the more challenging Ryan Mountain trail. The 7 sites are all found within the first mile of the trail, which gains over 800 ft. of elevation.



4.4 The ***Park Boulevard (PABO)*** monitoring sites are located on Park Boulevard, between the Ryan Mountain parking area and the West Entrance Station. Each of 3 monitoring sites is located near a pull-off, where CPP monitors can safely leave their vehicles while they are observing tagged individuals.



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 data sheets.

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 USA-NPN website (www.usanpn.org). See *Phenology Site and Trail Monitoring SOP #6* for additional instructions for downloading and using USA-NPN datasheets.

Direct links to datasheets for JOTR species:

Acacia greggii (Catclaw acaccia)*:*
http://www.usanpn.org/cpp/sites/www.usanpn.org.cpp/files/pdfs/species_776.pdf

Coleogyne ramosissima (Blackbrush):
http://www.usanpn.org/files/shared/observationsheets/species_440.pdf

Eriogonum fasciculatum (Mojave buckwheat)*:*
http://www.usanpn.org/files/shared/observationsheets/species_708.pdf

Larrea tridentata (Creosote):
http://www.usanpn.org/files/shared/observationsheets/species_117.pdf

Prosopis glandulosa (Honey mesquite)*:*
http://www.usanpn.org/files/shared/observationsheets/species_84.pdf

Yucca brevifolia (Joshua tree)*:*
http://www.usanpn.org/files/shared/observationsheets/species_442.pdf

Yucca schidigera (Mojave yucca)*:*
http://www.usanpn.org/files/shared/observationsheets/species_443.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 JOTR Focal Taxa: estimates of phenophase onset and duration

7.1 Blackbrush: 2012 observations at JOTR are summarized in the USA-NPN visualization tool below. Note absence of data collection after August. Based on these preliminary summaries, estimates the phenologically active season (at JOTR) for blackbrush phenophases are:

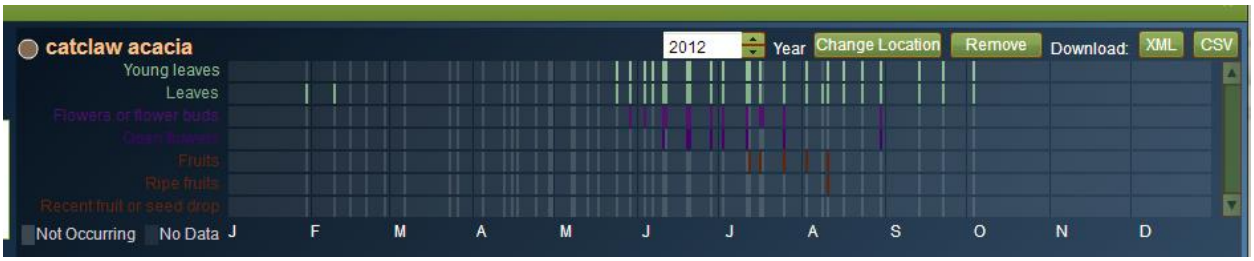
- *Breaking leaf buds/young leaves*: January-August
- *Leaves*: (January) March-August (*this phenophase was added to protocol in March '12)
- *Flowers and flower buds*: May
- *Open flowers*: May
- *Fruits*: June-August
- *Ripe fruits*: June-August
- *Recent fruit or seed drop*: June

7.2 California Buckwheat: 2012 observations at JOTR are summarized in the USA-NPN visualization tool below. Note absence of data collection after August. Based on these preliminary summaries, estimates the phenologically active season (at JOTR) for buckwheat phenophases are:

- *Breaking leaf buds/Young leaves*: April-August
- *Leaves*: March-August
- *Flowers and flower buds*: May-August
- *Open flowers*: May-August
- *Fruits*: January-August
- *Ripe fruits*: January-August
- *Recent fruit or seed drop*: April

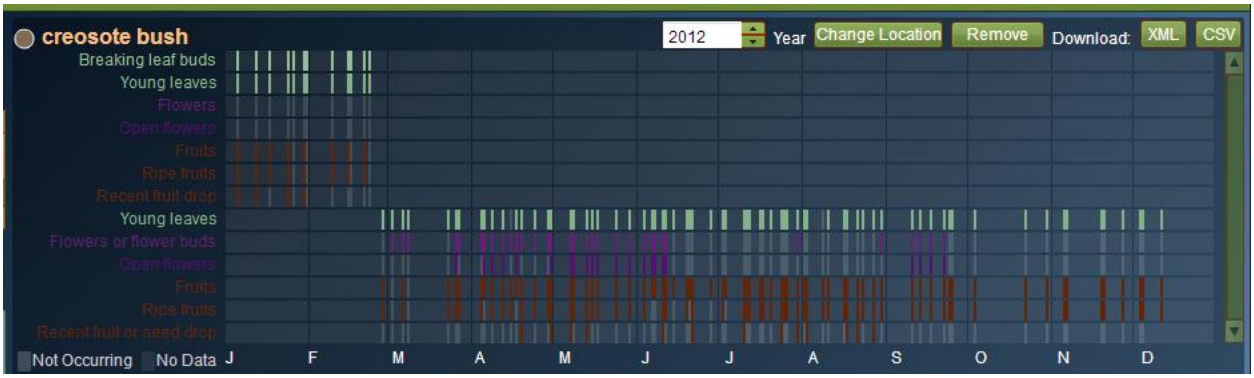
7.3 Catclaw Acacia: 2012 observations at JOTR are summarized in the USA-NPN visualization tool below. Note absence of data collection after August. Based on these preliminary summaries, estimates the phenologically active season (at JOTR) for cactclaw acacia phenophases are:

- *Young leaves*: May-October
- *Leaves*: February, May-October
- *Flowers and flower buds*: May-August
- *Open flowers*: June-August
- *Fruits*: July-August
- *Ripe fruits*: August
- *Recent fruit or seed drop*: TBD



7.4 Creosote: 2012 observations at JOTR are summarized in the USA-NPN visualization tool below. Note absence of data collection after early October. Based on these preliminary summaries, estimates the phenologically active season (at JOTR) for creosote phenophases are:

- *Breaking leaf buds/young leaves*: year-round
- *Flowers and flower buds*: March-September
- *Open flowers*: March-June, September
- *Fruits*: year-round
- *Ripe fruits*: year-round
- *Recent fruit or seed drop*: April-August

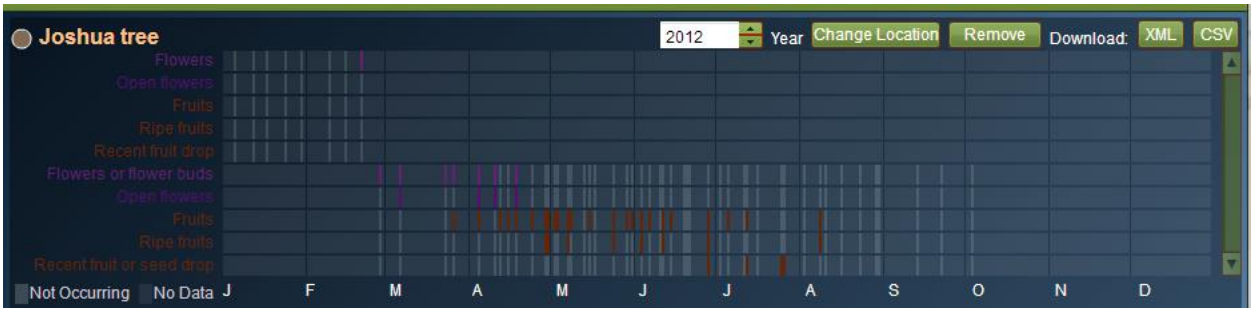


7.5 Honey Mesquite: 2012 observations at JOTR are summarized in the USA-NPN visualization tool below. Based on these preliminary summaries, estimates the phenologically active season (at JOTR) for honey mesquite phenophases are:

- *Breaking leaf buds/young leaves*: March-September
- *Leaves*: year-round
- *Flowers and flower buds*: April
- *Open flowers*: April-May
- *Fruits*: May-July
- *Ripe fruits*: June-July
- *Recent fruit or seed drop*: June-August

7.6 Joshua Tree: 2012 observations at JOTR are summarized in the USA-NPN visualization tool below. Based on these preliminary summaries, estimates the phenologically active season (at JOTR) for Joshua Tree phenophases are:

- *Flowers and flower buds*: February-April
- *Open flowers*: March-April
- *Fruits*: March-August
- *Ripe fruits*: April-August
- *Recent fruit or seed drop*: June-July



7.7 **Mojave Yucca:** 2012 observations at JOTR are summarized in the USA-NPN visualization tool below. Note absence of data collection after August. Based on these preliminary summaries, estimates the phenologically active season (at JOTR) for Mojave yucca phenophases are:

- *Flowers and flower buds*: TBD
- *Open flowers*: May
- *Fruits*: June
- *Ripe fruits*: June
- *Recent fruit or seed drop*: June

VIII. Suggestions for interpretive 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.