

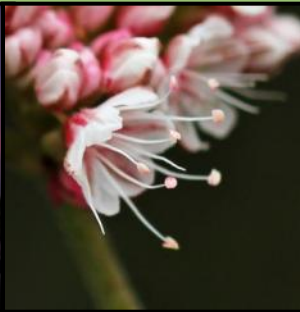
The California Phenology Project : *Tracking Nature's Pulse to Assess Climate Change Response Across California Landscapes and National Parks*

*Liz Matthews, UC Santa Barbara
S. Haultain, C. Brigham,
J. Coles, A. Evenden, S. Fritzke, K. Gerst,
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www.usanpn.org/cpp



- *What is phenology? why monitor phenology?*
- *California Phenology Project (CPP)*
 - *USA National Phenology Network (USA-NPN)*
- *Outreach and education: engaging with Citizen Scientists*
- *How can you get involved?*



Phenology is the science of the seasons



Spring wildflowers



Foliage color change



Migration patterns

PHENOLOGY is the study of recurring plant and animal life cycle stages (phenophases)

Phenology is the science of the seasons



Why study phenology?

Phenology: economic importance



Wildfires



Festivals



Flu season



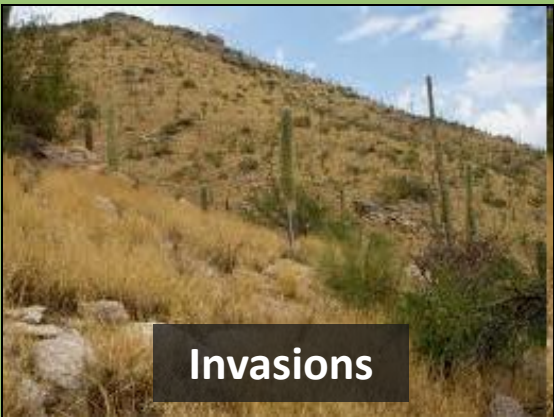
Pests & Diseases



Ecotourism



Allergies



Invasions

Timing and abundance are important



Agriculture

Phenology: biological importance

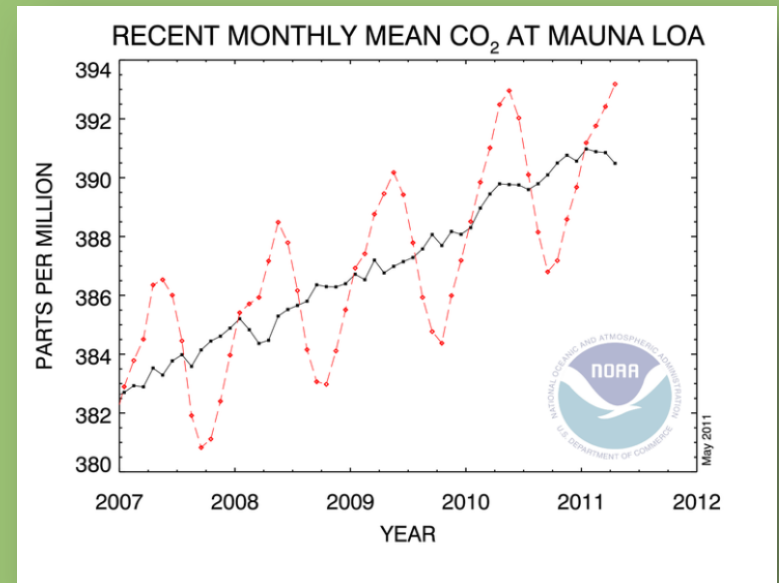
Vegetative and reproductive phenology



Phenology: biological importance

Vegetative phenology:

- Leaves provide energy to the plant for reproduction & growth, food for herbivores, shade and protection for understory animals
- Influences global biogeochemical cycles (e.g., C)



Phenological patterns are important (economically and biologically)

... and sensitive to climate

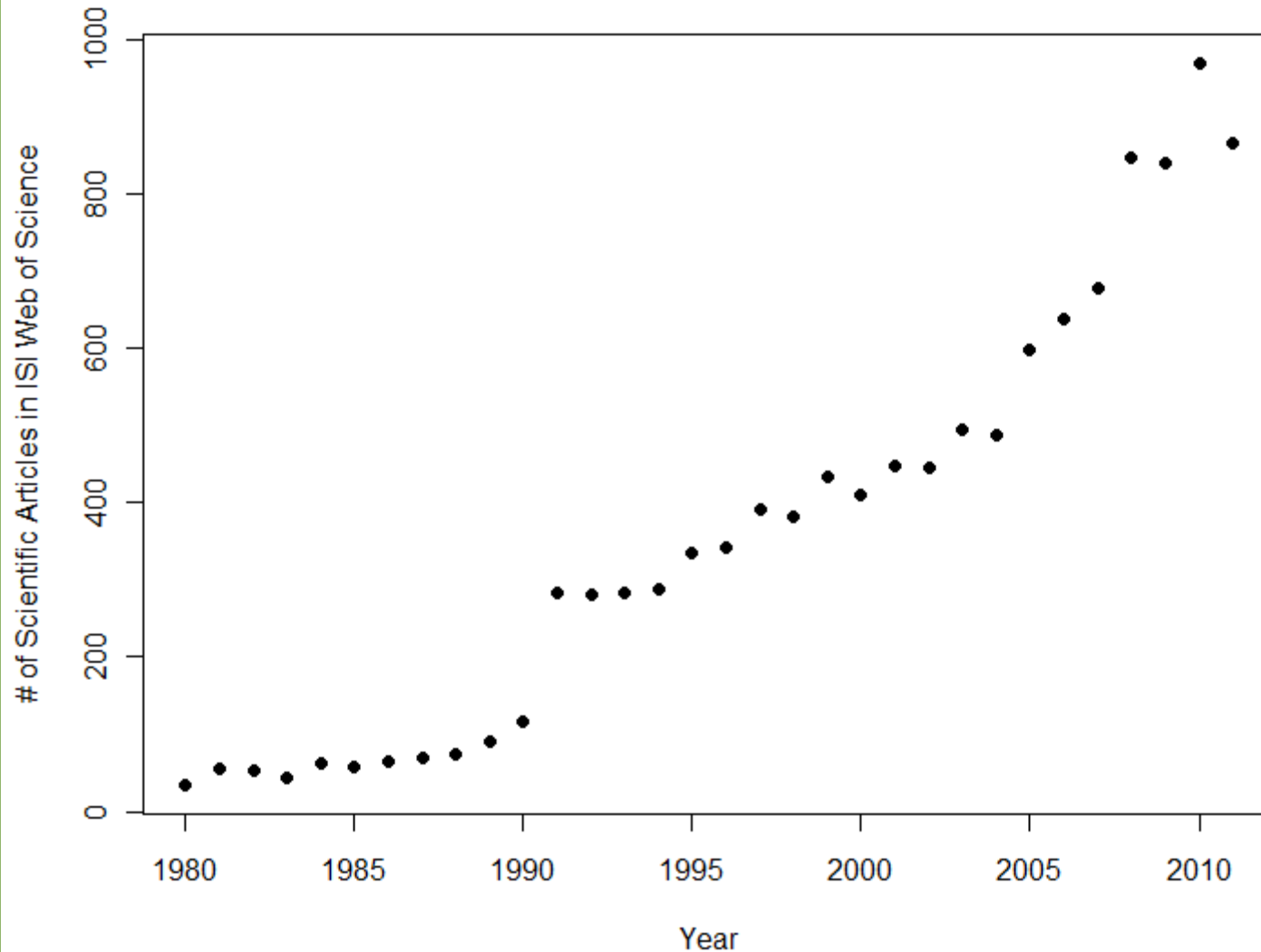
... and sensitive to climate change.

“Phenology...is perhaps the simplest process in which to track changes in the ecology of species in response to climate change.” (IPCC 2007)

“Because of their close connection with climate, the timing of phenological events can be accurate indicators of climate change.” (EPA 2010)



Phenology research



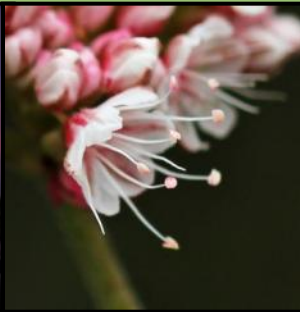
What is the relationship between phenology and local, regional, and statewide environmental conditions?

*Are phenological patterns changing in California?
How is this related to climate change in California?*

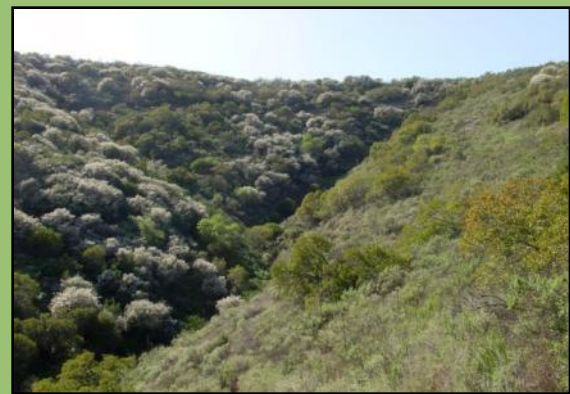
*How will this affect our natural resources
and public lands?*



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California Phenology Project



California Phenology Project: Goals

establish a California-wide phenological monitoring network



monitor across a large geographic area and along key environmental gradients



allow the CPP to:

(1) address important scientific questions, (2) guide resource management decisions, and (3) engage and educate people of all backgrounds and ages





California Phenology Project

- identify key scientific questions
- select focal species for three bioregions (desert, coastal, mountains)
- identify historical datasets
- develop and refine phenophase descriptions and monitoring protocols appropriate for California plant taxa
- develop monitoring infrastructure and tools in 7 pilot parks
- develop outreach and education programs to engage Citizen Scientists in phenology monitoring



CPP scientific questions

- What are the responses of iconic, widespread species?
- Which taxa or functional groups are most sensitive to climate change?
- Do communities or habitats differ in their general responses to climate change?
- What are the earliest indicators of spring?
- Are relationships between plant and animal mutualists disrupted by climate change?



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CPP: focal species

Joshua Tree, *Yucca brevifolia*

- Ability to address scientific questions
- Ability to engage Citizen Scientists
- Proximity to other monitoring efforts
- Species of local management concern
- Indicator species



CPP: focal species

- **26 species** are currently monitored in the National Parks
- **> 70 species** were selected as good candidates for monitoring in California; profiles available on USA-NPN website

A few more focal species, and where they are monitored:
Adenostoma fasciculatum (SAMO), *Aesculus californica* (SEKI),
Arctostaphylos patula (LAVO, SEKI), *Baccharis pilularis* (SAMO,
GOGA, REDW), *Eriogonum fasciculatum* (SAMO, JOTR),
Heracleum lanatum (GOGA, REDW), *Penstemon newberryi*
(LAVO, SEKI), *Quercus agrifolia* (SAMO, GOGA), *Sambucus nigra*
ssp. cerulea (SAMO)

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CPP: historical data

- Many potential sources of historical data: herbarium specimens, wildflower records, seed collection records, naturalists' journals, historical photographs
- UCSB project examining herbarium specimens of selected plant taxa



California Phenology Project

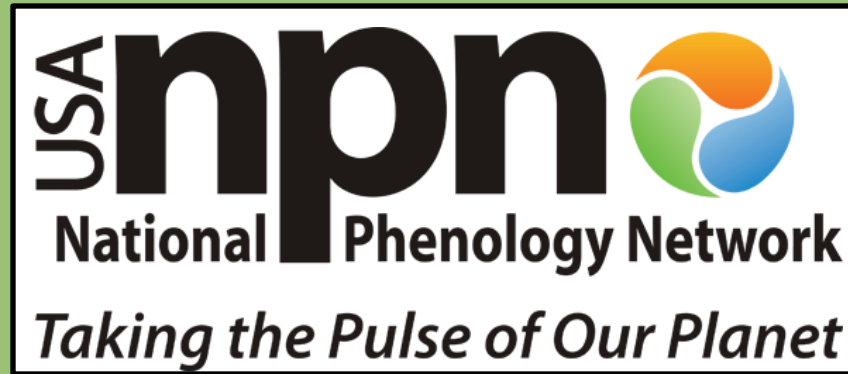
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Key Goal

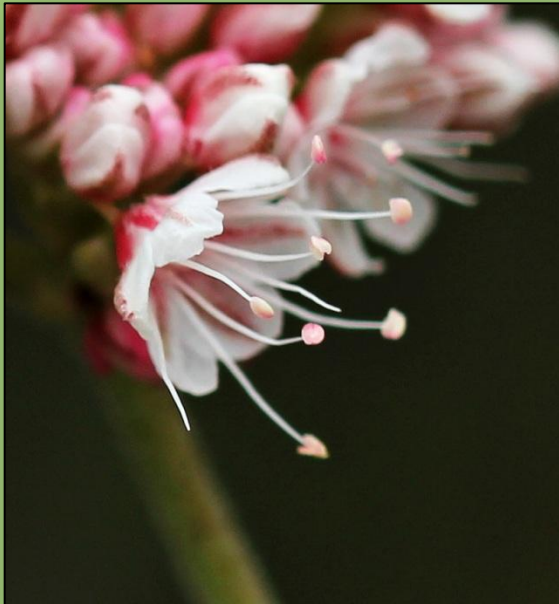
To detect and to understand how plants, animals, and landscapes respond to environmental variation and to climate change



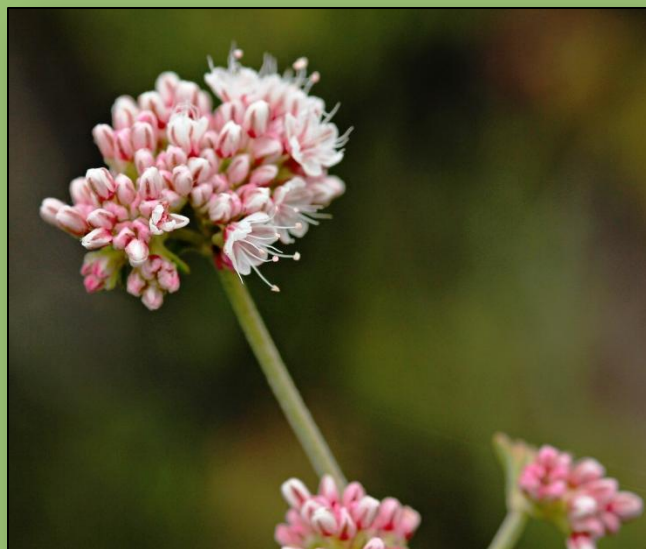
USA-NPN datasheets



Eriogonum fasciculatum
California buckwheat



USA-NPN datasheets



Eriogonum fasciculatum California buckwheat

Trees and shrubs

Broadleaf evergreen

Do you see...?	Date:	Date:	Date:	Date:	Date:
Breaking leaf buds	y n ? _____	y n ? _____	y n ? _____	y n ? _____	y n ? _____
Young leaves	y n ? _____	y n ? _____	y n ? _____	y n ? _____	y n ? _____
Flowers	y n ? _____	y n ? _____	y n ? _____	y n ? _____	y n ? _____
Open flowers	y n ? _____	y n ? _____	y n ? _____	y n ? _____	y n ? _____
Fruits	y n ? _____	y n ? _____	y n ? _____	y n ? _____	y n ? _____
Ripe fruits	y n ? _____	y n ? _____	y n ? _____	y n ? _____	y n ? _____
Recent fruit drop	y n ? _____	y n ? _____	y n ? _____	y n ? _____	y n ? _____
Check when data entered online:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

USA-NPN datasheets



Breaking leaf buds

One or more breaking leaf buds are visible on the plant. A leaf bud is considered "breaking" once a green leaf tip is visible at the end of the bud, but before the first leaf from the bud has unfolded to expose the leaf stalk (petiole) or leaf base.

How many buds are breaking? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Young leaves

One or more young unfolded leaves are visible on the plant. A leaf is considered "young" and "unfolded" once the leaf stalk (petiole) or leaf base is visible, but before the leaf has reached full size or turned the darker green color of mature leaves on the plant. The leaf may need to be bent backwards to see whether the leaf stalk or leaf base is visible.

How many young leaves are present? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Flowers

One or more fresh flowers or flower heads (inflorescences) are visible on the plant. Flower heads include many small flowers that usually do not open all at once. Do not include wilted or dried flowers that remain on the plant, or heads whose flowers have all wilted or dried.

How many fresh flowers or flower heads are present? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Open flowers

One or more open fresh flowers are visible on the plant. Flowers are considered "open" when the reproductive parts (male stamens or female pistils) are visible between unfolded or open flower parts. Do not include wilted or dried flowers that remain on the plant.

How many fresh flowers are open? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10); Peak flower (P): The plant has a large number of flowers and one half (50%) or more are open and still fresh.

Fruits

One or more fresh fruits are visible on the plant.

How many fresh fruits are present? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Ripe fruits

One or more ripe fruits are visible on the plant.

How many fruits are ripe? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Do you see...?	Date:	Date:
Breaking leaf buds	y n ? _____	y n
Young leaves	y n ? _____	y n
Flowers	y n ? _____	y n
Open flowers	y n ? _____	y n
Fruits	y n ? _____	y n
Ripe fruits	y n ? _____	y n
Recent fruit drop	y n ? _____	y n
Check when data entered online:	<input type="checkbox"/>	

te:

n ?

n ?

n ?

n ?

n ?

n ?

n ?

Refine phenophase descriptions



California taxa do not cooperate with the protocols!

California Phenology Project

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CPP: monitoring infrastructure



CPP: monitoring infrastructure

JOTR



REDW



GOGA



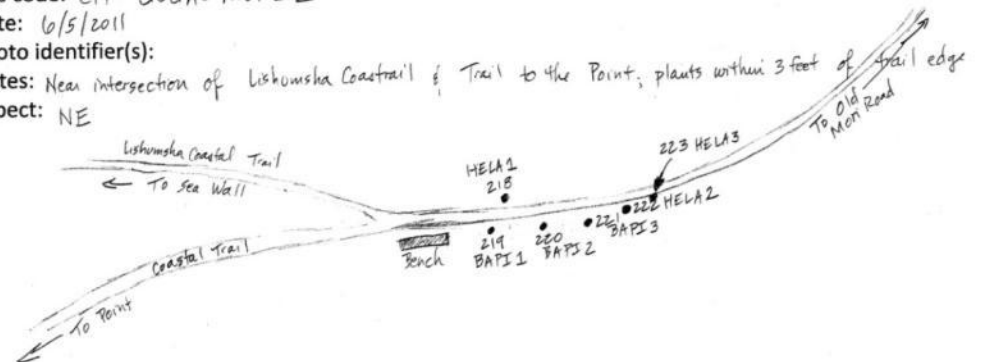
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Date: 6/5/2011

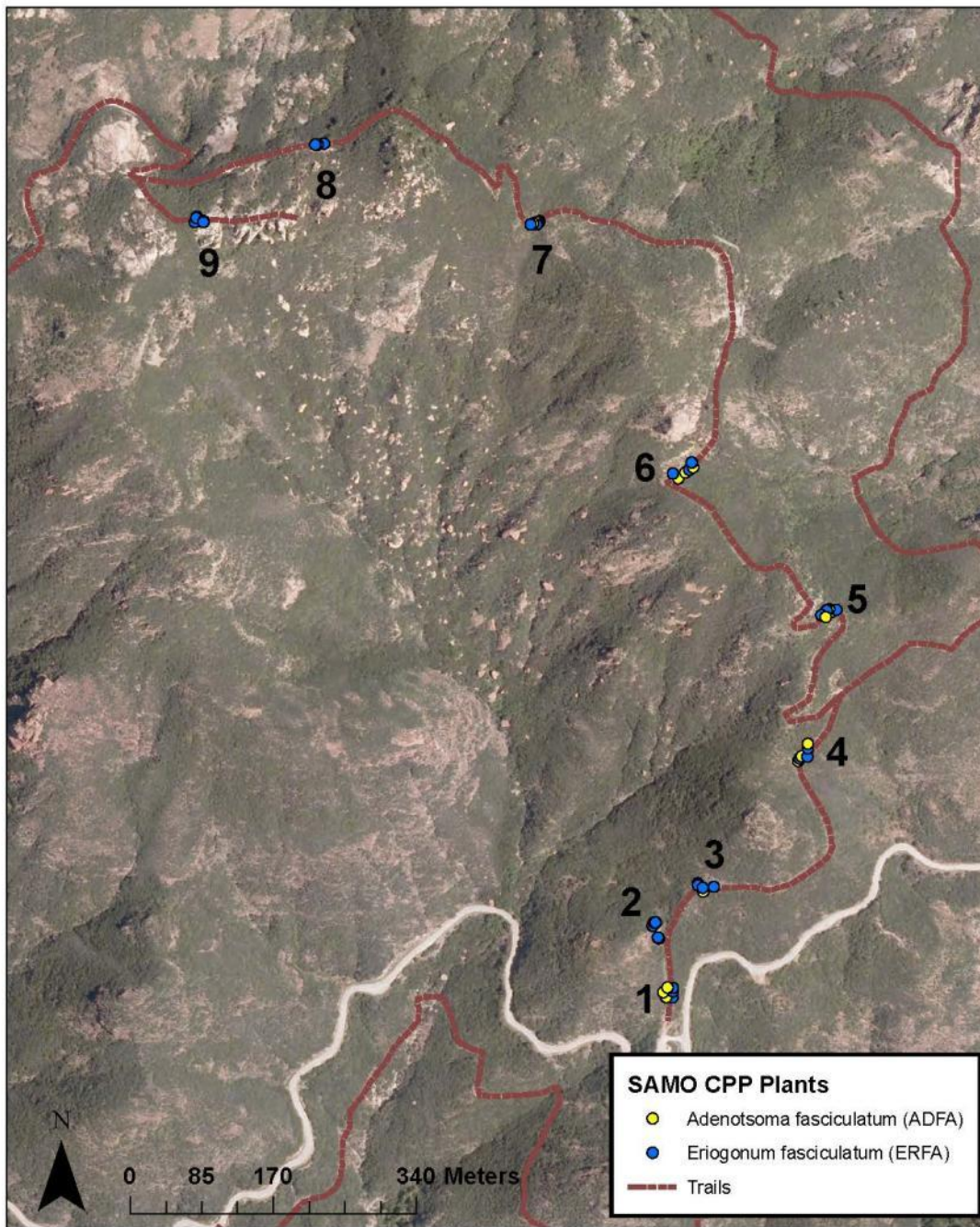
Photo identifier(s):

Notes: Near intersection of Liskumska Coasttrail & Trail to the Point; plants within 3 feet of trail edge

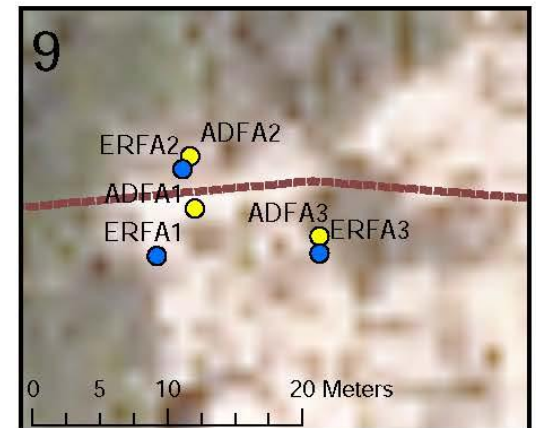
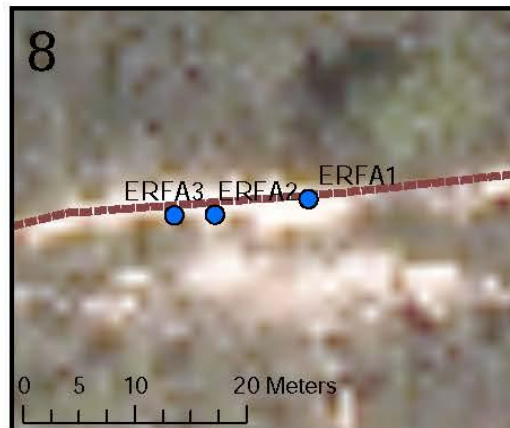
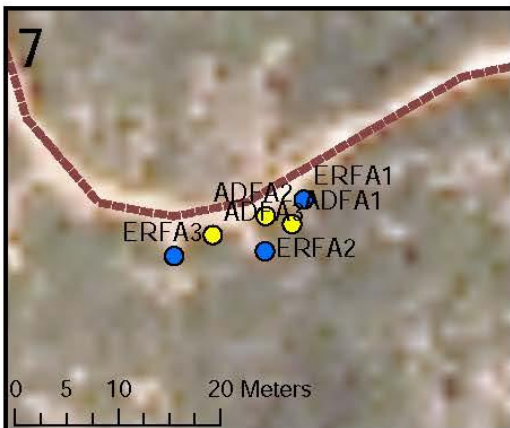
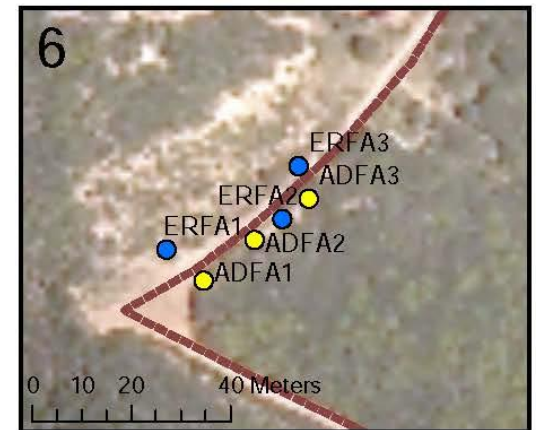
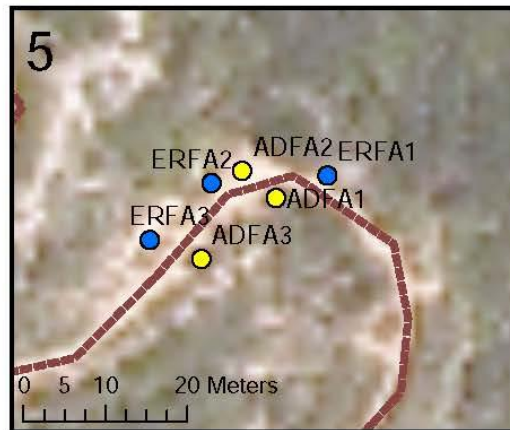
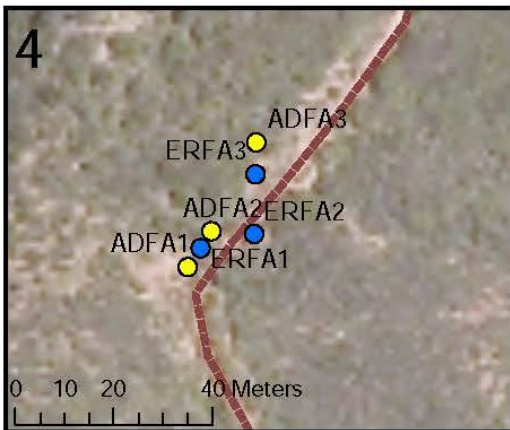
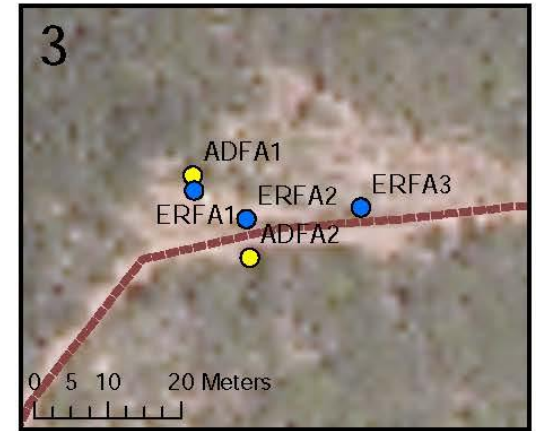
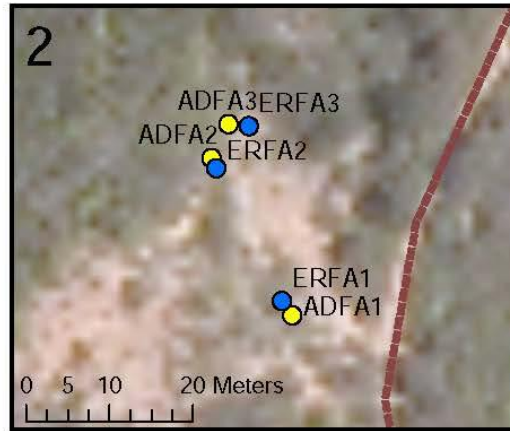
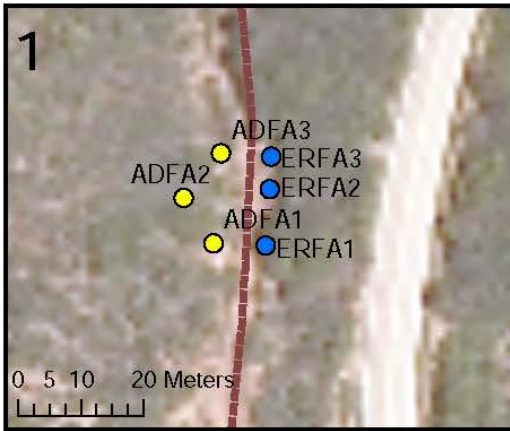
Aspect: NE



CPP SAMO Sandstone Peak Monitoring Sites



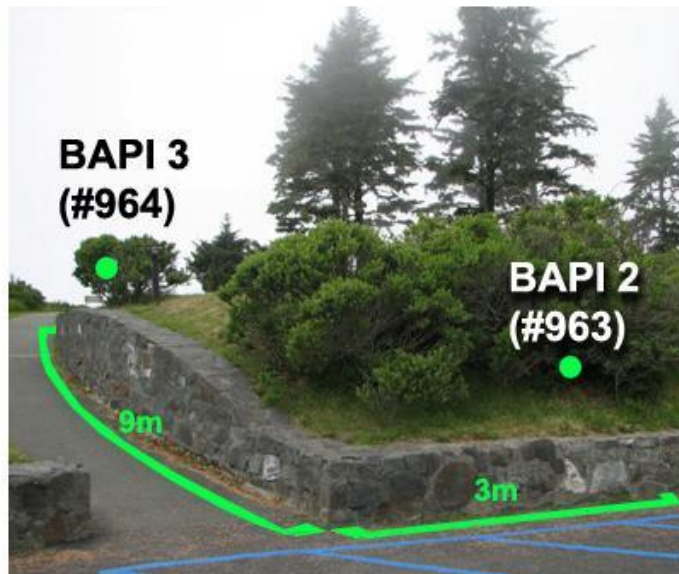
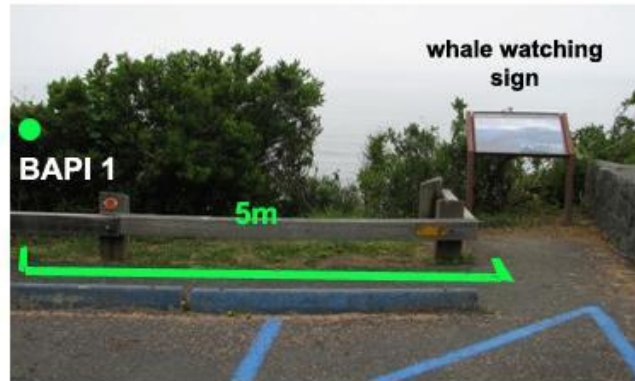
CPP SAMO Sandstone Peak (SAPE) Monitoring Sites and Plant



CPP: monitoring tools

CPP - REDW - CBO 1 - (BAPI 1 - 6)

Coyote Brush (*Baccharis pilularis*) Crescent Beach Overlook



CPP: monitoring tools

California Phenology Project: monitoring guide for Coyotebrush (*Baccharis pilularis*)



CPP site(s) where this species is monitored: Golden Gate National Recreation Area, Redwood National Park, Santa Monica Mountains National Recreation Area



Photo credit: stonebird (Flickr)

What does this species look like?

This shrub can be up to three meters tall. The leaves are toothed, oval, and sticky. The flowers are dioecious; meaning each plant has flowers with either all male parts or all female parts. The male flowers produce pollen and are yellowish, and the female flowers produce fruit and are white. The flower heads are shaped as round discs.

When monitoring this species, use the USA-NPN broadleaf evergreen (with pollen) datasheet.

Species facts!

- The CPP four letter code for this species is **BAPI**.
- A member of the sunflower family (Asteraceae).
- This species arrives as a secondary pioneer species after fire or grazing.
- *Baccharis* derives from the Greek word "bakkaris", referring to plants with fragrant roots, and *pilularis* refers to sticky globs on the flower buds.
- Native Americans used the heated leaves for swelling, and the wood to make arrow shafts and houses.
- This species is an important nectar source for wasps, flies, and butterflies.



Photo credit: Miguel Vieira (Flickr)

Where is this species found?

- Found in many habitats including coastal bluffs and oak woodlands.
- Found from 0 to 750 meters elevation, but occasionally up to 1500 meters.
- This species is occasionally found on serpentine soil.



Photo credit: KQED QUEST (Flickr)

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

California Phenology Project: monitoring guide for Coyotebrush (*Baccharis pilularis*)



Brian Haggerty

1. Breaking leaf buds

This phenophase can be difficult; remember, you can always circle? if you are unsure of what you are seeing!



Brian Haggerty

2. Young leaves

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



Crystal Anderson

3. Flowers

Flowers pictured to the left only have male parts and will not produce fruit. Flowers pictured to the right only have female parts and will produce fruit.



Crystal Anderson

4. Open flowers

Treat each cluster of small flowers as a unit when monitoring abundance!



Crystal Anderson

6. Fruits

The fruit is a tiny capsule having a tuft of white hairs, grouped in a seedhead, that changes from yellow-green to tan or light brown, and is blown from the plant



Steven Krause

7. Ripe fruits

The fruit is considered ripe when it is tan or light brown.

5. Pollen release (not pictured)

8. Recent fruit drop (not pictured)

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CPP: outreach and education



CPP: outreach and education



California Phenology Project (CPP)

The Science of the Seasons



A climate change initiative
at Joshua Tree National
Park



CPP: outreach and education

Species: Coast Live Oak (*Quercus agrifolia*)

Group Name: _____

Site: Lobos Dunes-Mountain Lake (LDML)

Subsite (#): _____

Phenophases



Young leaves: A leaf is considered young once the leaf stalk (petiole) or leaf base is visible, but before the leaf has reached full size or turned the darker green color of mature leaves on the plant.

Fresh flower: The flowers of the oak tree are pendulous strands of catkins (think of a strand of beads).

Fresh fruit: Look inbetween the leaf stalk and the main stem (the leaf armpit) to find *fresh* fruits developing.

Ripe fruit: The ripe fruits of the oak are acorns.

Plant Number _____

Do you see...? (Circle Y or N)

Young leaves **Y or N**
 Fresh flower **Y or N**
 Fresh fruit **Y or N**
 Ripe fruit **Y or N**

How many do you see?
 Less than 3 (<3); 3 to 10; More than 10 (>10)

Plant Number _____

Do you see...? (Circle Y or N)

Young leaves **Y or N**
 Fresh flower **Y or N**
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CPP: outreach and education

Phenology education materials available on the CPP website:

- Lesson plans for primary educators
- Activities for formal and informal education settings
- Undergraduate lecture series
- Readings and discussion questions for advanced undergraduate or graduate seminar in phenology

ETHNOPHENOLOGY

A hands-on nature exploration activity designed to engage participants in observing plant phenology while investigating how traditional cultures remedied health ailments with seasonally-available wild plants



"Ethnobotany" – the study of cultural uses of plants

"Phenology" – the study of seasonal plant and animal activities



Planting Memories: Santa Barbara Edition

A memory matching game filled with plants that grow in our own backyard



California Poppy Open Flower

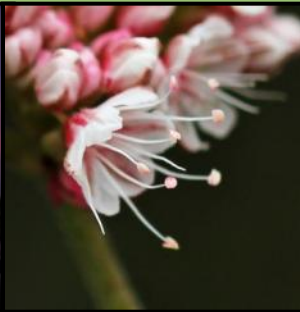
© Br. Alfred Brousseau, Saint Mary's College



California Poppy Buds

© Jo-Ann Ordano, California Academy of Sciences

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- *How can you get involved?*



California Phenology Project

- Recruit Citizen Scientists to observe plant phenology
- Develop new partnerships to fill spatial and ecological holes
 - University of California Natural Reserve System
 - California State Parks
 - Education partners
 - CNPS
- Continue testing new protocols to better capture phenological patterns of California plant taxa
 - Drought-deciduous plants
 - Annual plant monitoring
 - Community monitoring

California Phenology Project

www.usanpn.org/cpp

- List of CPP focal species
- Tools for monitoring: maps, monitoring guides, CPP species profiles, and more
- Includes a wide array of phenology education materials for formal and informal settings
- CPP documentation: scientific questions of interest, species-selection process, and more
- Calendar of upcoming CPP training events
- Instructions for joining the CPP listserv

The USA National Phenology Network

www.usanpn.org



- *Monitoring protocols*
- *300+ plant species*
- *160+ animal species*



Questions??

