

The California Phenology Project

Using phenology to detect plant responses to climate change

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Barbara

www.usanpn.org/cpp



TODAY'S WORKSHOP

- Introductions
- *9:00am- 12:00pm*-- presentation and hands-on practice monitoring plant phenology
- *12:00pm*– lunch break
- *1:00pm- 3:00pm*– wrap up the morning presentation, discussion, break-out groups and activity development, and Q & A



OUTLINE

- What is phenology? How is phenology related to climate and climate change?
 - Case studies
- California Phenology Project (CPP)
- USA National Phenology Network (USA-NPN)
- Nuts and bolts of phenological monitoring– *hands-on practice outside!*
- USA-NPN's *Nature's Notebook* online interface
- Discussion and Q&A



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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



Spring wildflowers



Foliage color change

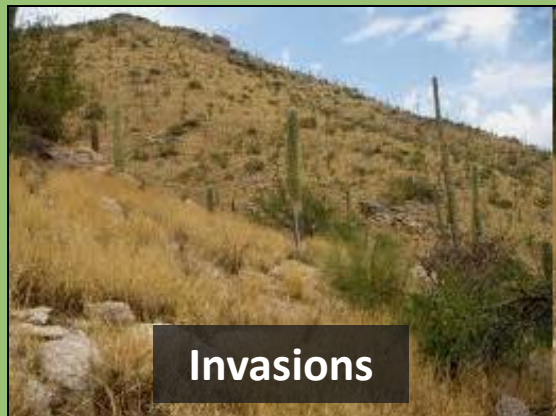


Migration patterns

Other examples?



Phenology: economic importance

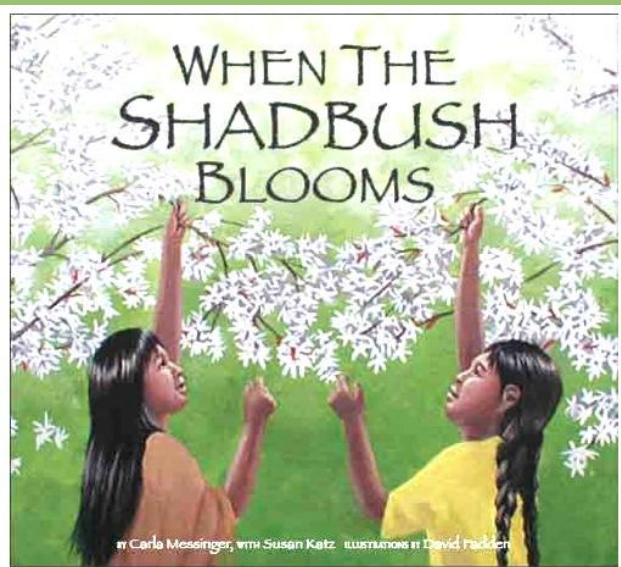


Timing and abundance are important



Phenological indicators used by fisherman:
plant phenophases can predict the best time to hunt

Fisherman on the east coast of Canada would not fish for shad (*Alosa sapidissima*) until after the shadbush (*Amelanchier* spp.) flowered.



Phenological indicators used by hunters:
plant phenophases can predict the best time to hunt

Okanagan indians used blooming of mock-orange
(*Philadelphus lewisii*) as an indicator that marmots
were fat and ready to hunt.



Gavin Davies

Turner et al., 1980. Ethnobotany of the Okanagan-Colville Indians of British Columbia and Washington. Occ. Pap. Brit. Col. Prov. Mus. No. 21., Ministry of Provincial Secretary and Government Services Provincial Secretary, Victoria, B.C.

Phenological indicators used by hunters:
plant phenophases can predict the best time to hunt

Comox indians use oceanspray (*Holodiscus discolor*)
flowering as an indicator of the best time to dig for butter
clams (*Saxidomus gigantea*)



Phenological indicators used by indigenous people: plant phenophases can predict harvest times of animals

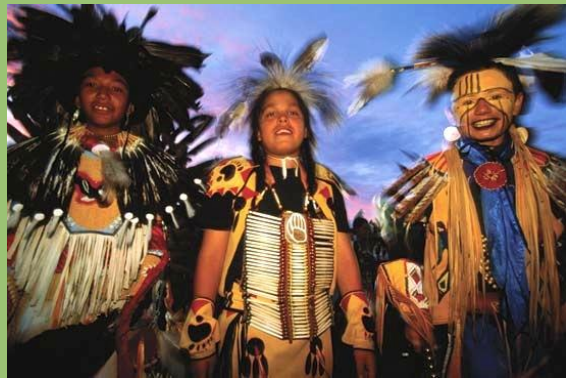
The Nuu-Chah-Nulth tribe of Vancouver Island used the ripening of salmonberries (*Rubus spectabilis*) to predict the return of adult sockeye salmon (*Oncorhynchus keta*) to freshwater.



Bouchard & Kennedy, 1990. Clayoquot Sound Indian Land Use. Report prepared for MacMillan Bloedel Ltd.
Peacock, S. L. 1992 Piikani Ethnobotany: Traditional Plant Knowledge of the Piikani Peoples of the Northwest Plains. MS thesis, University of Calgary.

Phenological indicators used by indigenous people: plant phenophases can predict harvest times of animals

The Blackfoot tribe of s. Alberta and Canada used the flowering of the buffalo bean (*Thermopsis rhombifolia*) to indicate that bison males (*Bison bison*) had eaten enough spring browse to be ready to hunt (their meat was sufficiently marbled with fat).



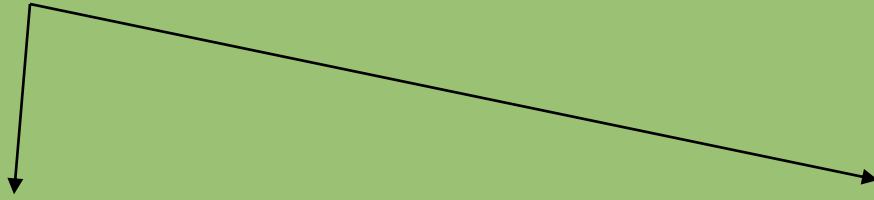
Phenological Indicators used by indigenous people: plant phenophases at one location can predict harvest times for plants at another location

The Tubatulabal tribe of Kern County (CA) used the ripening of coffeeberry fruits (*Rhamnus californica*) at low elevations to indicate that pinyon pine (*Pinus monophylla*) seeds in the mountains were ready to harvest.



Phenology: biological importance

Plants & animals are dynamic over the seasons



Vegetative phenology

Reproductive phenology

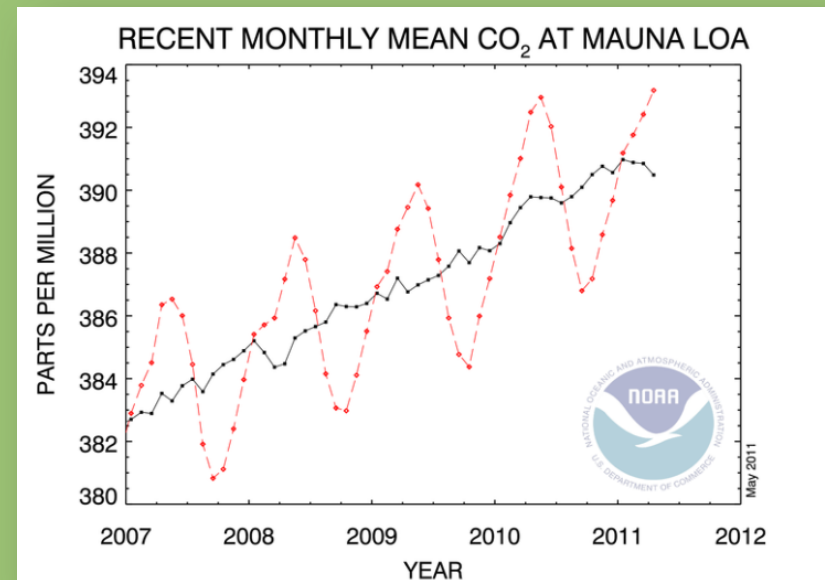


Phenology: biological importance

Plants & animals are dynamic over the seasons

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-cycle)



Phenology: biological importance

Plants & animals are dynamic over the seasons

Reproductive phenology:

- Plant reproduction depends on flowers → fruits
- Many flowers provide nectar & pollen for pollinators
- Many plants provide fruits & seeds for animals



Phenological patterns are important, economically and biologically



In your neck of the woods....

Can you provide an example of the biological, agricultural, or economic importance of phenology?

Are there ways in which phenology was important to your parents or grandparents but that we currently overlook?

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)



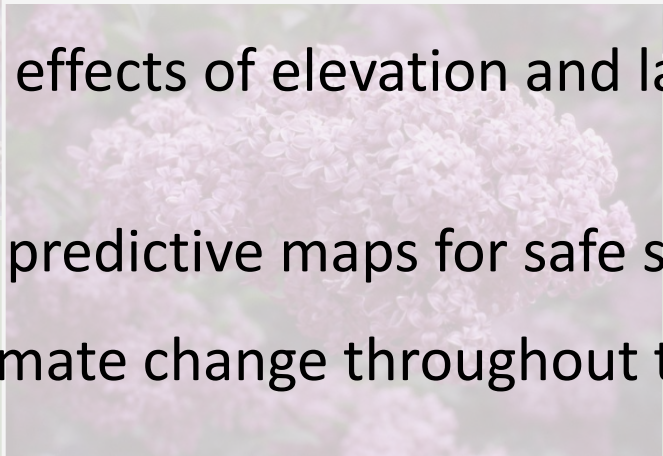
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Common Lilac Monitoring Nationwide

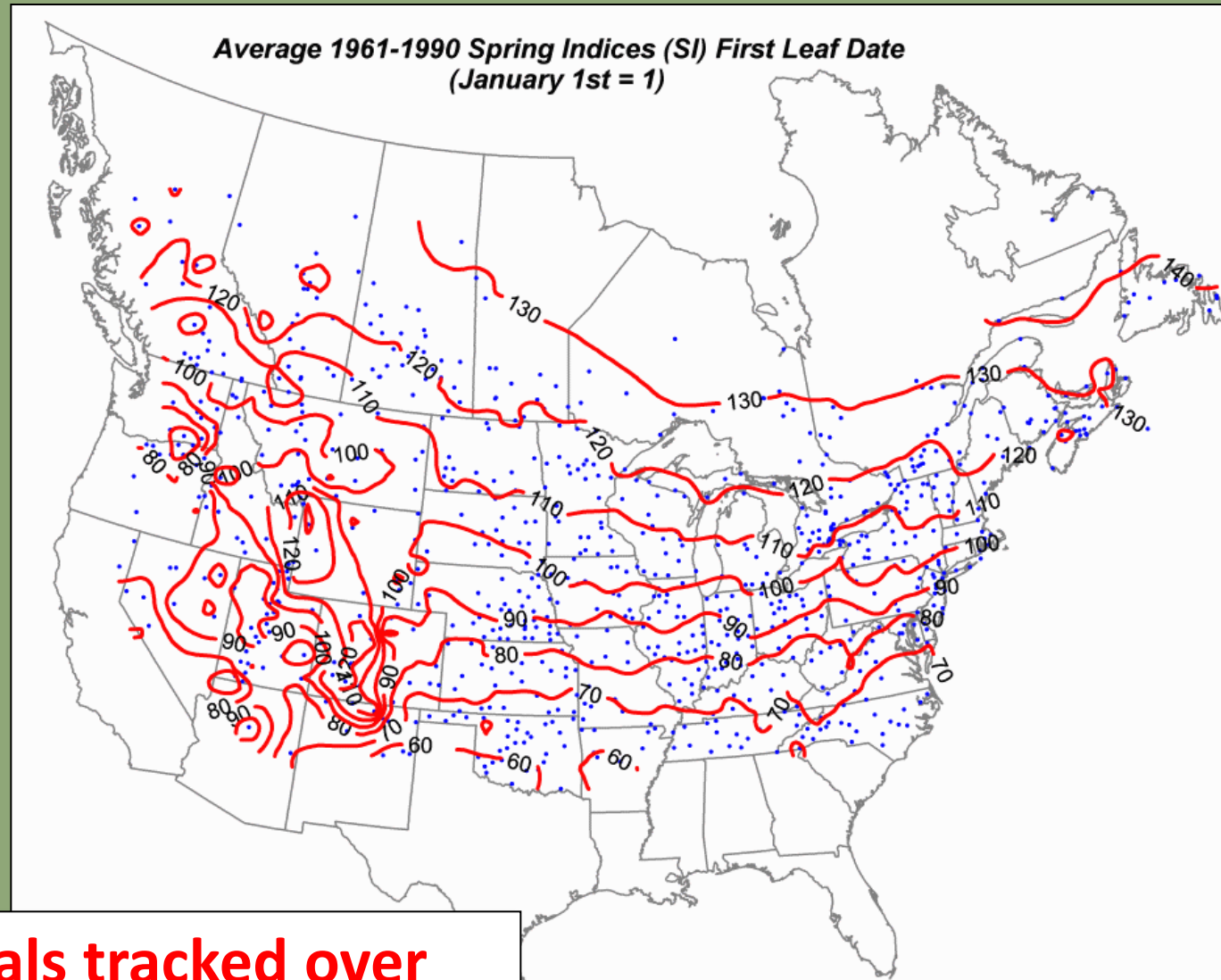
- The first phenological monitoring effort in the U.S.
- 1950's - 1990's: ~3500 private citizens monitored lilac plants in backyards and gardens
- Each year, they sent postcards reporting the date of first bloom to Professor Joe Caprio at Montana State Univ.
- First bloom dates of these lilacs have been used:
 - To show the effects of elevation and latitude on the onset of spring
 - To generate predictive maps for safe sowing dates
 - To assess climate change throughout the U.S.



Common Lilac Leaf Phenophases

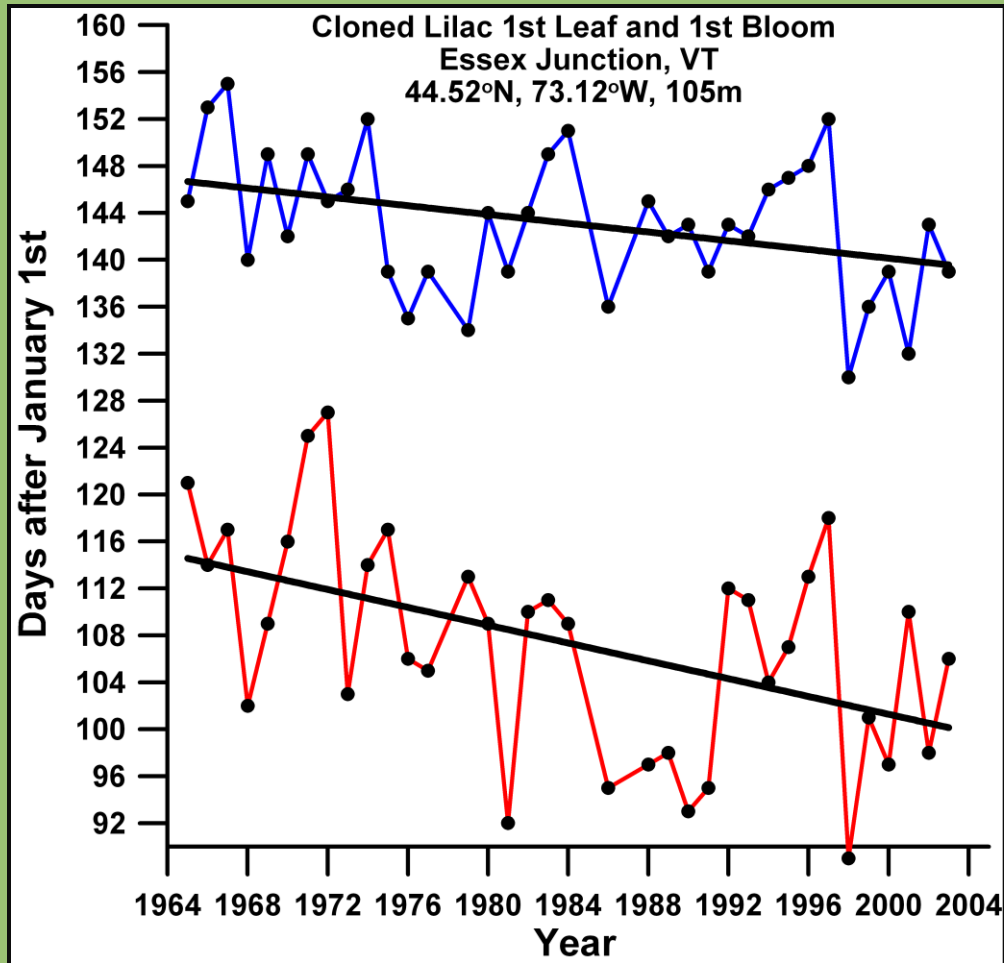


Common Lilac Monitoring Nationwide



Many individuals tracked over time... what about one individual?

Phenology is an indicator of environmental change



Phenology for one Lilac individual

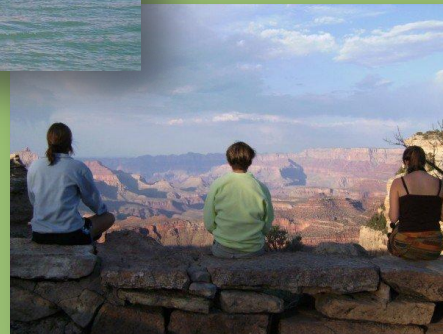
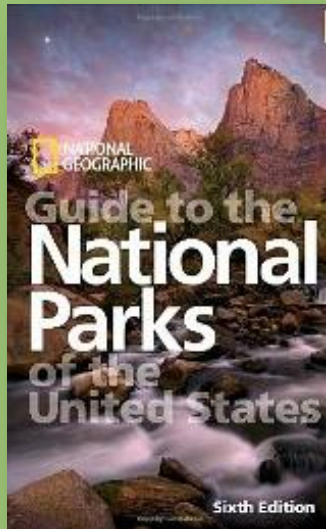
Date of first flower

Date of first leaf

Phenological events in this lilac have advanced as the climate has warmed

Phenology – Timing Affects Everything!

- *Species interactions*
- *Human activities*



“Phenological mismatches” may cause population crashes



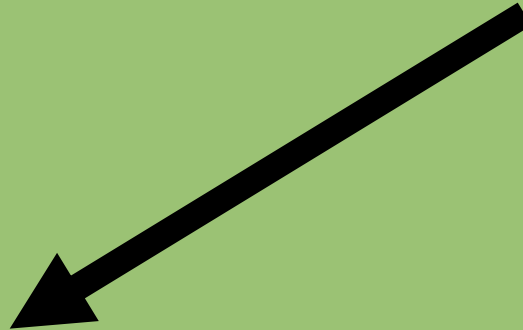
Leafing out earlier

English oak



Emerging earlier

Winter moth

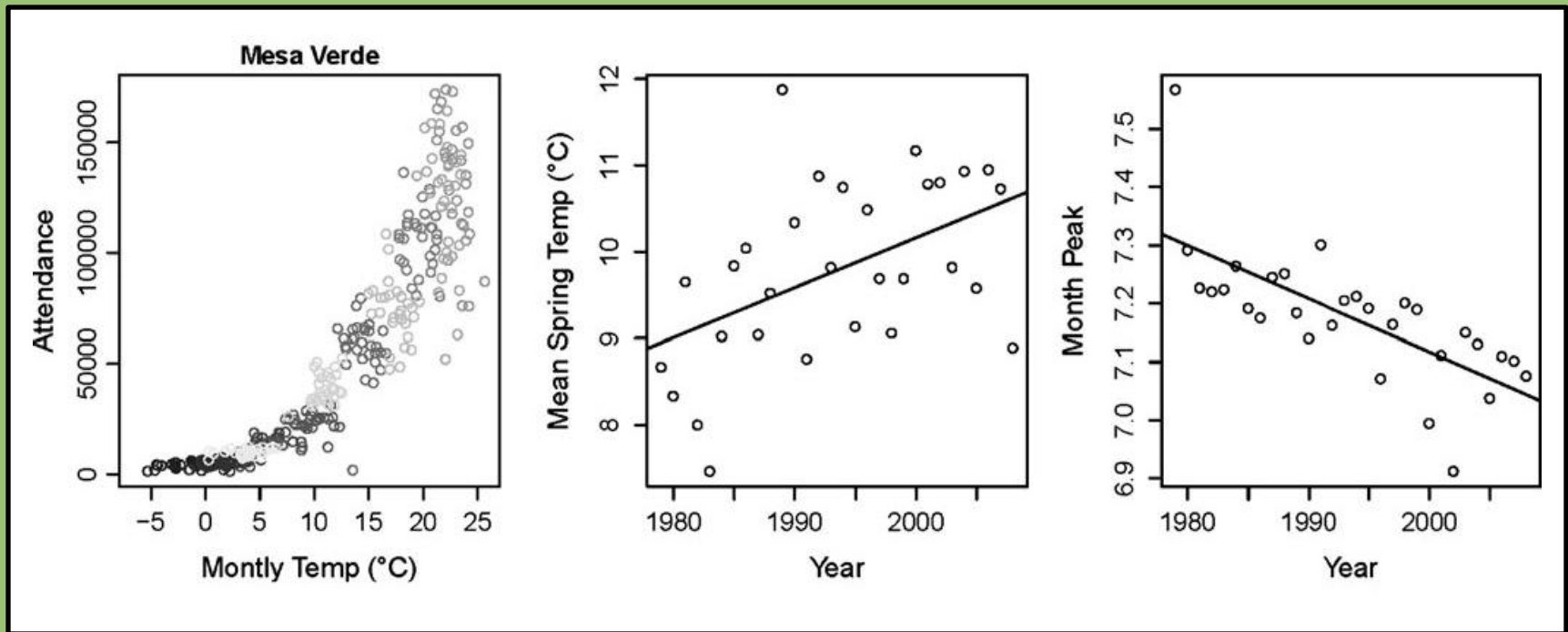


Pied flycatcher

Migrating the same time each year

Bird populations have declined by 90% where food for nestlings is peaking earlier in the season and the birds' arrival and breeding events are now mistimed.

Climate change may drive shifts in human behaviors



From 1979 to 2008, peak attendance at Mesa Verde National Park changed from July 10 to July 1 (the average shift was 4 days).

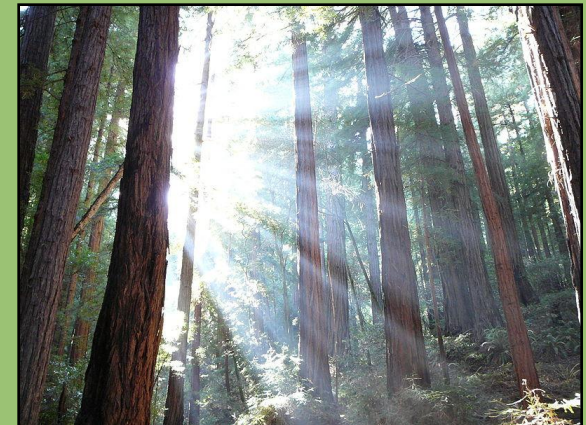
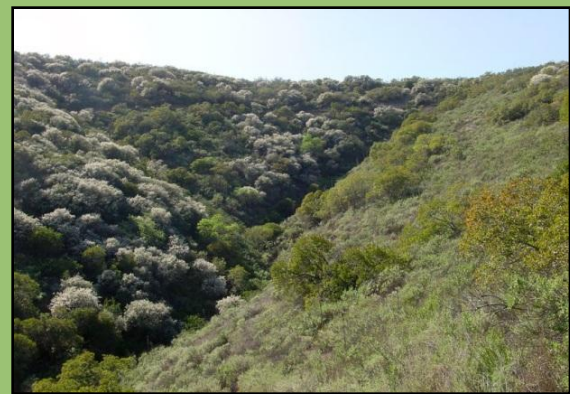
Of the nine national parks that have experienced significant temperature increases since 1979 (out of 27 examined), 78% exhibit shifts in the timing of peak abundance.

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California Phenology Project



California Phenology Project: Goals

establish a coordinated phenological monitoring network



monitor across a large geographic area and along key environmental gradients



allow the CPP and each park to:

- (1) address important scientific questions,**
- (2) guide resource management decisions, &**
- (3) educate people of all backgrounds & ages about phenology & climate change research**

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?



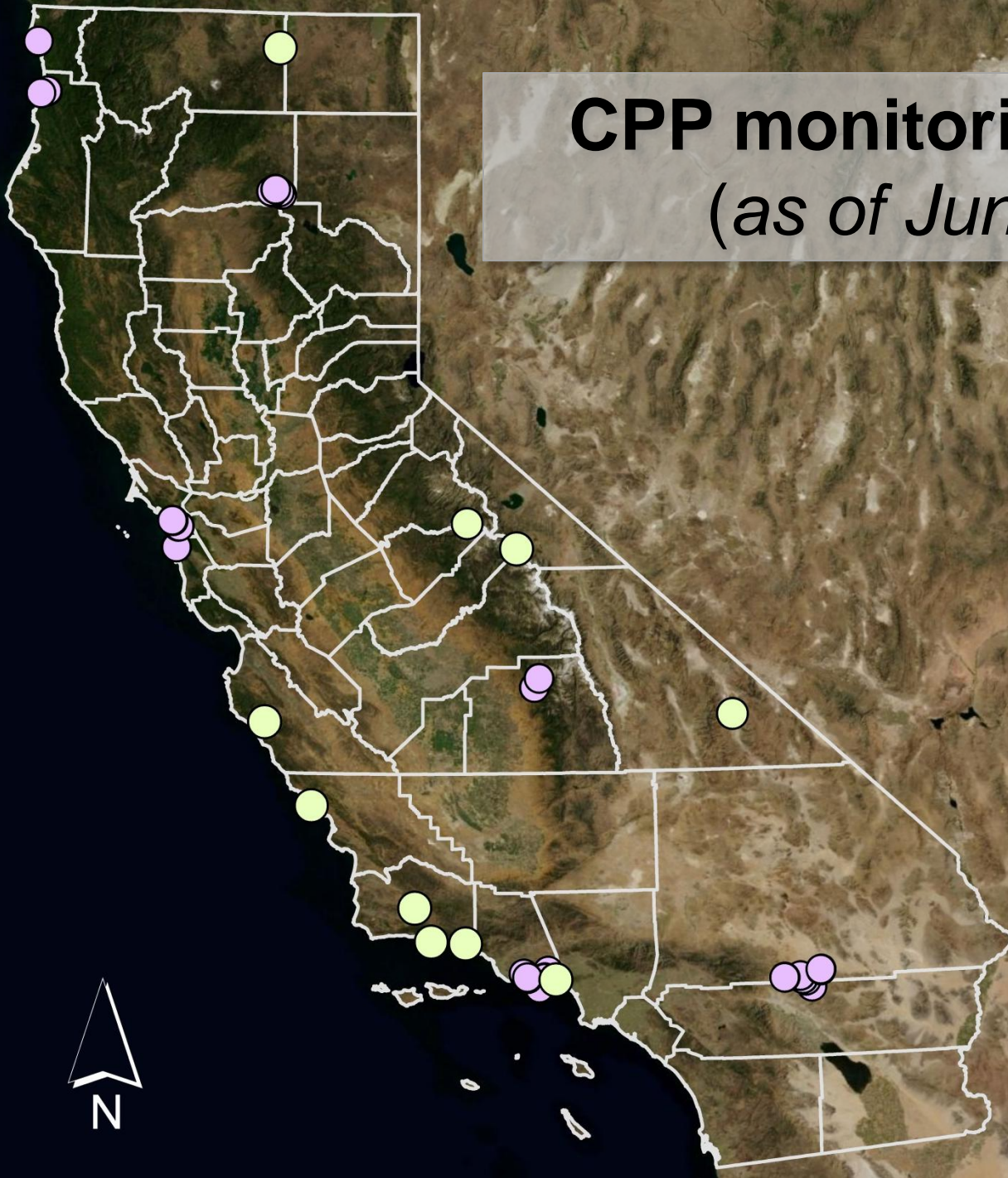
CPP: focal species


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 monitoring network (as of June 2012)



 *CPP plants monitored since March 2011*

 *CPP sites to be established 2012*

CPP in the National Parks



California Phenology Project

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

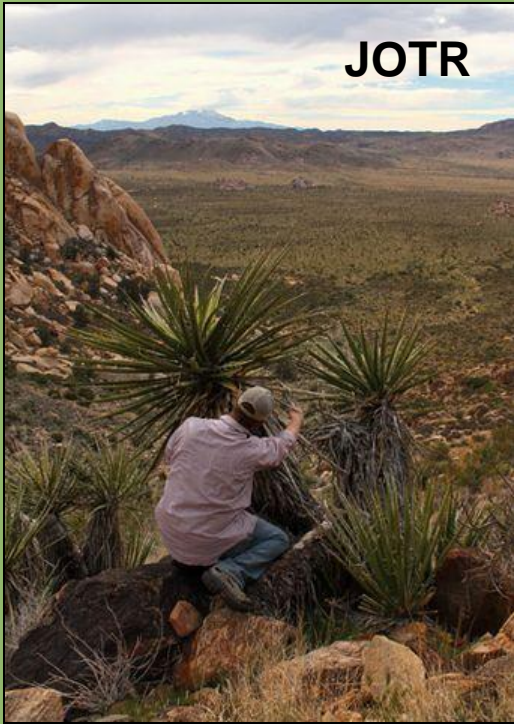


Monitoring by Citizen Scientists

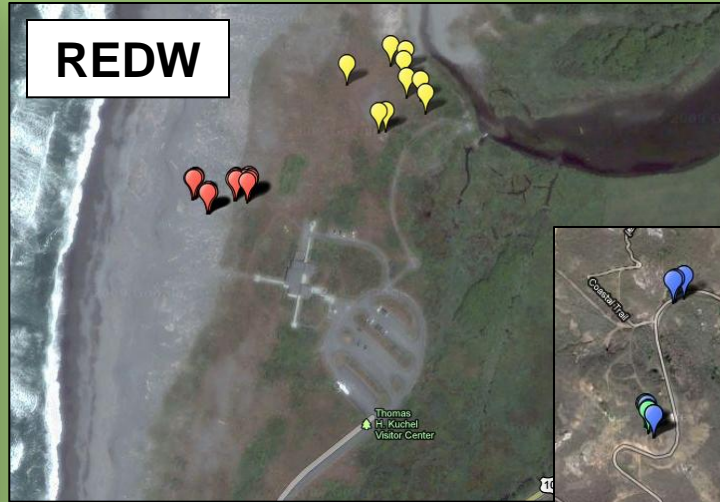
1. Visit and monitor labeled and mapped plants: each plant is visited frequently when it is phenologically active
(e.g., CPP plants in National Parks)
2. Visit and monitor labeled (unmapped) plants whenever it's convenient
(e.g., plants in a schoolyard)
3. Visit and monitor unlabeled plants whose location you're familiar with
(e.g., the big tree at the corner)
4. Visit and monitor unlabeled plants one time, or opportunistically
(e.g., plants you encounter while hiking the Pacific Crest Trail)

CPP: monitoring infrastructure

JOTR



REDW



GOGA



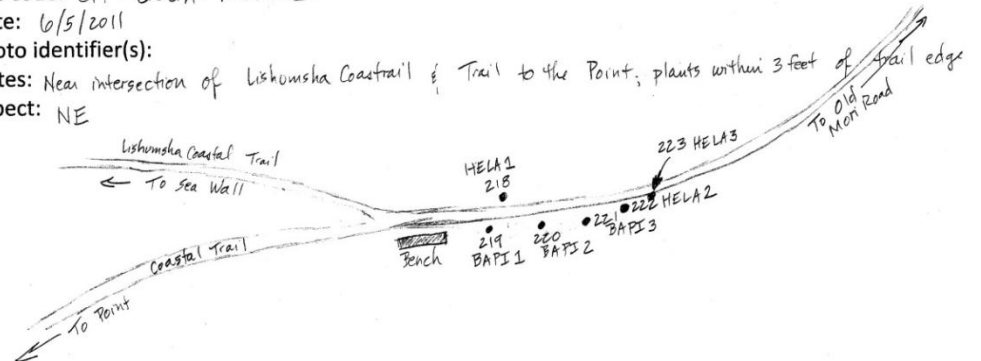
Site code: CPP-GOGA-MORI 2

Date: 6/5/2011

Photo identifier(s):

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

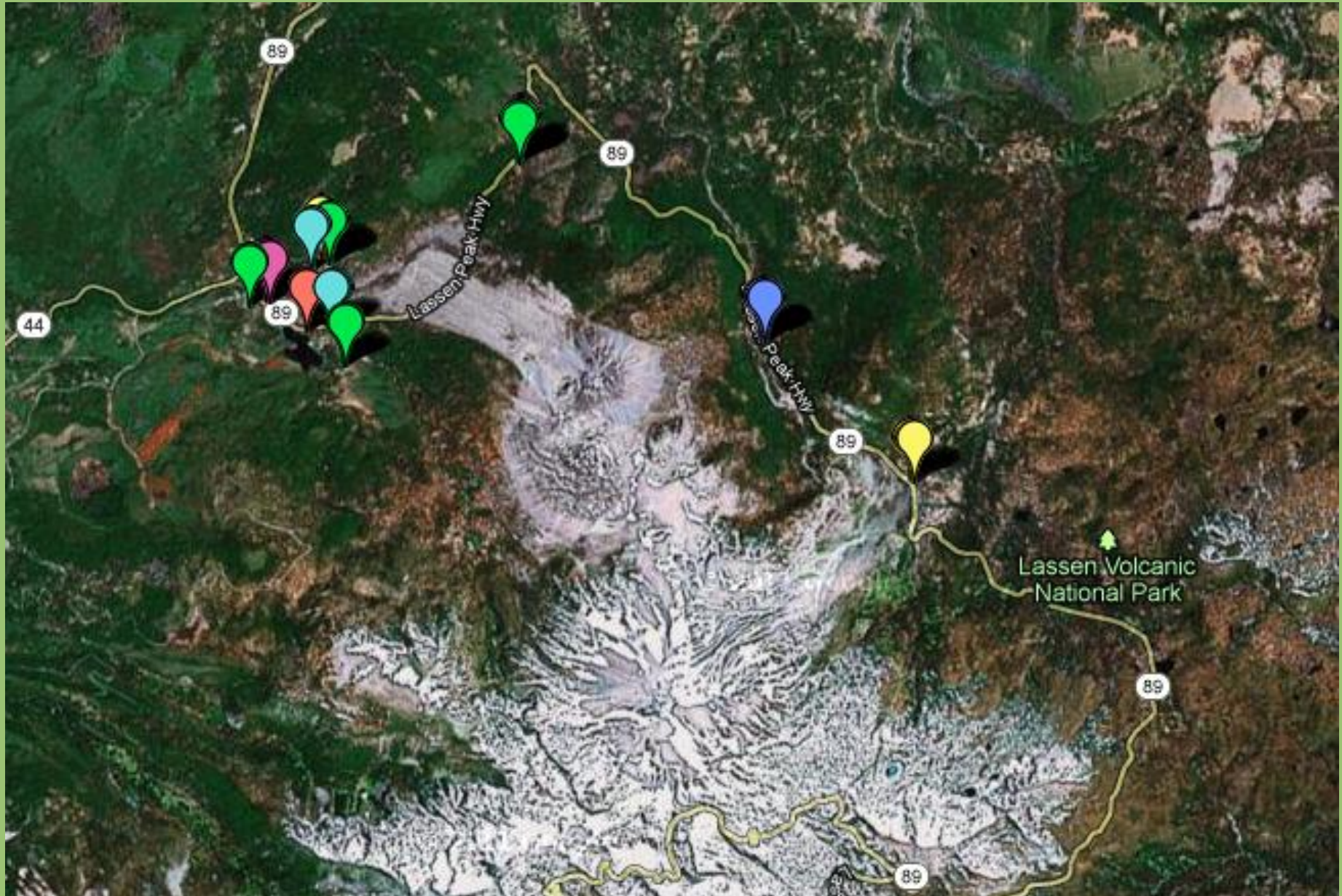
Aspect: NE



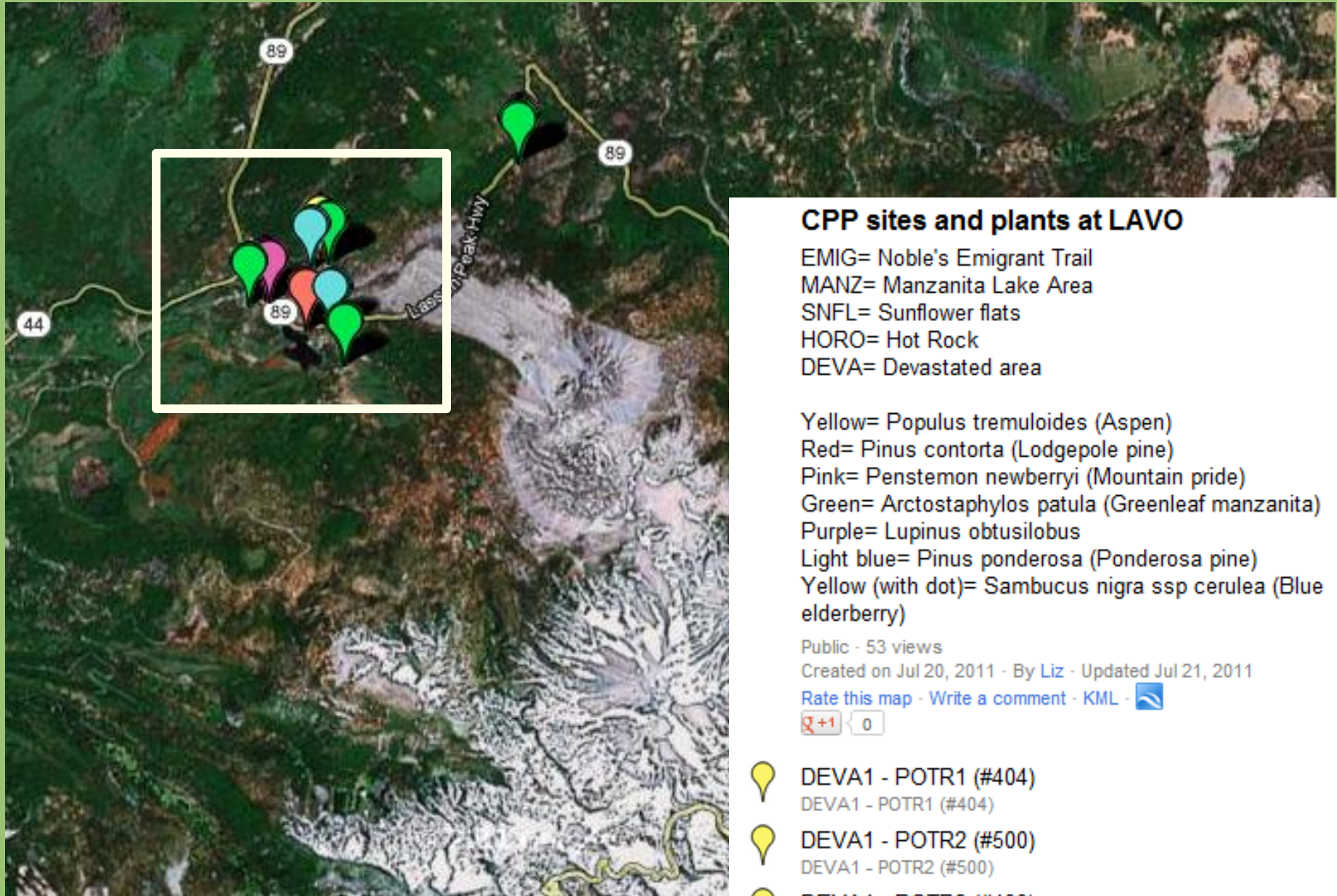
CPP: monitoring infrastructure



CPP: Google maps of CPP plants



CPP: Google maps of CPP plants



CPP sites and plants at LAVO

EMIG= Noble's Emigrant Trail
MANZ= Manzanita Lake Area
SNFL= Sunflower flats
HORO= Hot Rock
DEVA= Devastated area

Yellow= *Populus tremuloides* (Aspen)
Red= *Pinus contorta* (Lodgepole pine)
Pink= *Penstemon newberryi* (Mountain pride)
Green= *Arctostaphylos patula* (Greenleaf manzanita)
Purple= *Lupinus obtusilobus*
Light blue= *Pinus ponderosa* (Ponderosa pine)
Yellow (with dot)= *Sambucus nigra* ssp *cerulea* (Blue elderberry)

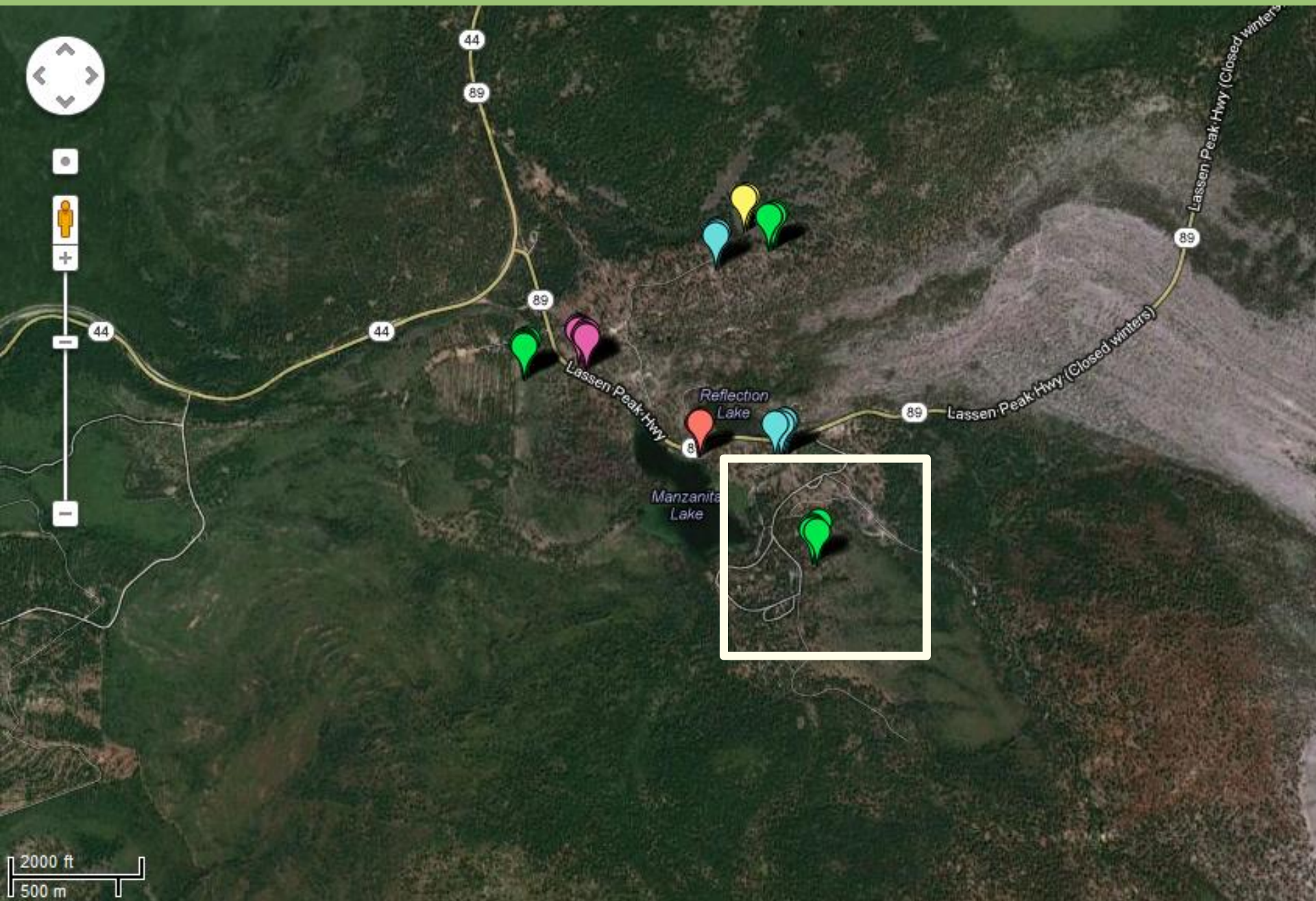
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Created on Jul 20, 2011 · By Liz · Updated Jul 21, 2011

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+1 0

- DEVA1 - POTR1 (#404)
DEVA1 - POTR1 (#404)
- DEVA1 - POTR2 (#500)
DEVA1 - POTR2 (#500)
- DEVA1 - POTR3 (#499)

LAVO: Manzanita Lake Monitoring Sites



LAVO: Manzanita Lake Monitoring Sites

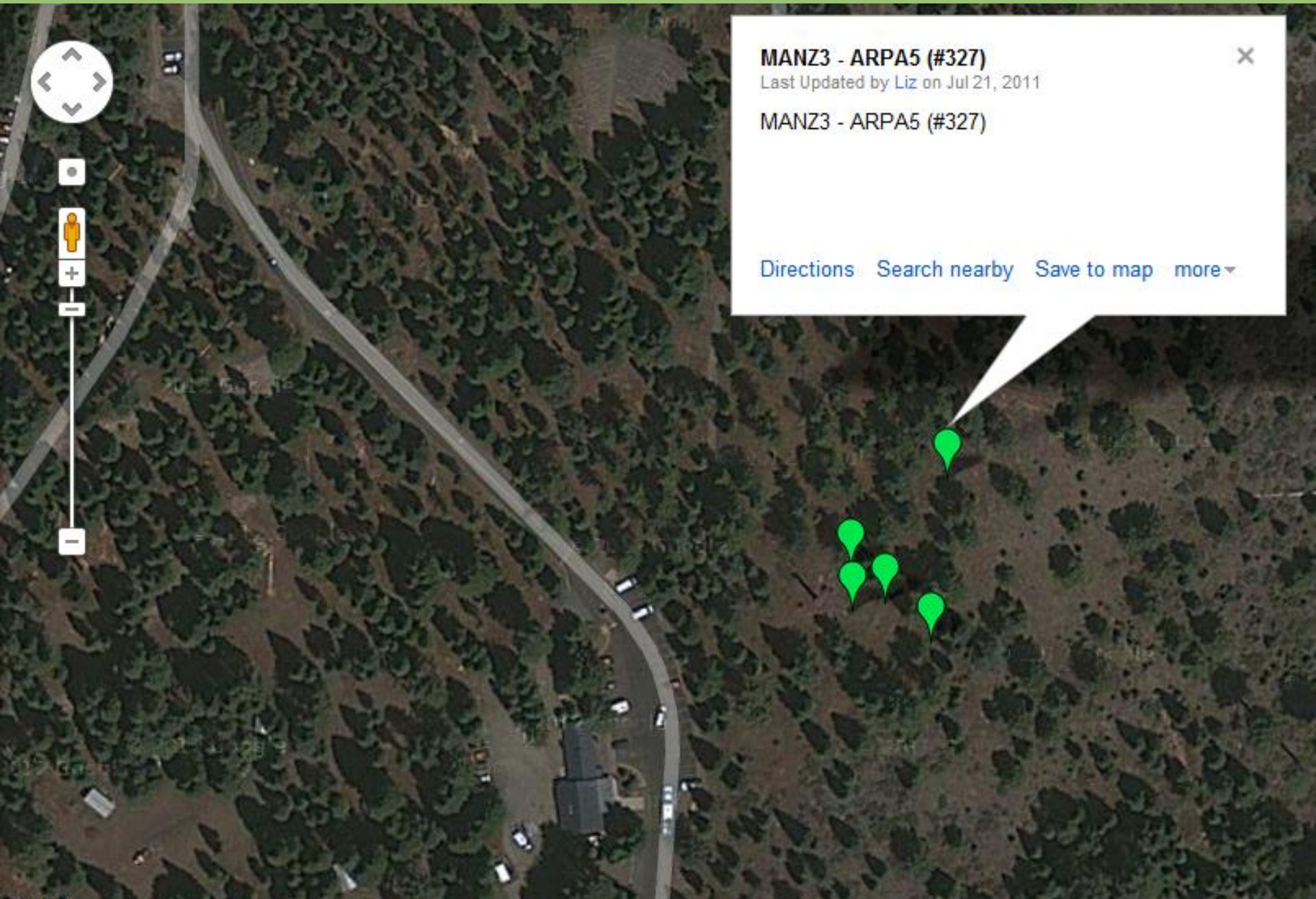


Manzanita
Lake



200 ft
100 m

LAVO: Manzanita Lake Monitoring Sites



MANZ3 - ARPA5 (#327)



Last Updated by Liz on Jul 21, 2011

MANZ3 - ARPA5 (#327)

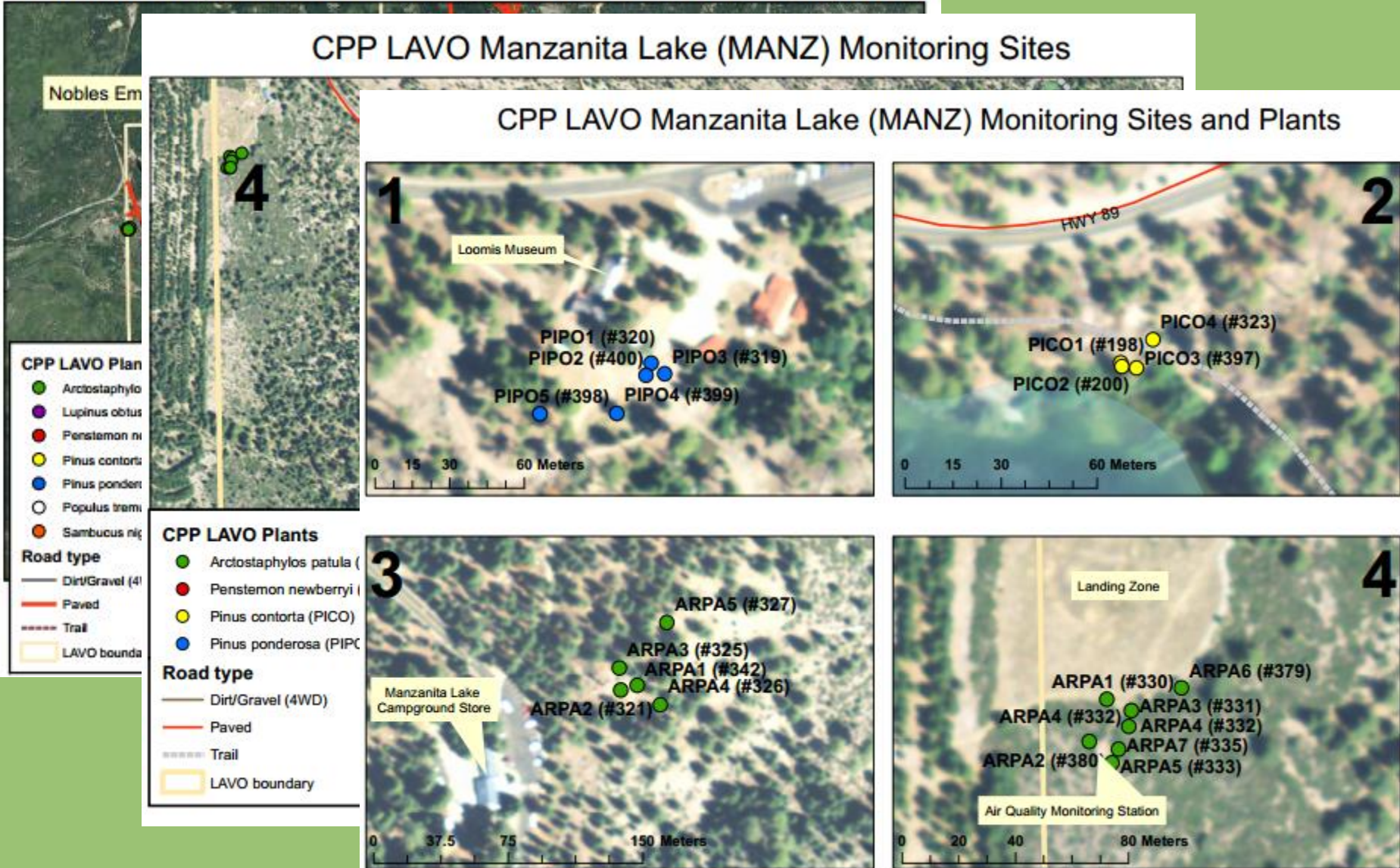
[Directions](#) [Search nearby](#) [Save to map](#) [more](#)

CPP: static maps

CPP Monitoring Locations at Lassen Volcanic National Park (LAVO)

CPP LAVO Manzanita Lake (MANZ) Monitoring Sites

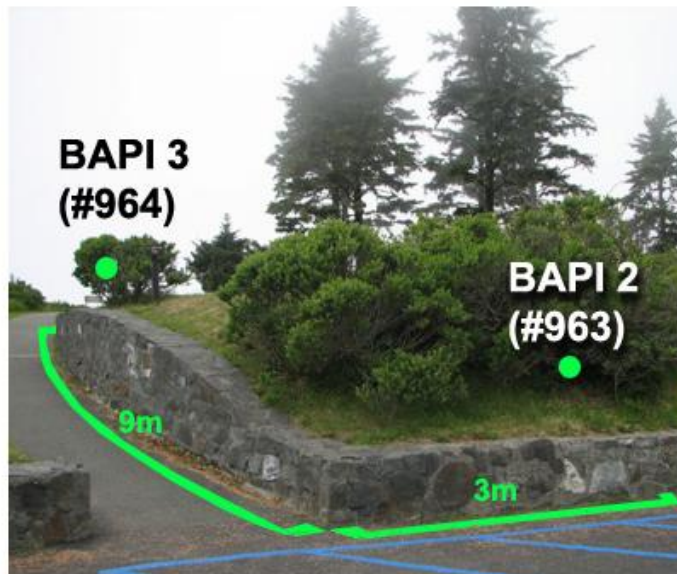
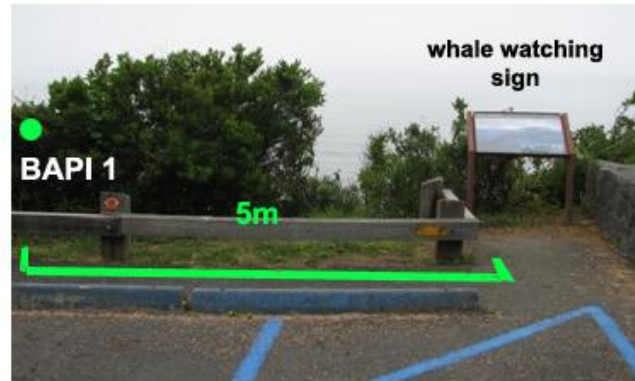
CPP LAVO Manzanita Lake (MANZ) Monitoring Sites and Plants



CPP: other monitoring tools

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

Coyote Brush (*Baccharis pilularis*) Crescent Beach Overlook



CPP: other monitoring tools

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)

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

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

Plant Number _____

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

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

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

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Ripe fruit	Y or N	_____

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

CPP: outreach and education



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

California Phenology Project

www.usanpn.org/cpp

- Tools for monitoring: maps, monitoring guides, species profiles, and more
- Includes a wide array of phenological education materials for formal and informal settings
- CPP documentation: scientific questions, species-selection process, and more
- Powerpoint presentations
- CPP *DRAFT* Interpreters' Guide
- ***Instructions for joining the CPP listserv***

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nature's notebook

a project of the USA-NPN



www.usanpn.org

- 300+ plant species
- 160+ animal species
- Core protocols

1 
Search plants & animals

2 
Learn how to observe

3 
Register yourself

4 
Start reporting

Using USA-NPN datasheets



Penstemon newberryi

Mountain Pride



Using USA-NPN datasheets



Penstemon newberryi Mountain Pride

Trees and Shrubs *Broadleaf evergreen (no leaf buds)*

Directions: Fill in the date and time in the top rows and circle the appropriate letter in the column below.

y (phenophase is occurring); **n** (phenophase is not occurring); **?** (not certain if the phenophase is occurring).

Do not circle anything if you did not check for the phenophase. In the adjacent blank, write in the appropriate measure of intensity or abundance for this phenophase.



Nickname: _____
 Species: mountain pride
 Site: _____
 Year: _____
 Observer: _____

	Date:	Date:	Date:	Date:	Date:	Date:	Date:
Do you see...	Time:	Time:	Time:	Time:	Time:	Time:	Time:
Young leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Flowers or flower buds	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Open flowers	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Ripe fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Recent fruit or seed drop	y n ? ____	y n ? ____	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"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments:

Using USA-NPN datasheets



Mountain Pride
(*Penstemon newberryi*)



Phenophase Definitions

Directions:

As you report on phenophase status (Y, N or ?) on the datasheets, refer to the definitions on this sheet to find out what you should look for, for each phenophase in each species. To report the intensity of the phenophase, choose the best answer to the question below the phenophase, if one is included. Feel free not to report on phenophases or intensity questions that seem too difficult or time-consuming.



Leaves

Young leaves

One or more young, unfolded leaves are visible on the plant. A leaf is considered "young" and "unfolded" once its entire length has emerged from the breaking bud so that the leaf stalk (petiole) or leaf base is visible at its point of attachment to the stem, but before the leaf has reached full size or turned the darker green color or tougher texture of mature leaves on the plant. Do not include fully dried or dead leaves.

How many young leaves are present?

Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000;

Flowers

Flowers or flower buds

One or more fresh open or unopened flowers or flower buds are visible on the plant. Include flower buds that are still developing, but do not include wilted or dried flowers.

How many flowers and flower buds are present? For species in which individual flowers are clustered in flower heads, spikes or catkins (inflorescences), simply estimate the number of flower heads, spikes or catkins and not the number of individual flowers.

Do you see...	Date: Time:	Date: Time:
Young leaves	y n ? ____	y n ? ____
Flowers or flower buds	y n ? ____	y n ? ____
Open flowers	y n ? ____	y n ? ____
Fruits	y n ? ____	y n ? ____
Ripe fruits	y n ? ____	y n ? ____
Recent fruit or seed drop	y n ? ____	y n ? ____
Check when data entered online:	<input type="checkbox"/>	<input type="checkbox"/>
Comments:		

CPP species profiles

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



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



Photo credit: Dan Allison (Flickr)

What does this species look like?

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

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

Species facts!

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



Photo credit: Mr.Stobbe (Flickr)

Where is this species found?

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



Photo credit: Gravitywave (Flickr)

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

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



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



CPP *Penstemon newberryi* at Lassen Volcanic National Park.



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



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



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



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

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

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

Using USA-NPN datasheets

Sambucus nigra Blue elderberry



Using USA-NPN datasheets

Sambucus nigra Blue elderberry



Trees and Shrubs *Deciduous*

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Do not circle anything if you did not check for the phenophase. In the adjacent blank, write in the appropriate measure of intensity or abundance for this phenophase.



Nickname: _____
Species: **black elderberry**
Site: _____
Year: _____
Observer: _____

	Date:	Date:	Date:	Date:	Date:	Date:	Date:
Do you see...	Time:	Time:	Time:	Time:	Time:	Time:	Time:
Breaking leaf buds	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Increasing leaf size	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Colored leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Falling leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Flowers or flower buds	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Open flowers	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Ripe fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Recent fruit or seed drop	y n ? ____	y n ? ____	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"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments:

Using USA-NPN datasheets



Black Elderberry

(*Sambucus nigra*)



Phenophase Definitions

Directions:

As you report on phenophase status (Y, N or ?) on the datasheets, refer to the definitions on this sheet to find out what you should look for, for each phenophase in each species. To report the intensity of the phenophase, choose the best answer to the question below the phenophase, if one is included. Feel free not to report on phenophases or intensity questions that seem too difficult or time-consuming.



Do you see...	Date:	Date:
	Time:	Time:
Breaking leaf buds	y n ? ____	y n ?
Leaves	y n ? ____	y n ?
Increasing leaf size	y n ? ____	y n ?
Colored leaves	y n ? ____	y n ?
Falling leaves	y n ? ____	y n ?
Flowers or flower buds	y n ? ____	y n ?
Open flowers	y n ? ____	y n ?
Fruits	y n ? ____	y n ?
Ripe fruits	y n ? ____	y n ?
Recent fruit or seed drop	y n ? ____	y n ?
Check when data entered online:	<input type="checkbox"/>	

Leaves

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 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000;

Leaves

One or more live, unfolded leaves are visible on the plant. A leaf is considered "unfolded" once its entire length has emerged from the breaking bud so that the leaf stalk (petiole) or leaf base is visible at its point of attachment to the stem. Do not include fully dried or dead leaves.

What percentage of the canopy is full with leaves? Ignore dead branches in your estimate.

Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more;

Increasing leaf size

CPP species profiles

California Phenology Project:
species profile for
Blue Elderberry
(*Sambucus nigra ssp. cerulea*)



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



Photo credit: flit (Flickr)

What does this species look like?

This deciduous shrub forms thickets with many branches and can have multiple trunks. It grows up to 8 meters tall. The leaves are subdivided into 5 to 9 leaflets with toothed edges. The small yellowish-white flowers are found in dense clusters. They are bisexual, having both male and female parts within each flower. The fruits are a dark blue berry displayed in clusters.

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

Species facts!

- The CPP four letter species code for this species is **SANI**.
- The fruit is used to make wine, jellies, candy, pies, and sauces.
- Its wood is used to make combs, spindles, mathematical instruments, blowguns, flutes, and whistles.
- The bark is used to make a dye, and its leaves are used as an insecticide and medicinally.
- Several parts of the plant, including its unripe fruit, contain a poisonous alkaloid and cyanogenic glycoside.



Photo credit: James Gaither (Flickr)

Where is this species found?

- Found in openings in moist forest habitat and moist areas within drier, open habitats
- Associated with riparian plant communities
- Grows best on loam or sandy loam soils.
- Most common at low to mid elevations.



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:
species profile for
Blue Elderberry
(*Sambucus nigra ssp. cerulea*)



Crystal Anderson

Breaking leaf buds



Crystal Anderson

Increasing leaf size



Forest & Kim Starr

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.



Liz Matthews

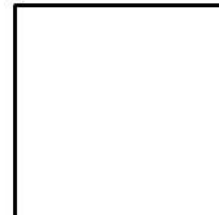
Fruits

The fruit is berry-like and changes from green to dark purple to black.



Brewbooks

Leaves



Colored leaves



Liz Matthews

Open flowers

Can you see stigmas and anthers? **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 or flower buds"



Liz Matthews

Ripe fruits

The fruit is ripe when it is dark purple to black

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

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

CPP: focal species

- 30 CPP species with profiles
<http://www.usanpn.org/cpp/meet-the-species>
- >100 USA-NPN plant species occur in CA
http://www.usanpn.org/species_search

The screenshot shows the USA NPN website interface. At the top left is the logo for USA NPN (National Phenology Network) with the tagline "Taking the Pulse of Our Planet". To the right is a "Log In" button. Below the logo is a navigation menu with links for ABOUT, PARTICIPATE, RESOURCES, EDUCATION, RESULTS, and ARCHIVE. A search bar labeled "Search Site" with a "search" button is also present. The main content area is titled "Search Plants & Animals to Observe" and includes a sidebar for "nature's notebook" (A project of the USA-NPN) with links like Overview, Observe Plants & Animals, etc. The search filters include: Sort by (Common Name), Name contains (text input), State (All States), Partner (All Partners), Plant type (All Species), Animal group (All Species), and Results to Display (radio buttons for 25, 50, 100, All). There are "search" and "Clear Filters" buttons. Two image galleries are shown: "All Species" and "Focal Species".

Benefits of monitoring CPP focal species



- species-specific monitoring tools, including species profiles, are available for download on the CPP website;

- new sites complement CPP data collected at the National Parks and UC Natural Reserves, which collectively contribute to our understanding of how CA taxa respond to environmental & climatic variation; and,



- benefit from the collective experiences of the CPP observer network, share your experiences monitoring CPP species, and mentor new CPP observers in your area.



Monitoring by Citizen Scientists

1. Visit and monitor labeled and mapped plants: each plant is visited frequently when it is phenologically active
(e.g., CPP plants in National Parks)
2. Visit and monitor labeled (unmapped) plants whenever it's convenient
(e.g., plants in a schoolyard)
3. Visit and monitor unlabeled plants whose location you're familiar with
(e.g., the big tree at the corner)
4. Visit and monitor unlabeled plants one time, or opportunistically
(e.g., plants you encounter while hiking the Pacific Crest Trail)

OUTLINE

- What is phenology? How is phenology related to climate and climate change?
 - Case studies
- California Phenology Project (CPP)
- USA National Phenology Network (USA-NPN)
- **Nuts and bolts of phenological monitoring– *hands-on practice outside!***
- USA-NPN's *Nature's Notebook* online interface
- Discussion and Q&A



Basic Botany Review

Vegetative structures

- Leaf buds
- Leaves & stems

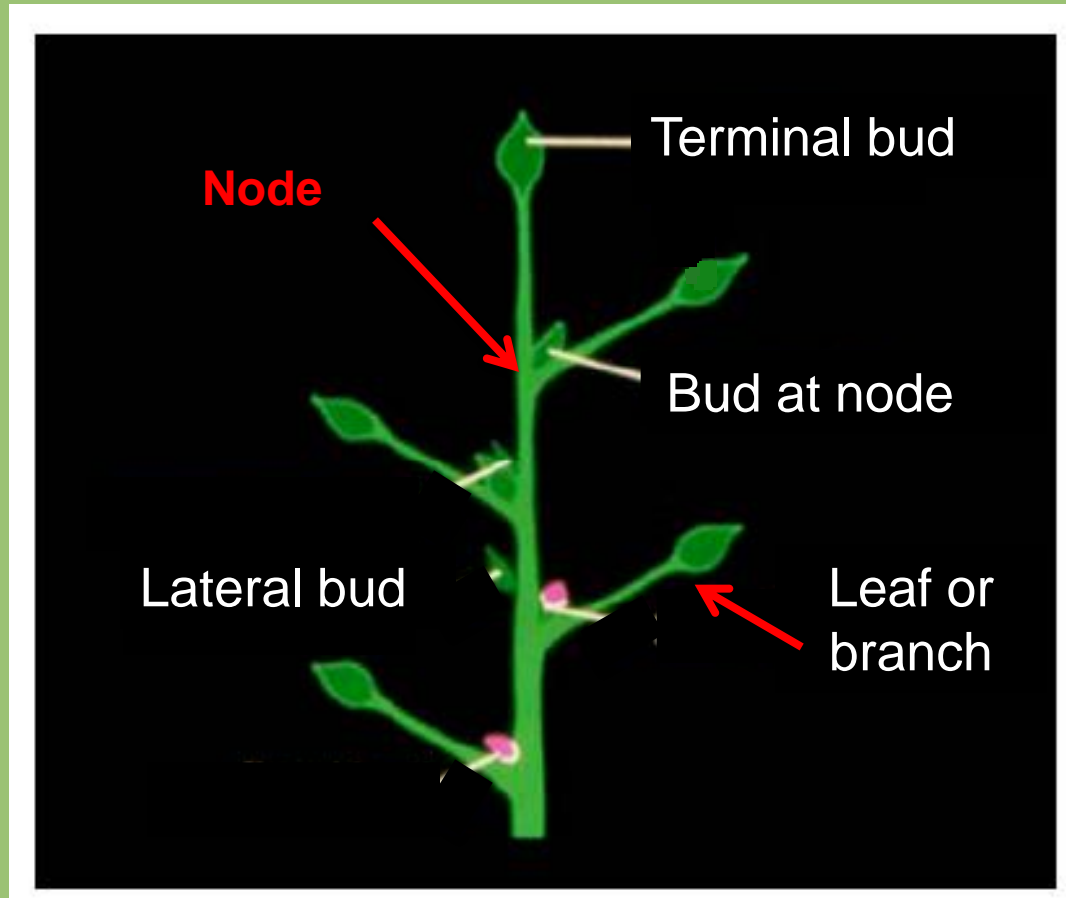
Reproductive structures

- Flower buds
- Flowers
- Fruits & seeds

Do you see...
Breaking leaf buds
Leaves
Increasing leaf size
Colored leaves
Falling leaves
Flowers or flower buds
Open flowers
Pollen release
Fruits
Ripe fruits
Recent fruit or seed drop

Pollination → Fertilization → Seeds & Fruits develop

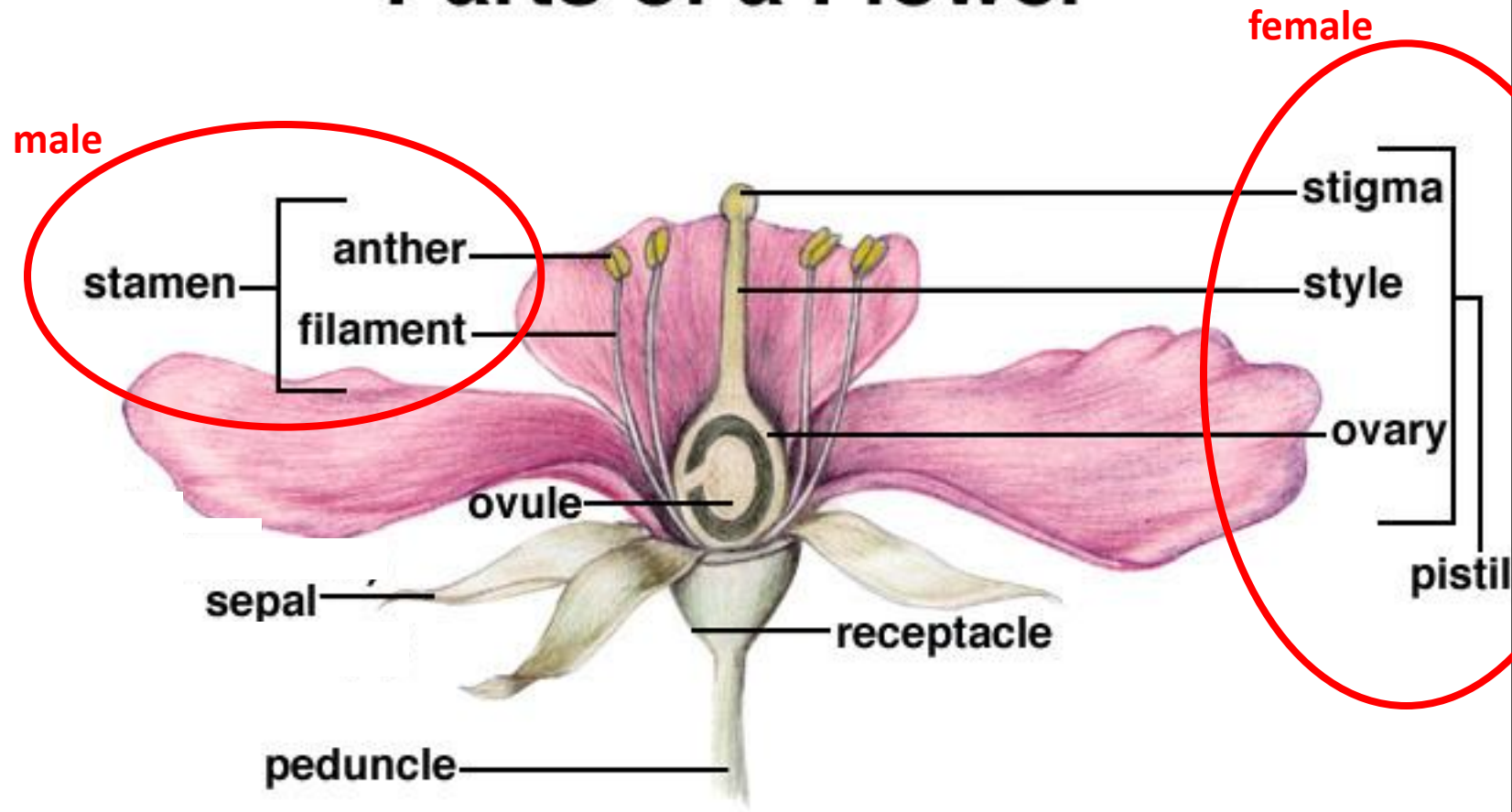
Basic Botany Review



Buds may be found in several locations relative to leaves and stems. Generally, leaves ALWAYS have a bud in their axil, even though it may be very small

Reproductive structures: flower buds, flowers, fruits & seeds

Parts of a Flower



Pollination & fertilization

Vegetative structures: breaking leaf buds, expanding leaves, and full-sized leaves

Common Lilac



Red Elderberry



Pacific Rhododendron



CPP: phenophase descriptions



Reproductive structures: flower buds, open flowers, and fruits

Joshua Tree



Red elderberry





Let's go observe!!



Mountain Pride-- *Penstemon newberryi*
Greenleaf Manzanita– *Arctostaphylos patula*
Satin Lupine– *Lupinus obtusilobus*
Ponderosa Pine– *Pinus ponderosa*
Lodgepole Pine– *Pinus contorta*
Quaking Aspen– *Populus tremuloides*

OUTLINE

- What is phenology? How is phenology related to climate and climate change?
 - Case studies
- California Phenology Project (CPP)
- USA National Phenology Network (USA-NPN)
- Nuts and bolts of phenological monitoring– *hands-on practice outside!*
- **USA-NPN's *Nature's Notebook* online interface**
- Discussion and Q&A



[Log In](#)[ABOUT](#)[PARTICIPATE](#)[RESOURCES](#)[EDUCATION](#)[RESULTS](#)[ARCHIVE](#)[search](#)

western columbine

[View All Species](#)

Join Us!

We are looking for volunteers to help us monitor plant and animal species found across the United States. Click "Nature's Notebook" to join us!



Visualization Tools



USA National Phenology Network

The USA National Phenology Network brings together citizen scientists, government agencies, non-profit groups, educators and students of all ages to monitor the impacts of climate change on plants and animals in the United States. The network harnesses the power of people and the Internet to collect and share information, providing researchers with far more data than they could collect alone.

[Learn more about us](#)[USA-NPN News](#)[Phenology Feed](#)[Join the Conversation](#)

- ▶ [Dynamic Visualizations Now Available](#)
- ▶ [Leaderboards See Top Observers & Top Species Observed](#)
- ▶ [Explore Local and Regional Phenology-Oriented Groups](#)
- ▶ [Live phenology data now available](#)
- ▶ [Phenology and USA-NPN highlighted in agency and White House reports](#)

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Featured Projects

[PLANTS PROJECT](#)

What is Phenology?

Phenology refers to recurring plant and animal life cycle stages, or phenophases, such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. [More.](#)

Geographic Affiliates



Explore local and regional phenology-oriented groups.

Top Observers This Week

1	Christopher@MN	328
2	nancy@OH	68
3	Kelly@KY	44
4	Jake@AZ	36
5	Greg@NC	30

[See all leaderboards.](#)[Are you...?](#)



Overview

Observe Plants & Animals

Rescue Historical Data

Share Existing Data

Join Email List

Partner your Organization

Learn About Other Efforts

[Home](#) > [Ways to Participate](#)

Ways to Participate

Observe Plants & Animals

Learn how to observe plant and animal phenology and sign up to contribute new observations to the USA-NPN's program Nature's Notebook.



T. Crimmins

Rescue Historical Data

The North American Bird Phenology Program currently houses six million cards which are being scanned and transcribed to a digital format by volunteers around the globe.

Find out more and get involved on the Bird Phenology Program's [website](#).



J. Zelt

Share your existing data

If you have recorded phenological data for plants or animals in past years, or have the records of someone who has, we would like to know about these data sets and make information about them available through our website.

- Get started on our [data set registry tool](#).
- You may also [contact us](#) with information about your data set.



R. Primack

[Overview](#)[Observer Resources](#)[Partner Resources](#)[Presentations](#)[Publications](#)[Upcoming Meetings](#)[Home](#) > [Resources](#)

Resources

Resources for Observers

Online training videos are available for observers.

Please also explore [How to Observe](#) and our [Frequently Asked Questions](#).



T. Crimmins

Resources for Partners

Outreach and training resources are available for people and organizations collaborating with the USA-NPN.



A. Miller-Rushing

Presentations and Podcasts

View and download USA-NPN powerpoint presentations and posters, as well as listen to podcasts & other recordings.



J. Weltzin

Publications

As part of the USA-NPN's mission to make phenology data and related information available,





Overview

Maps and Visualizations

Download Data

Access Historical Data

Share Existing Data

Publications

Reports

Home > Results

Results

Visualize and download contemporary data

- Explore dynamic [visualizations](#) of contemporary data
- [Download](#) contempory (2009-present) plant and animal phenology [observations](#)
- View static [map gallery](#)



Map of USA-NPN Observers

Access historical data sets

There are three ways to access phenology data sets through the USA-NPN:

- [View data sets](#) records submitted through the USA-NPN data set registry tool.
- [Use the USA-NPN Mercury Search Engine](#) This meta database contains information about phenology data sets, including the meta database previously housed at the University of Wisconsin-Milwaukee and metadata records extracted from the National Biological Information Infrastructure Metadata Clearinghouse.
- [View the National Climatic Data Center's Phenology Records](#) This resource includes a number of phenological and related information data sets available for downloading, including: 1) North American first leaf and first bloom lilac data from 1956-2003; 2) French records of grape-harvest dates in Burgundy used to reconstruct spring-summer temperatures from 1370 to 2003; 3) Winter half-year temperature reconstruction for the middle and lower reaches of the Yellow River and Yangtze River, China, during the past 2000 years; 4) Weighted annual means for the flowering of cherry and apple tree and budburst beech from plant phenological observations across a range of sites in Switzerland from 1702 to 2005; and 5) A 280-year composite series (includes a set of 14 different records) of the flowering of cherry trees from 1721-2000 in Switzerland.



M. Schwartz





[Home](#) » [User account](#)

User account

Username or e-mail address: *

You may login with either your assigned username or your e-mail address.

Password: *

The password field is case sensitive.



[Home](#) » [User account](#)

User account

Username or e-mail address: *

You may login with either your assigned username or your e-mail address.

Password: *

The password field is case sensitive.



[Home](#) > [User account](#) > [User account](#)

User account

Note: Please add to add nco@usanpn.org (the National Coordinating Office of the USA-NPN) to your email address book or whitelists so that our emails are not diverted by your spam filter.

Account information

Username: *

Please select a username that does not include punctuation (other than periods, hyphens, the @ symbol, and underscores). You may use your e-mail address as your username.

E-mail address: *

Your email address will not be publicly viewable or distributed outside USA-NPN.

Confirm e-mail address: *

Please re-type your e-mail address to confirm it is accurate.

Password: *

Confirm password: *

Please choose a password for your account; it must be at least 8 characters.



[Home](#) » [User account](#)

User account

Username or e-mail address: *

You may login with either your assigned username or your e-mail address.

Password: *

The password field is case sensitive.

- Home Nature's Notebook Home
- My Account
- Help
- Download My Data



Nature's Notebook Home

My Sites

My home
EX: CPP-JOTR-TRAIL1-SITE1

Edit Site

Add a New Site

My Plants & Animals

Add or Edit Plants

Add or Edit Animal Checklist

Details for this Organism



- [Nature's Notebook Home](#)
- [My Account](#)
- [Help](#)
- [Download My Data](#)



Nature's Notebook Home

My Sites

- My home
- EX: CPP-JOTR-TRAIL1-SITE1

-
-

My Plants & Animals

- creosote bush-1
- creosote bush-2
- creosote bush-3

-
-
-
-
-

Details for this Organism

creosote bush-1
 creosote bush (*Larrea tridentata*)
 Site: EX: CPP-JOTR-TRAIL1-SITE1
 Wild? Yes
 Shade? Mostly sun
 Watered? No
 Fertilized? No



-
-



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Nature's Notebook Home

My Sites

- My home
- EX: CPP-JOTR-TRAIL1-SITE1

-
-

My Plants & Animals

- creosote bush-1
- creosote bush-2
- creosote bush-3

-
-
-
-
-

Details for this Organism

creosote bush-1
creosote bush (*Larrea tridentata*)

Site: EX: CPP-JOTR-TRAIL1-SITE1

Wild? Yes

Shade? Mostly sun

Watered? No

Fertilized? No



-
-




Add or Edit Plants

Select the site where your plant is located. Site: [Need to add a new site? Click here.](#)

To add a plant, start typing the common or scientific name of a plant in the field marked "Plant Species". Select from the list of possible matches that will be displayed.

If you don't find a match,

- [View available plants](#)
- [View calibration species](#)


(Help: For more information on each option, hold your cursor over )


Your plants:


[Add new plant](#)

creosote bush-1
creosote bush-2
creosote bush-3


creosote bush-1

* Plant Species 

* Nickname 

Shade status 


Mostly sun

Wild? 

Yes

Watered? 

No

Fertilized? 

No

Planting date:

Month (MM):

Day (DD):

Year (YYYY):


Delete?

Dead?

Comments



Add or Edit Plants

Select the site where your plant is located. Site:  [Need to add a new site? Click here.](#)

To add a plant, start typing the common or scientific name of a plant in the field marked "Plant Species". Select from the list of possible matches that will be displayed.

If you don't find a match,

- [View available plants](#)
- [View calibration species](#)

(Help: For more information on each option, hold your cursor over )







Your plants:

[Add new plant](#)

creosote bush-1
creosote bush-2
creosote bush-3
honey mesquite-1

Your plants were successfully saved.





honey mesquite-1

* Plant Species 	<input type="text" value="honey mesquite"/>
* Nickname 	<input type="text" value="honey mesquite-1"/>
Shade status 	<input type="text" value="Full sun"/>
Wild? 	<input type="text" value="Yes"/>
Watered? 	<input type="text" value="Yes"/>
Fertilized? 	<input type="text" value="Unknown"/>
Planting date:	Month (MM): <input type="text"/>
	Day (DD): <input type="text"/>
	Year (YYYY): <input type="text"/>

Delete?

Dead?

Comments

-  Nature's Notebook Home
-  My Account
-  Help
-  Download My Data



Nature's Notebook Home

My Sites

- My home
- EX: CPP-JOTR-TRAIL1-SITE1

My Plants & Animals

- creosote bush-1
- creosote bush-2
- creosote bush-3
- honey mesquite-1

Details for this Organism

creosote bush-1
creosote bush (*Larrea tridentata*)
Site: EX: CPP-JOTR-TRAIL1-SITE1
Wild? Yes
Shade? Mostly sun
Watered? No
Fertilized? No






-  Nature's Notebook Home
-  My Account
-  Help
-  Download My Data



Enter Observations

To submit observations fill out the form below. For help, scroll over (i) icons and row headers. Click on each species name to expand the phenophase reporting section. After you finish reporting, you can collapse the section again. When you have completed the form, click "Submit observations." Submitted observations will show in blue, but maybe edited ([more info](#)).

For each phenophase listed, click:  if the phenophase was occurring;  if the phenophase was not occurring; or  if you were not certain of the species or occurrence of the phenophase. If you did not look for the phenophase, do not click anything.

Select the site where your plant is located. Site:

Review submitted observations:  3 columns   1 column 

Date	<input type="text" value="03/29/2011"/>	<input type="text"/>	<input type="text"/>
------	---	----------------------	----------------------

» Report your contribution of time

» Report your animal observation methods

» Report on snow

» creosote bush-1

» creosote bush-2

» creosote bush-3

» honey mesquite-1

Review submitted observations:  3 columns   1 column 

-  Nature's Notebook Home
-  My Account
-  Help
-  Download My Data



Enter Observations

To submit observations fill out the form below. For help, scroll over (i) icons and row headers. Click on each species name to expand the phenophase reporting section. After you finish reporting, you can collapse the section again. When you have completed the form, click "Submit observations." Submitted observations will show in blue, but maybe edited ([more info](#)).

For each phenophase listed, click: y if the phenophase was occurring; n if the phenophase was not occurring; or ? if you were not certain of the species or occurrence of the phenophase. If you did not look for the phenophase, do not click anything.

Select the site where your plant is located. Site: ▼

Review submitted observations: ◀ 3 columns ▶ ▶ 1 column ▶

Date	<input type="text" value="03/29/2011"/>	<input type="text"/>	<input type="text"/>
------	---	----------------------	----------------------

» Report your contribution of time

» Report your animal observation methods

» Report on snow

« creosote bush-1

	3/29/2011 Circle all no Delete	Circle all no Delete	Circle all no Delete
Do you see breaking leaf buds?	<input checked="" type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="Less than"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼
Do you see young leaves?	<input type="radio"/> y <input checked="" type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼
Do you see flowers?	<input type="radio"/> y <input checked="" type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼
Do you see open flowers?	<input type="radio"/> y <input checked="" type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼
Do you see fruits?	<input type="radio"/> y <input checked="" type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼
Do you see ripe fruits?	<input type="radio"/> y <input checked="" type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼
Do you see recent fruit drop?	<input type="radio"/> y <input checked="" type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼	<input type="radio"/> y <input type="radio"/> n ? <input type="radio"/> i <input type="text" value="What valu"/> ▼
Comments			

California Phenology

With funding from the California Change Response Initiative (CPP) was launched to develop and test projects for infrastructure to support and public education of the effort is how to and visitors in the phenological data.

The CPP is initially encompassing design programs of project support monitoring

Please explore our the CPP is currently [updates and upcoming](#)

Project collaborators Barbara (UCSB), and NPN). Visit our [cool](#) currently spearheaded



Using Nature's Notebook to Observe Phenology



Follow these steps to set up your observation program for plants and/or animals. More details can be found on the Nature's Notebook "How to Observe" page (www.usanpn.org/participate/observe).

1. Select a site to make phenology observations.

A site is the area within which you will look for your chosen animal species, and which encompasses any plants you choose to observe.

2. Select plant and/or animal species to observe.

Explore the list of USA-NPN recommended species at www.usanpn.org/species_search.

Tips for observing plants and animals:

Plants: Observe the same individual plants each time you visit your site. For example, you would observe the same red maple tree in your backyard all through the year.

Animals: Create a checklist of animal species and look for them each time you visit your site. For example, if your checklist included robins, wood frogs, and tent caterpillars, you would record whether you saw or heard each of those species anywhere in your site each time you visited.

3. Register yourself with Nature's Notebook.

Create an account with Nature's Notebook. All you need is a valid email account.

4. Register your site.

Using the online mapping tool, the address of your site, or latitude and longitude, create and describe your site in Nature's Notebook.

5. Register your plants and/or animals.

If you are observing plants, register your individual plants with Nature's Notebook. If you are observing animals, create an Animal Checklist on Nature's Notebook.

6. Record your observations of plants and/or animals.

Using datasheets that you download from Nature's Notebook, record the following for each of your species:

- **Yes (Y)** – if you saw that the phenophase (e.g., open flowers or mating) *is* occurring
- **No (N)** – if you saw that the phenophase *is not* occurring
- **Uncertain (?)** – if you were not certain whether the phenophase was occurring, or if you did not check for the phenophase

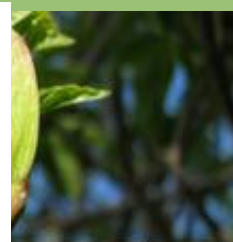
7. Report your data in Nature's Notebook online.

As you collect data during the season, log in to Nature's Notebook and enter the observations you recorded.

Key Resources:

- Nature's Notebook "How to Observe" page - www.usanpn.org/participate/observe
- Frequently Asked Questions page - www.usanpn.org/participate/faq
- Training Videos - www.usanpn.org/participate/guidelines

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more about the USA-
:12 protocol updates

ad the CPP [Fall](#)
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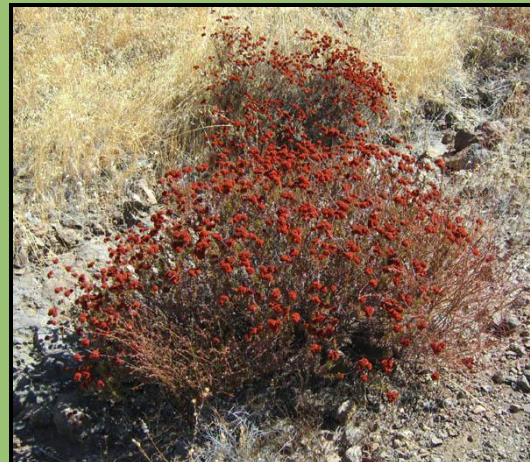
OUTLINE

- What is phenology? How is phenology related to climate and climate change?
 - Case studies
- California Phenology Project (CPP)
- USA National Phenology Network (USA-NPN)
- Nuts and bolts of phenological monitoring– *hands-on practice outside!*
- USA-NPN's *Nature's Notebook* online interface
- Discussion and Q&A



Discussion and Q&A

- Logistics of implementing phenological monitoring at natural areas (e.g., establish monitoring sites, label plants, & record important field information)
- How to get involved in the CPP, as an educator, scientist, student, or natural area representative
- Developing educational and interpretive activities around phenological monitoring



- What is being done at Lassen Volcanic NP to respond to the Call to Action
- Do you have internet access anywhere in the park?
Access to a smartphone or tablet?
- Are there any joint activities or programs between resources and education/interpretation at Lassen?



Developing an interpretive activity on phenological monitoring

- **Participants who are interested in developing an informal interpretive activity (in which students or park visitors would participate) will break up into two groups of ~3 people**
- **Each group will have a draft interpretive guide from the CPP website that provides ideas for how to introduce the study of phenology in outdoor settings**
- **Each group should use the guide to design and to practice an introduction to phenology and an activity.**
- **Each group has 30 minutes to present a ~10 minute presentation to one half of the rest of the group (who will be doing their own activity)**
- **Each group will present the same presentation to the other half of the rest of the group (with a different leader presenting)**

Alternative models for monitoring: what works where?

- **Frequent monitoring at a given location: labeled plants, multiple species, multiple individual plants/species (the CPP model at national parks)**
- **Make your own phenology trail (at a school, city park, library)**
- **Monitoring an individual plant in your backyard or schoolyard**
- **Monitoring a special individual plant that you've always noticed at your workplace**
- **Monitoring unlabeled plants on a hike (or multiple hikes)**
- **Other alternatives?**