Phenological responses to climatic variation among California native plants: inter-annual and spatial patterns detected by the California Phenology Project (CPP)

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www.usanpn.org/cpp

USA npn National Phenology Network

NATIONAL PARK SERVICE

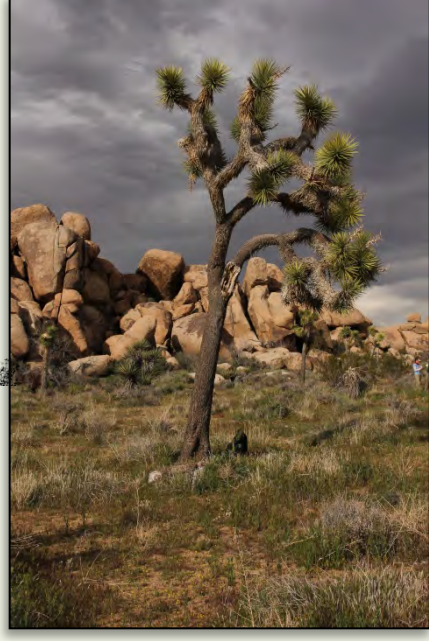
UCSB Phenology Stewardship Program

Natural Reserve System
UNIVERSITY OF CALIFORNIA

CPP:
Statewide phenological monitoring program to track the effects of local climate and climate change on the seasonal cycles of wild plant species

CALIFORNIA PHENOLOGY PROJECT

Connect with the seasons



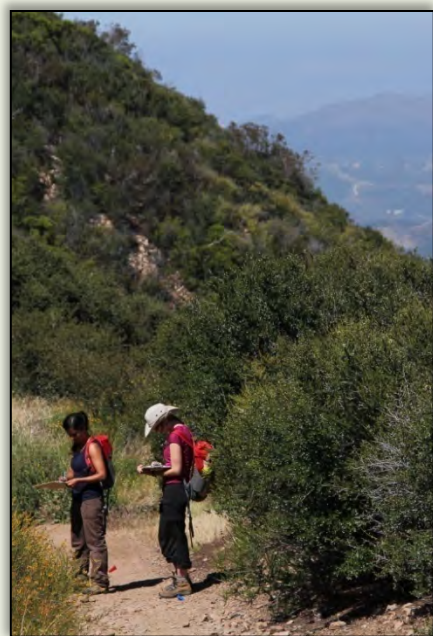
Scientific goals:

Establish a phenological monitoring network in 7 pilot parks (and at UC Reserves, botanic gardens, etc.) using standardized protocols

Cover a large geographic area

Sample across environmental gradients

Assess the effects of climatic conditions on the seasonal cycles of California taxa to predict responses to future climate change



CALIFORNIA
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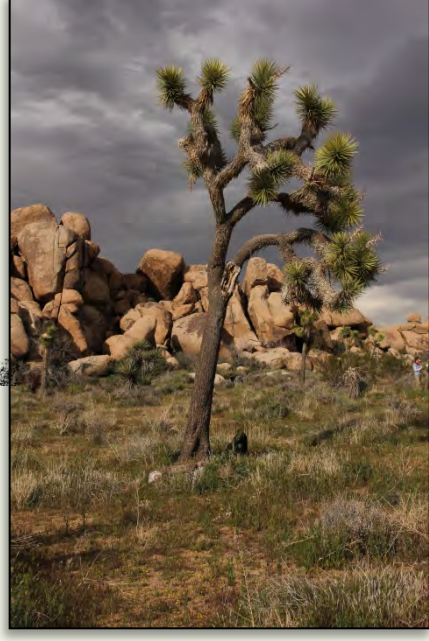


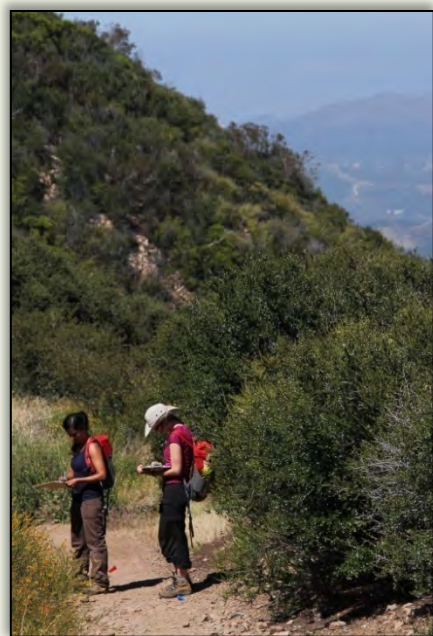
Public service:

Guide resource management decisions

Educate park visitors

Prepare the public to observe and to interpret changes in the landscape

Engage citizen scientists in genuine research



CPP
CALIFORNIA PHENOLOGY PROJECT

About | Meet the Species | Phenology in the Parks | Education | Participate | Resources | News

California Phenology Project

www.usanpn.org/cpp

With funding from the National Park Service (NPS) Climate Change Response Program, the **California Phenology Project (CPP)** was launched in 2010 as a 3-year 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. A primary focus of the effort is how to recruit and engage California residents and visitors in the collection and interpretation of phenological data.

The CPP is initially focusing on **plants** in **seven pilot parks,** encompassing desert, coastal and mountain biomes, and building upon existing monitoring protocols and programs of project collaborators. In addition, new project products and infrastructure are being designed to support monitoring and educational activities for 18 California NPS units and parks in adjacent states.

Please explore our website to learn more about phenology, the origin and current activities of the CPP, where the CPP is currently monitoring plant phenology, and how to become involved. Also visit the **news tab for recent updates and upcoming events.**

Project collaborators include the National Park Service (NPS), the University of California, Santa Barbara (UCSB), and the National Coordinating Office of the **USA National Phenology Network (USA-NPN)**.

Visit our **cooperators and points of contact** page **to contact us directly** or to learn more about the project partners who are currently spearheading this effort.

USGS science for a changing world | USA npn National Phenology Network | UCSB Phenology Stewardship Program | UCSB

Recent news

Check out new videos about CPP efforts at Lassen Volcanic NP (video) and John Muir NHS (video).

Download the DRAFT ***CPP Interpretive Guide!***

Join us at a CPP workshop near you

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Navigation

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Vital stats in a nutshell

- 30 species monitored in 7 national parks
- 8 species monitored in multiple parks
- > 950 tagged monitored individuals
- > 763,000 observation records (2011-2014)
  - CPP observations account for ~20% of observations submitted to the USA-NPN database from 2010-2014
  - With three years of data, can detect associations between phenological onset dates and seasonal rainfall and monthly minimum temperature.






The California Phenology Project: 7 pilot parks

NPS heroes:

Angie Evenden
Stassia Samuels
Allison Forestal
Will Elder
Fernando Villalba
Sylvia Haultain
Denise Robertson
Christy Brigham
Josh Hoines

Seasonal interns, contractors and volunteers

CPP species profiles: Coyotebrush

Download from the CPP website: www.usanpn.org/cpp

California Phenology Project: species profile 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. Coyotebrush is dioecious, meaning that each plant either produces flowers with only male parts or with only female parts. The male flowers produce yellow pollen and appear yellowish from a distance, and the female flowers produce fruit and are white. The flower heads appear round and disc-like.

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

Species facts!

- The CPP four letter code for this species is **BAPI**.
- BAPI is 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 to reduce swelling, and the wood to make arrow shafts and houses.
- This species is an important nectar source for wasps, flies, and butterflies.

Insect gall (note: do not confuse galls for flower buds on this species!)

Photo credit: Jess Gambel

Photo credit: Jerry Kirkhart (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.

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 Coyotebrush (*Baccharis pilularis*)

Brian Haggerty

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

Crystal Anderson

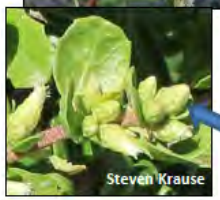
The flowers pictured to the left have only male parts (anthers) and will not produce fruit.

Crystal Anderson

The flowers pictured to the right have only female parts and will produce fruit. Each flower may produce a single seed.

Miguel Viera

Flowers or flower buds
When monitoring flower and 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.



Steven Krause

BAPI flower buds; Do not mistake for a gall (pictured on the front)

Steven Krause

Open flowers
Can you see the anthers or stigma? **Proportion of *open flowers*** *should be recorded at the scale of individual flowers, not inflorescences (i.e. count individual flowers)!*

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

Crystal Anderson

Fruits
The fruit is a tiny, one-seeded capsule tipped with a tuft of white hairs. Fruits are grouped in a seed head and change from yellow-green to tan or light brown as they ripen. When fully dry, the fruits are blown from the plant.

Steven Krause

Ripe fruits
The fruit is considered ripe when it is tan or light brown.
***Note:** fruit phenophases are nested; if you record Y for "ripe fruits" you should also record Y to "fruits"*

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

Using NPN datasheets

Download from the CPP website: www.usanpn.org/cpp

Baccharis pilularis
Coyotebrush

Trees and Shrubs
Broadleaf evergreen (with pollen, no leaf buds)

nature's notebook

Species: Baccharis pilularis
Common Name: coyotebrush
Nickname: _____
Site: _____
Year: _____
Observer: _____

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.

Do you see...	Date: / Time:	Date: / Time:	Date: / Time:	Date: / Time:	Date: / Time:	Date: / Time:	Date: / Time:	Date: / Time:
Young leaves	y n ? ____	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 ? ____	y n ? ____
Open flowers	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Pollen release	y n ? ____	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 ? ____	y n ? ____
Ripe fruits	y n ? ____	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 ? ____	y n ? ____
Check when data entered online	☐	☐	☐	☐	☐	☐	☐	☐

How do local conditions (monthly temperature and rainfall) preceding leafing and flowering affect the onset date (DOY) of these phenophases?

Example: Effects of May temperature on the onset of late summer flowering of coyotebrush

Baccharis pilularis sites monitored by the CPP (2011-2013)

Redwood NP

Pepperwood Preserve

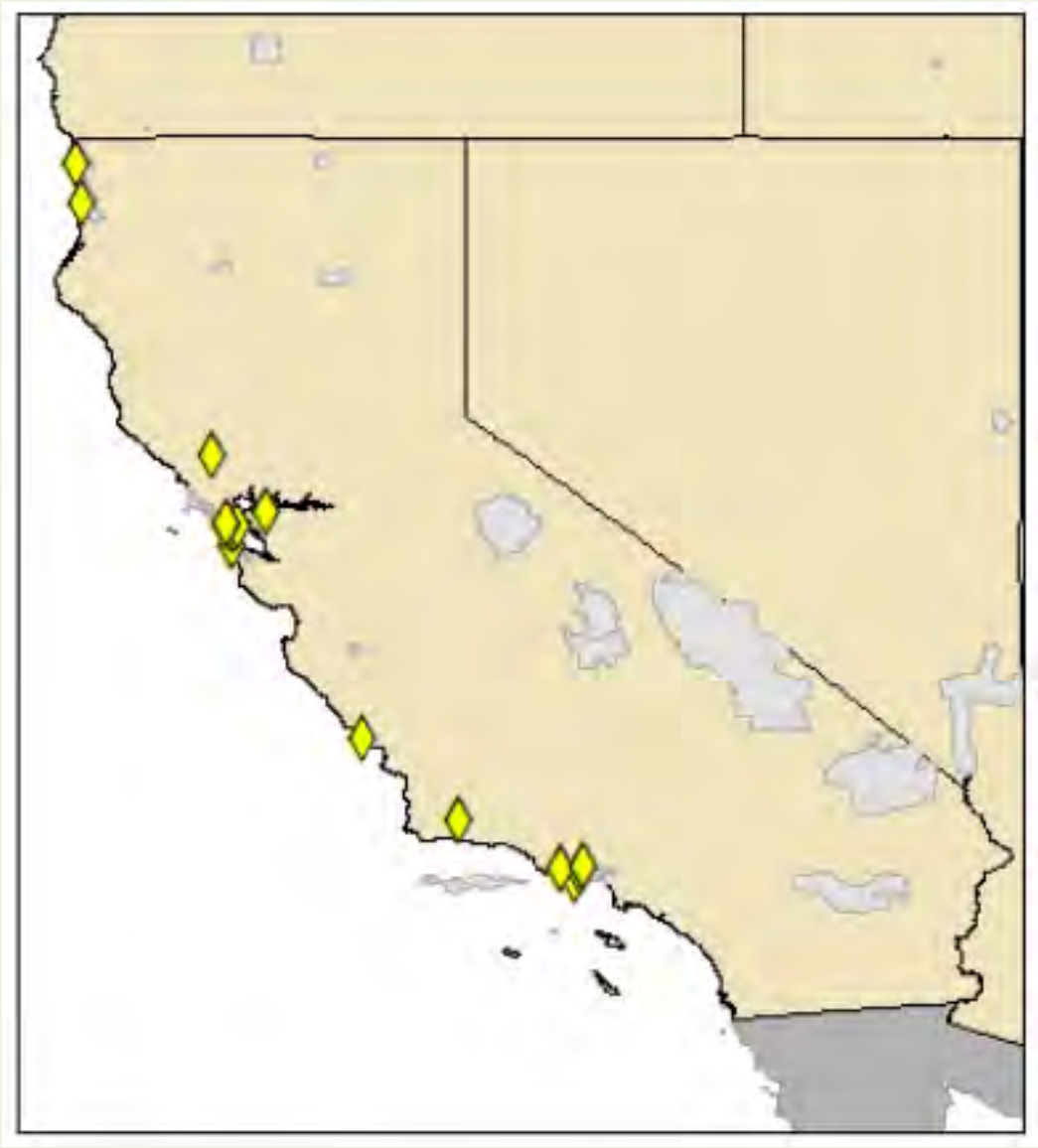
Golden Gate

John Muir NHS

Rancho Marino NR

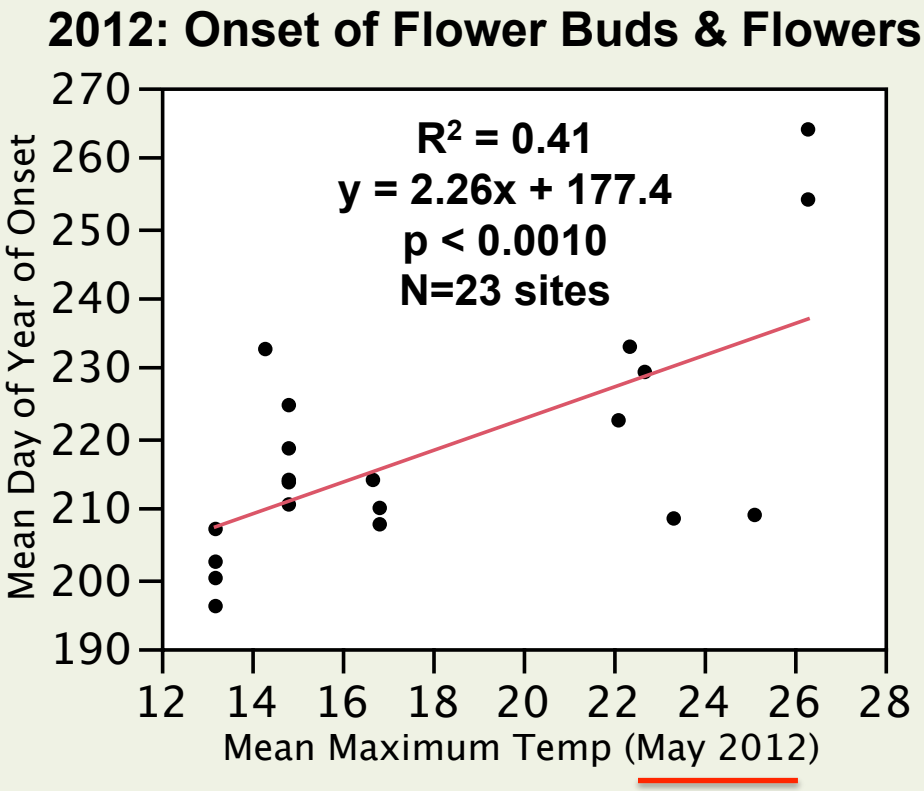
Coal Oil Point

Santa Monica Mtns NRA



Baccharis pilularis: **Across California**, points are site means (1-9 plants/site).

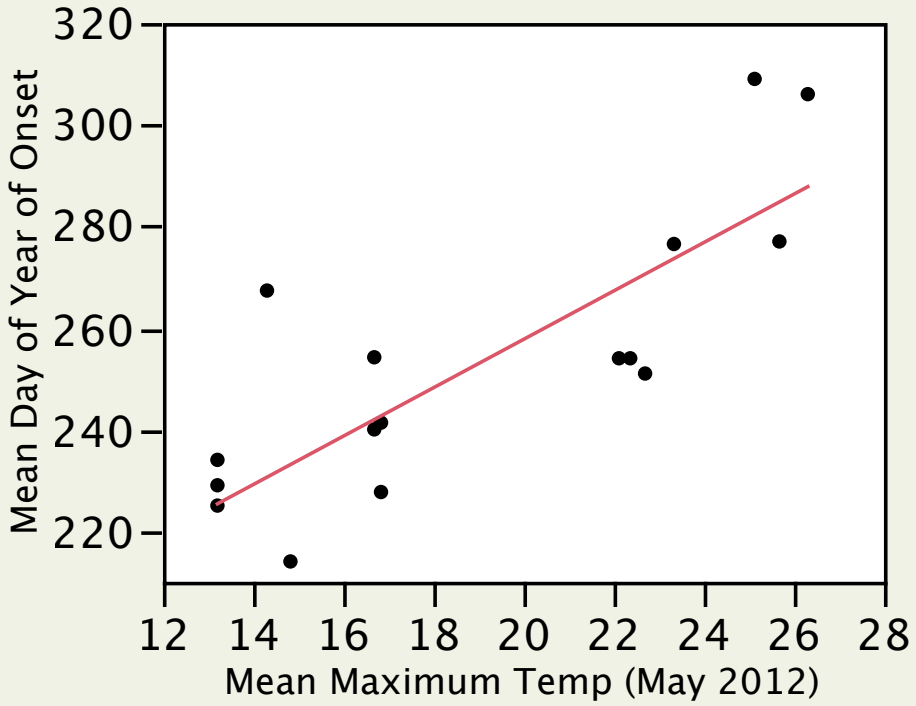
Climate data obtained from PRISM website: prismmap.nacse.org/nn/



Warmer May maximum temperatures *delayed* flowering

Conditions in different months may have different effects

DOY (Day of year of onset) = a (May Tmax) + b



Conditions in different months may have different effects

DOY (Day of year of onset) = a (May Tmax) + b

$$DOY = a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6$$

X_1 = Tmin (°C) (preceding January)

X_2 = Tmin (°C) (preceding February)

X_3 = Tmin (°C) (preceding March)

X_4 = PPT (mm) (preceding January)

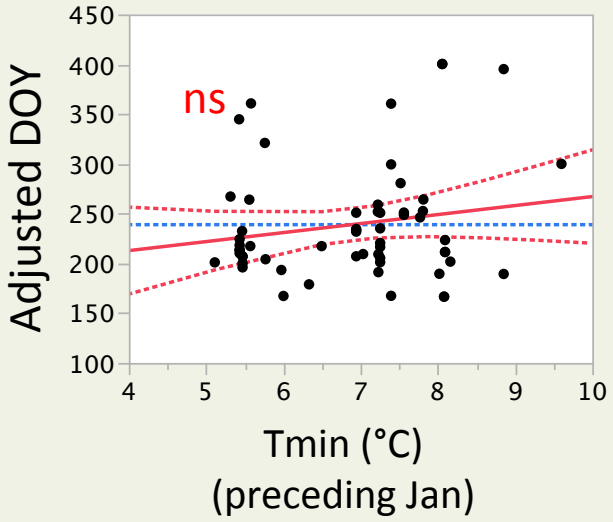
X_5 = PPT (mm) (preceding February)

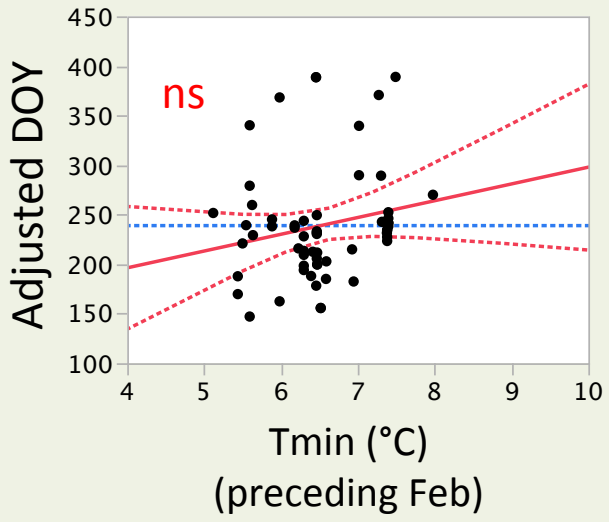
X_6 = PPT (mm) (preceding March)

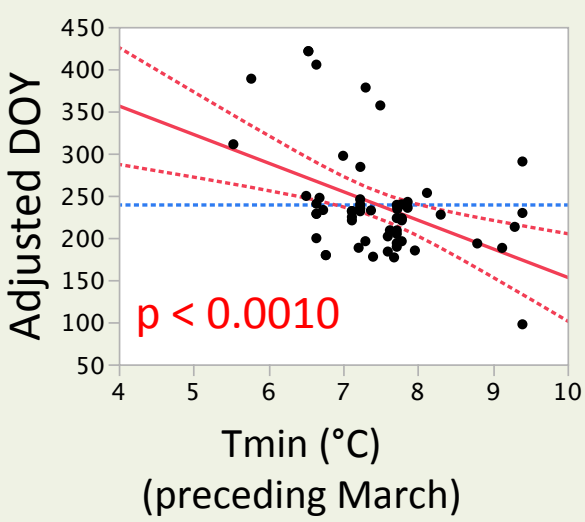
Effects of Jan-Feb-March temperature and rainfall on the onset of late summer flowering

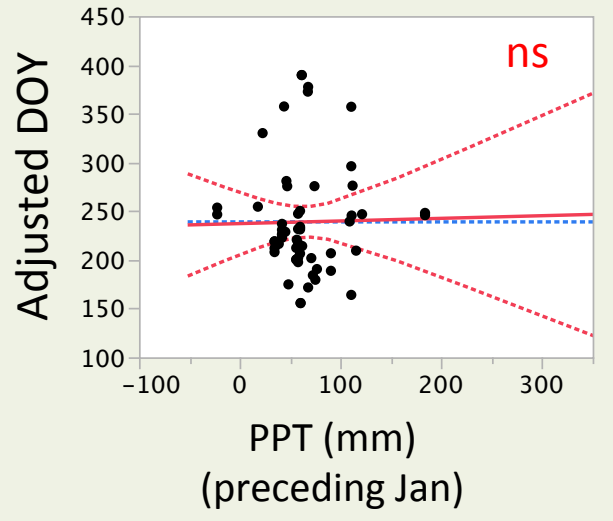
Effects of Tmin & rainfall depend on the month:
sites and years (2011-2013) pooled

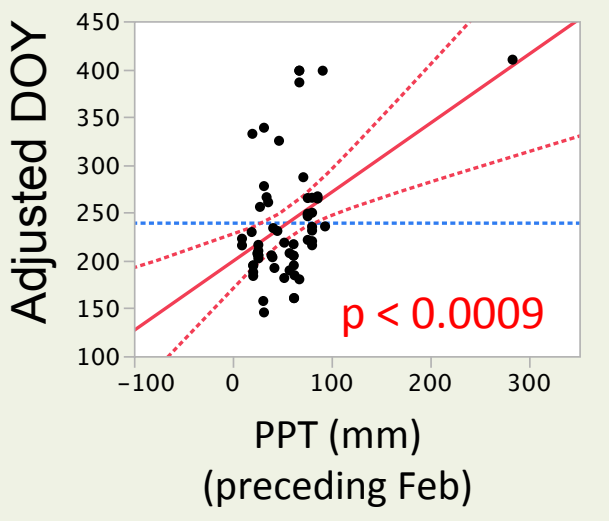
Baccharis pilularis: Flowers and Flower Buds ($R^2 = 0.32$)

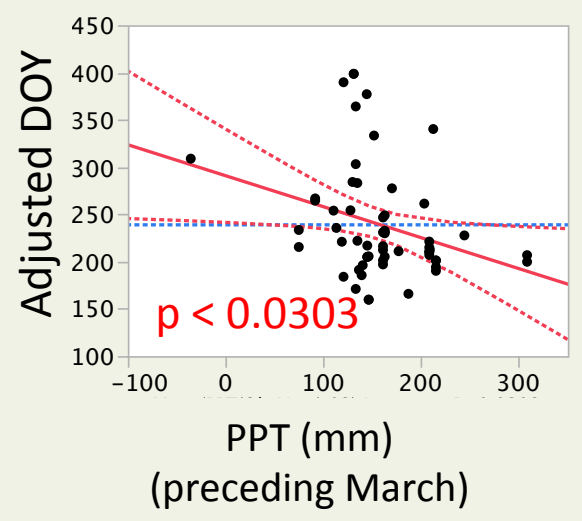






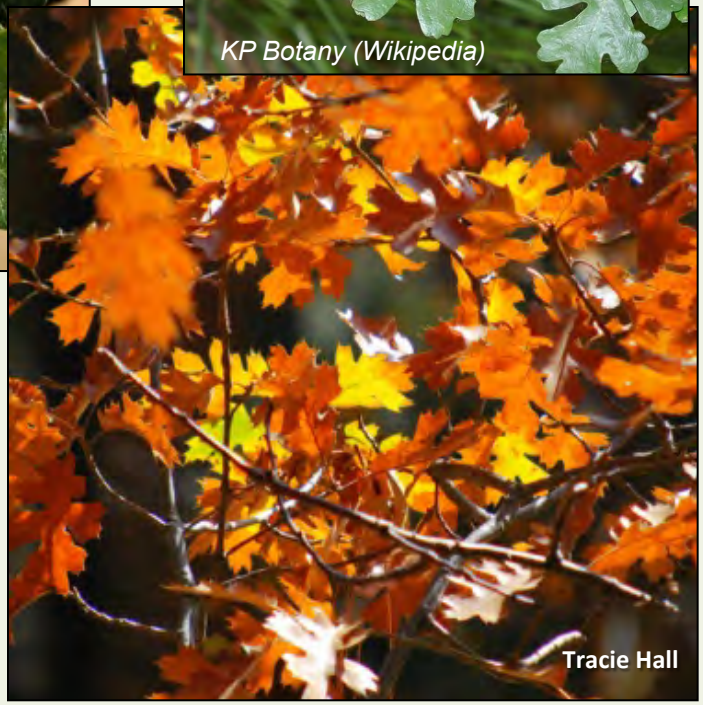






Quercus lobata

Valley Oak



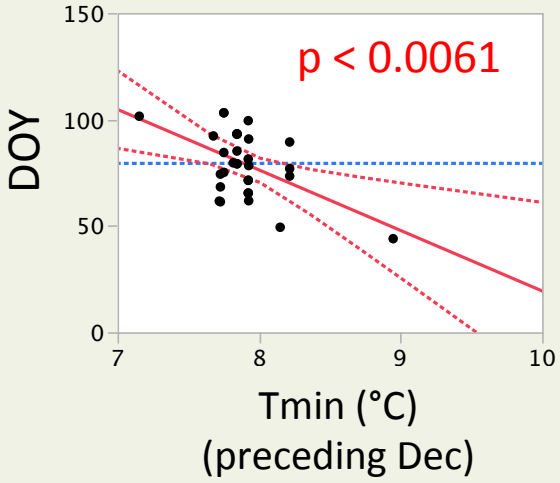
Quercus lobata sites monitored by the CPP (2011-2013)

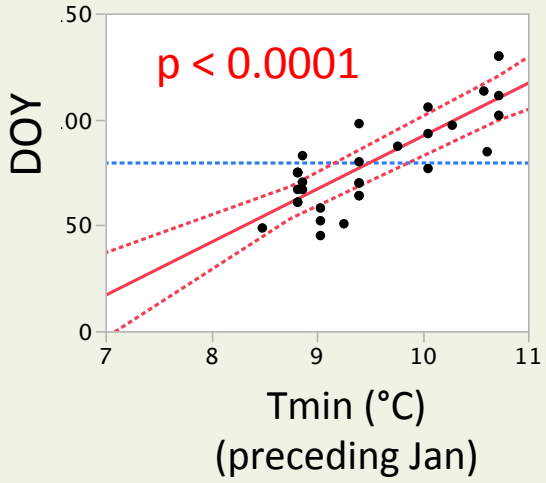
Sedgwick Ranch

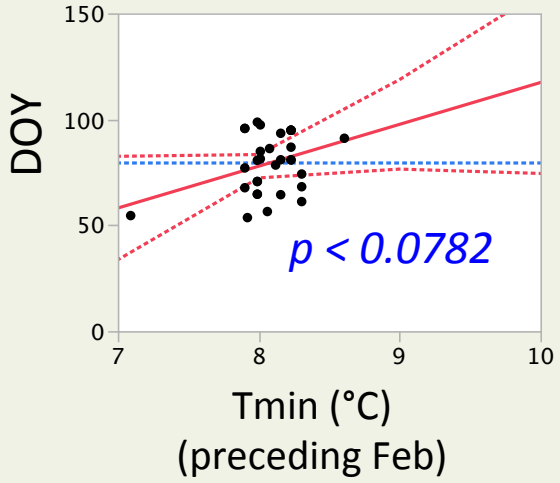
Santa Monica Mtns.

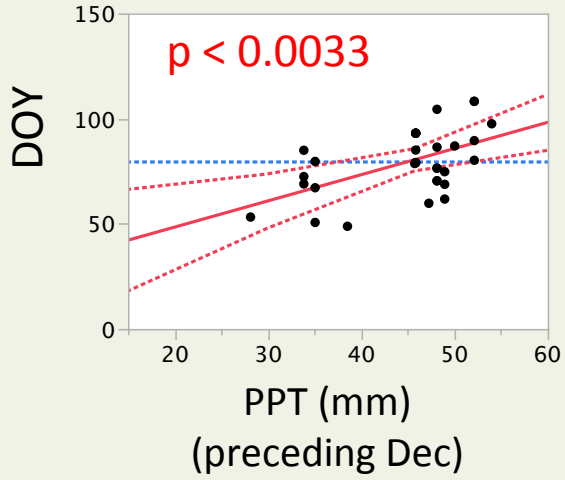
Effects of Tmin depends on the month; High rainfall delays leaf bud break

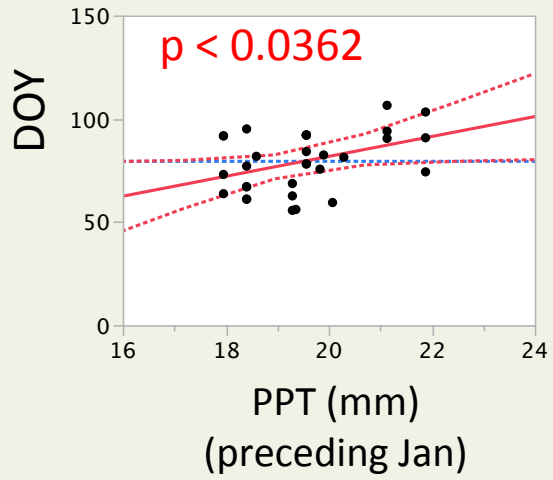
Quercus lobata: Breaking Leaf Buds ($R^2 = 0.96$)

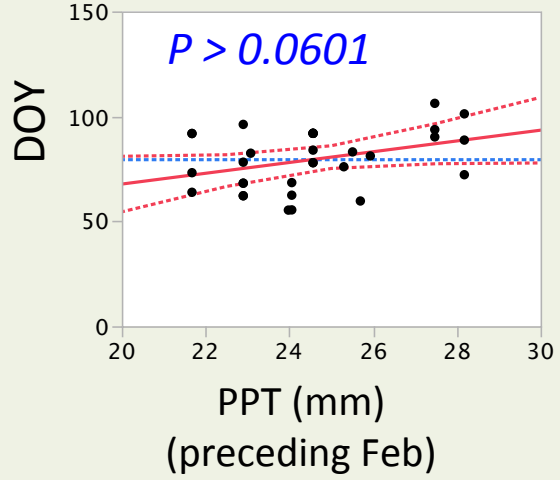






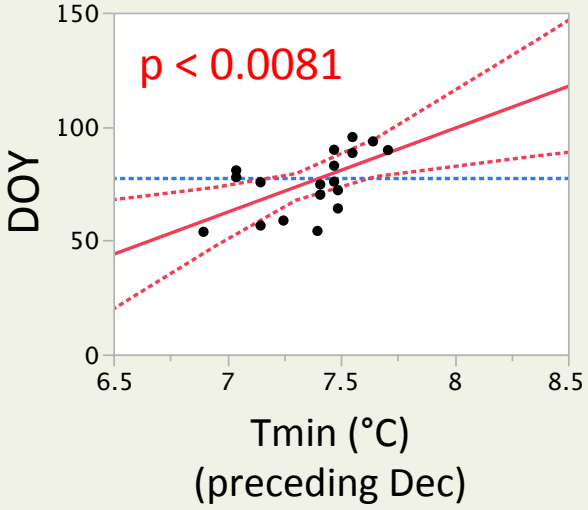


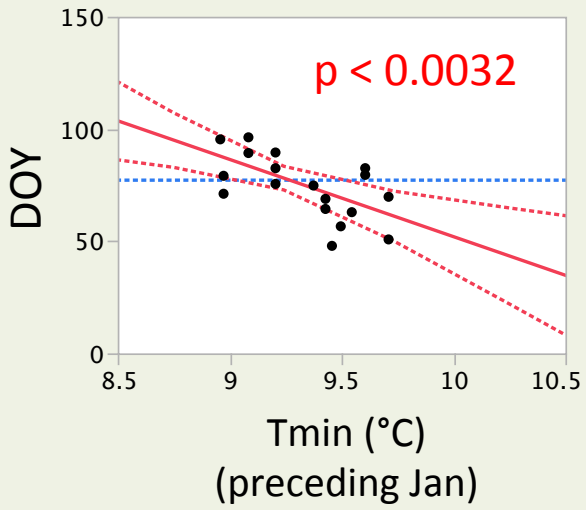


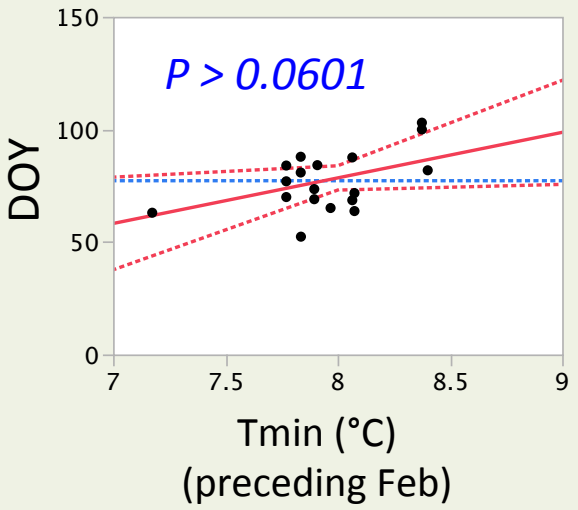


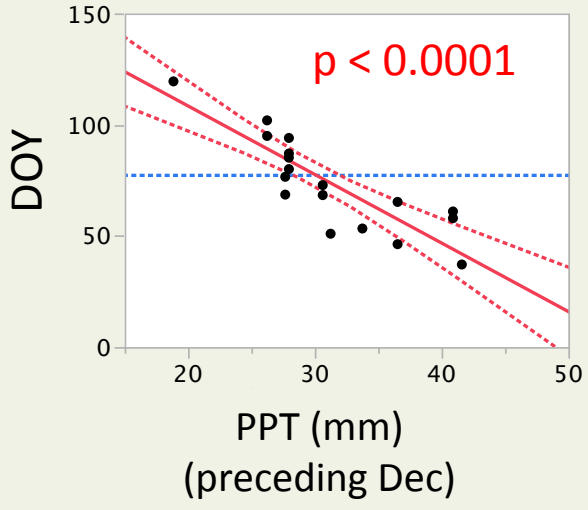
Effects of Tmin & rainfall on flowering time depend on the month

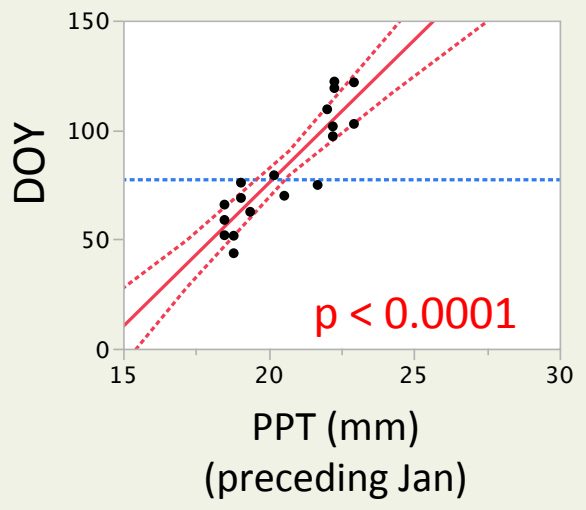
Quercus lobata: Flowers or Flower Buds ($R^2 = 0.97$)

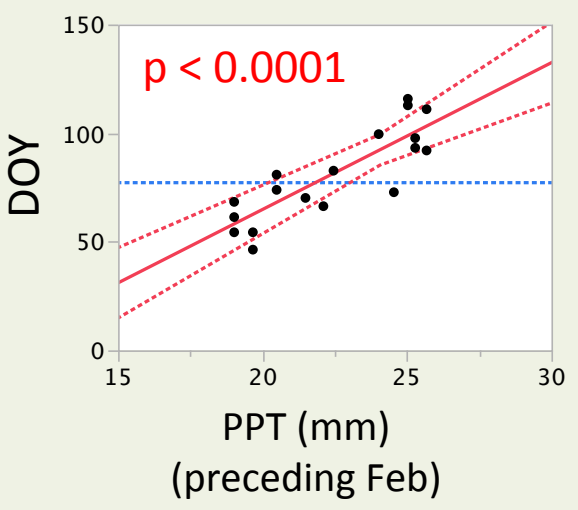








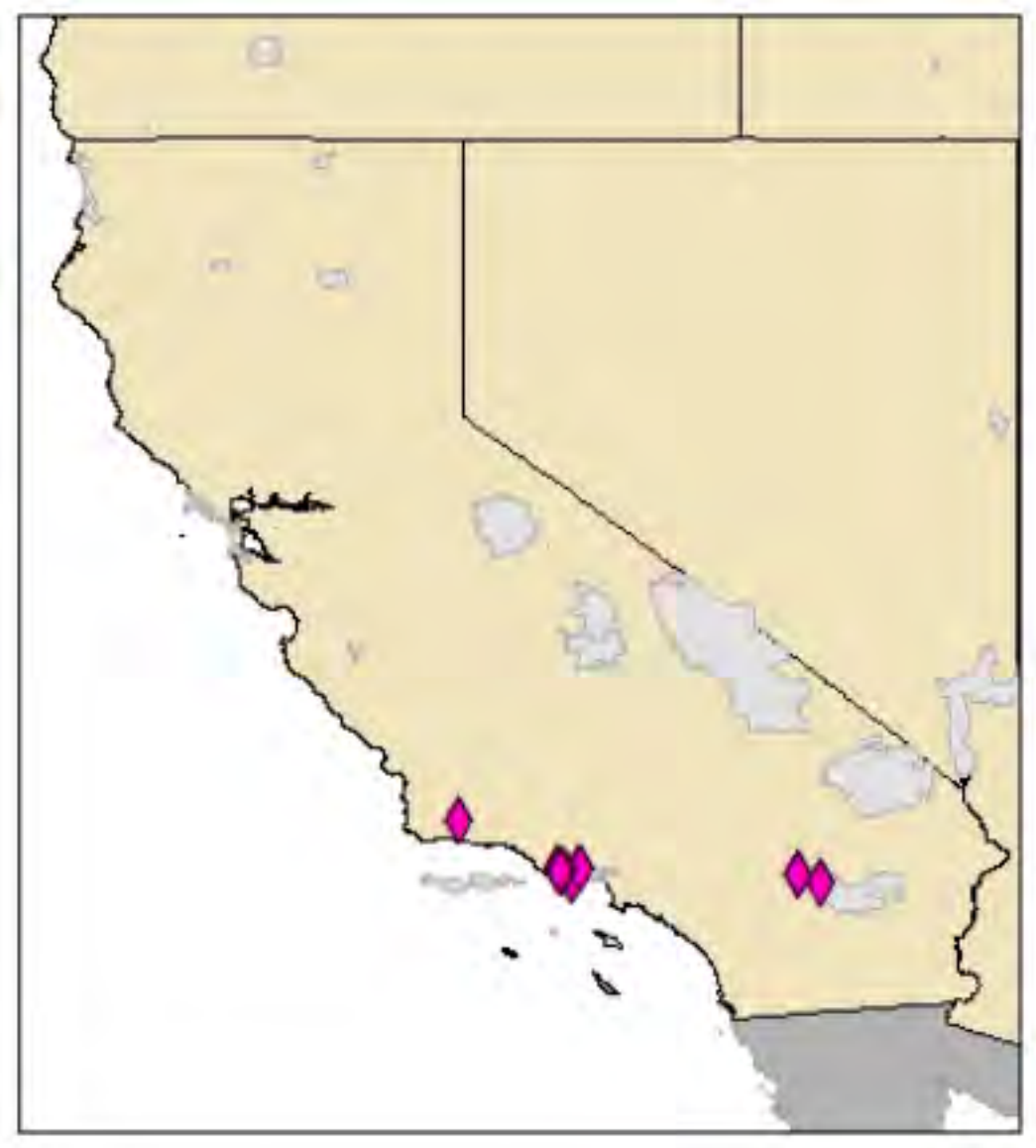




Targeted Species: California buckwheat

Eriogonum fasciculatum

E. fasciculatum sites monitored by the CPP (2011-2013)



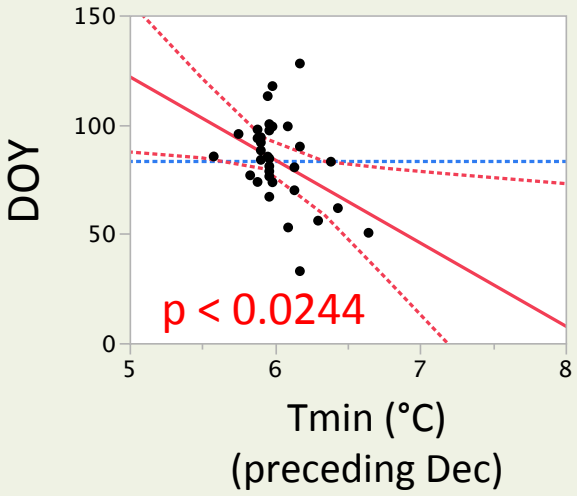
Sedgwick Ranch

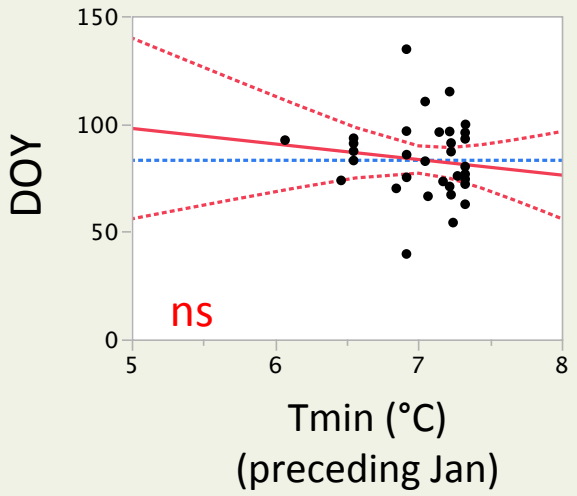
Santa Monica Mtns NRA

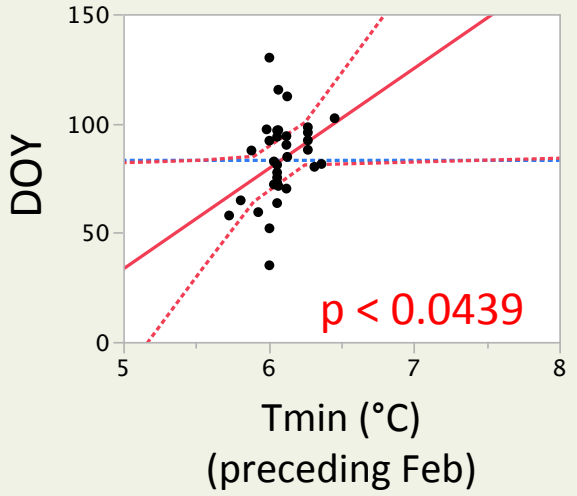
Joshua Tree NP

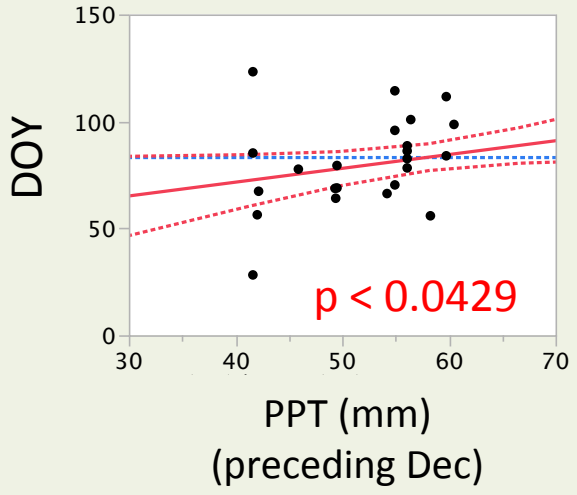
Effects of Tmin & rainfall depend on the month

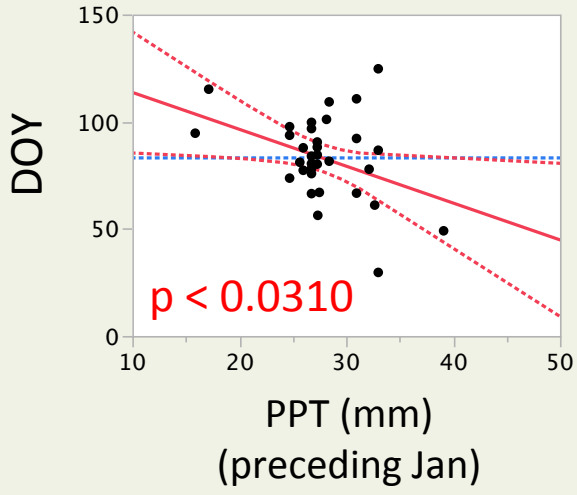
Eriogonum fasciculatum: Flowers or flower buds ($R^2 = 0.74$)

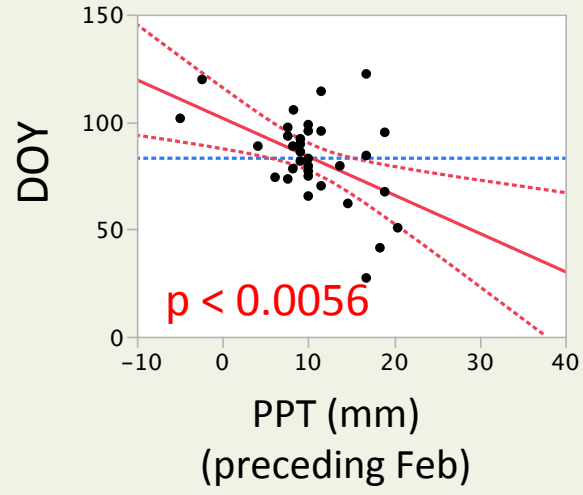












R^2 of multivariate GLM

Species	Breaking Leaf Buds	Young Leaves	Flower buds or Flowers	Open flowers	Pollen Release	Fruit
Baccharis pilularis ***(Jan-Feb-Mar)***		0.35	0.32		0.48	0.32
Baccharis pilularis ***(Jun-Jul-Aug)***		0.26	0.27		0.60	0.38
Quercus lobata (***Dec-Jan-Feb***)	**0.96**		**0.97**	**0.85**	**0.87**	
Eriogonum fasciculatum (***Dec-Jan-Feb***)		0.48	**0.74**	0.52		**0.71**

Qualitative Predictions

	Warmer winters	Wetter winters
	↓	↓
Baccharis pilularis	Earlier flowering	?
Quercus lobata	Later leaf-out Later flowering	Later leaf-out Later flowering
Eriogonum fasciculatum	?	Earlier flowering

Community-level Conservation Implications

	Warmer winters	Drier winters
	↓	↓
Baccharis pilularis	Earlier flowering	?
Quercus lobata	Later leaf-out Later flowering	Earlier leaf-out Earlier flowering
Eriogonum fasciculatum	?	Later flowering

→ Changes in the timing of floral and vegetative resources

Summary

- Effects of higher Tmin on DOY differ among winter months, phenophases, and species
- Effects of monthly rainfall on DOY are stronger than Tmin but not necessarily more consistent
- Multivariate models can account for a very high proportion of the variance in spring phenology
- The associations between monthly conditions and the onset of subsequent onset dates differ among phenophases and species.
- Species-specific responses could lead to a seasonal thinning of floral resources

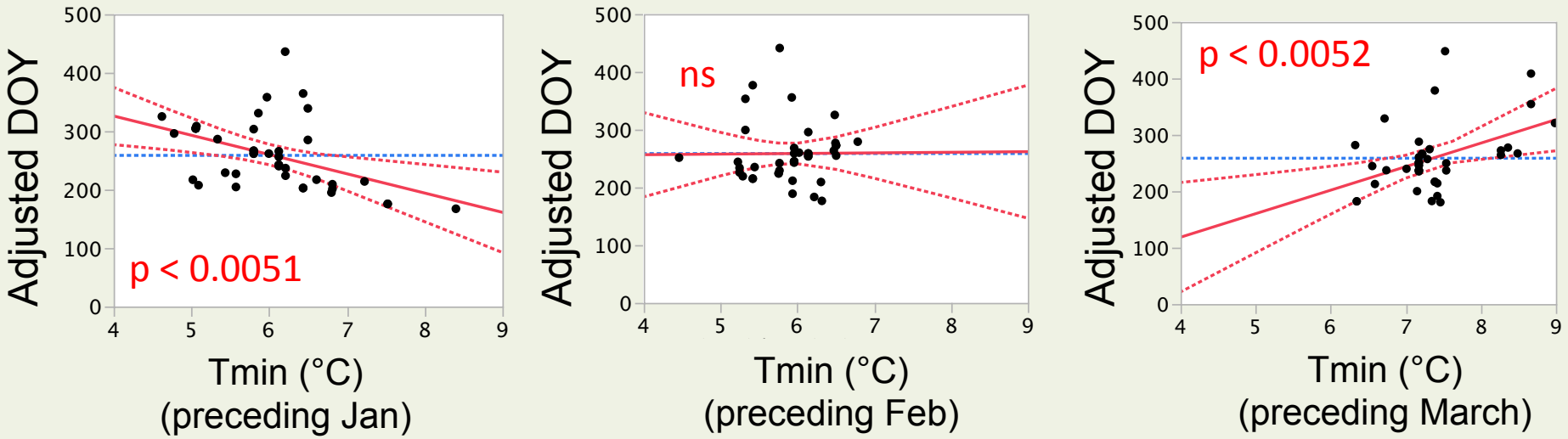
www.usanpn.org/cpp

Thank also to:

Dr. Liz Matthews (UCSB)
Dr. Kathy Gerst (NPN)
Brian Haggerty (UCSB)

Baccharis pilularis: Effects of Tmin differ between male and female phenophases

A. Pollen Release: $R^2 = 0.48$



Warm March conditions *delay* pollen release

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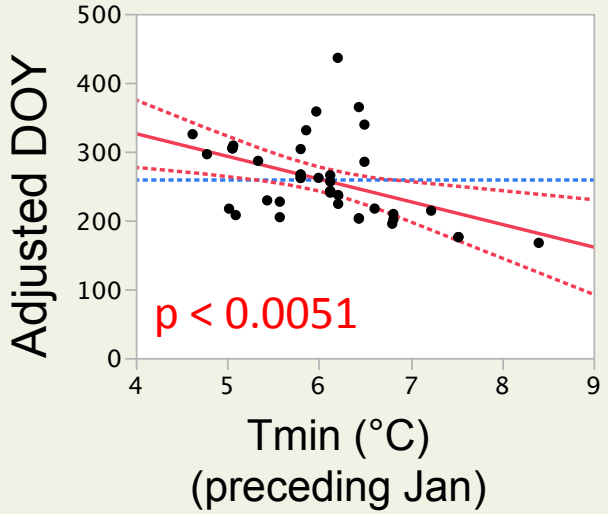
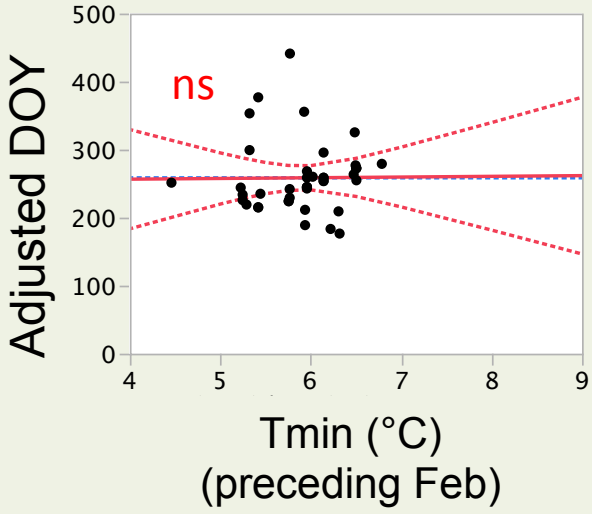
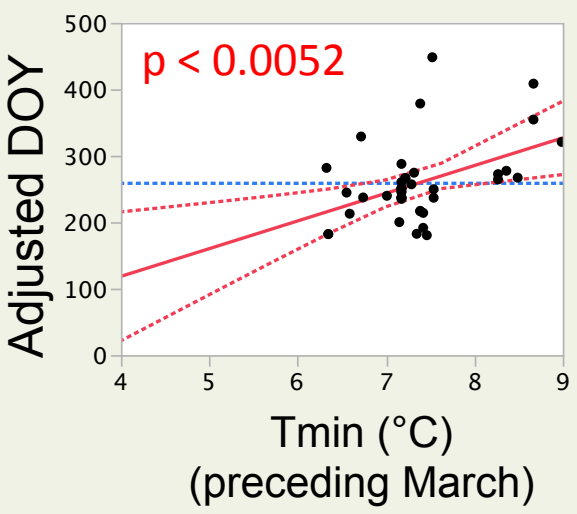
A. Pollen Release: $R^2 = 0.48$

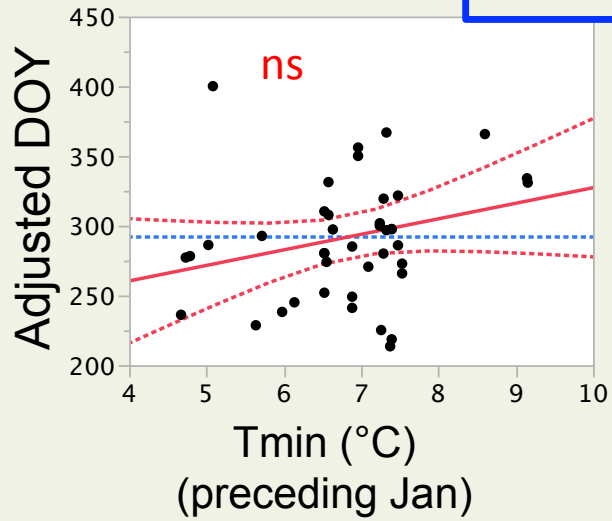


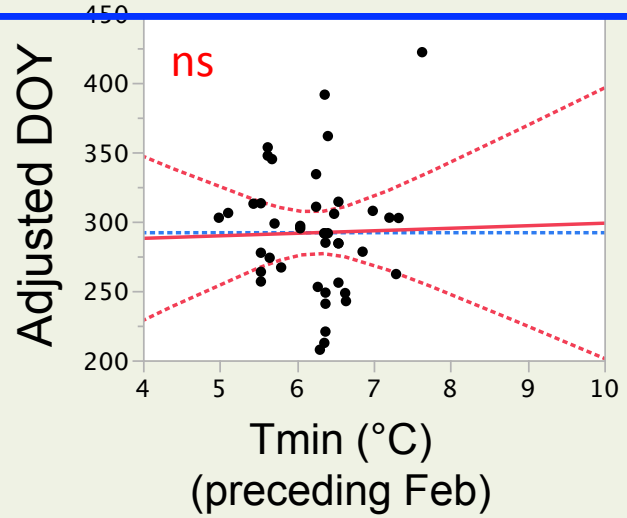


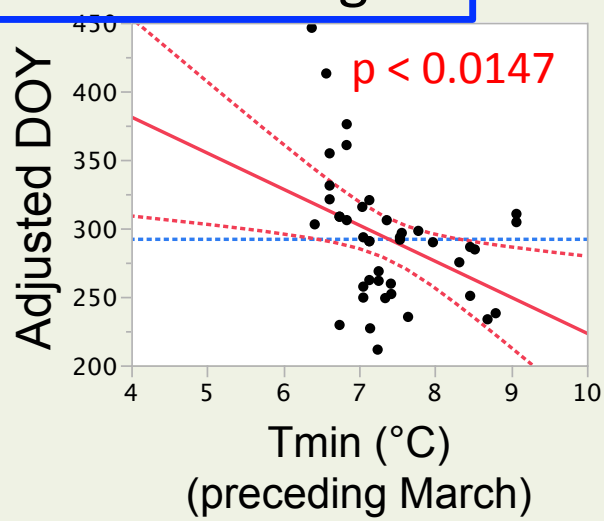


B. Fruit: $R^2 = 0.32$

Warm March conditions *advance* fruiting





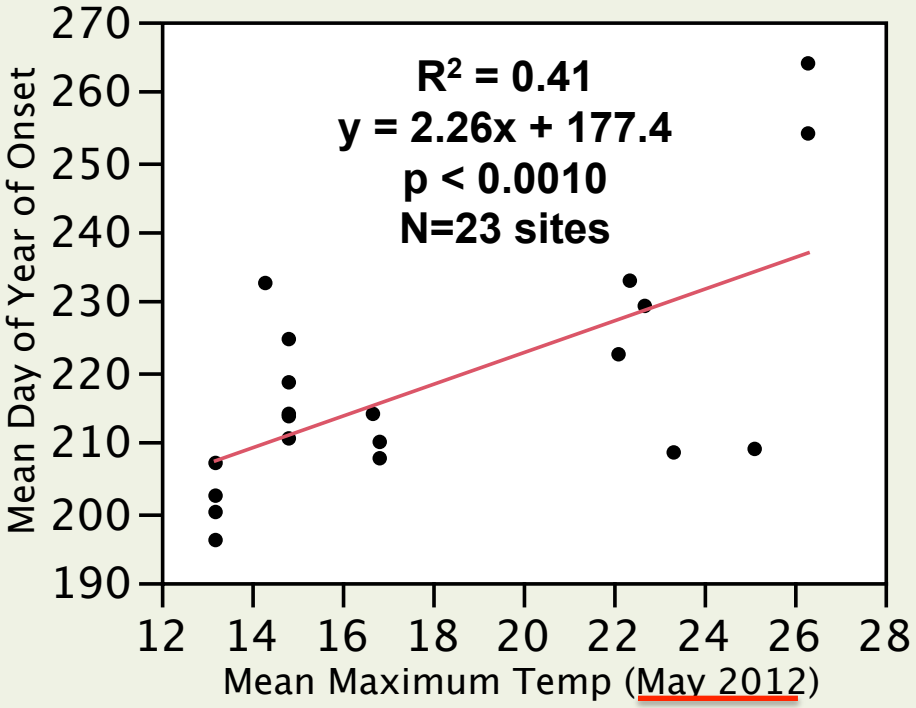


Baccharis pilularis: **Across California**, points are site means (1-9 plants/site).

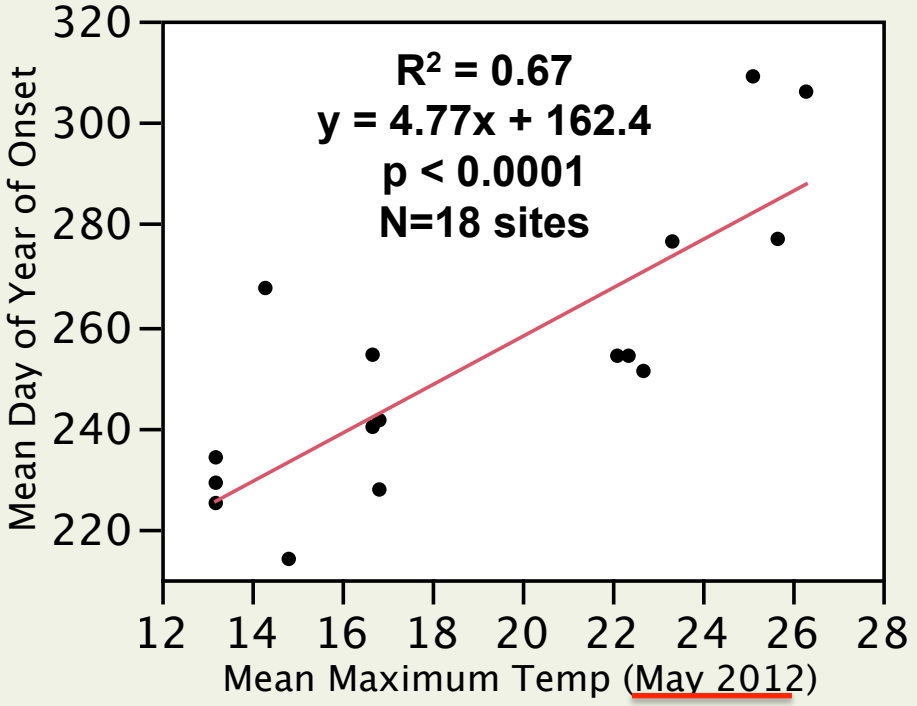
Climate data obtained from PRISM website: prismmap.nacse.org/nn/

Sites include: **Golden Gate NRA**, **Redwood NP**, **Santa Monica Mtns NRA**

2012: Onset of Flower Buds & Flowers



2012: Onset of Open Flowers



Warmer May maximum temperatures *delayed* flowering