

An image is worth a thousand words



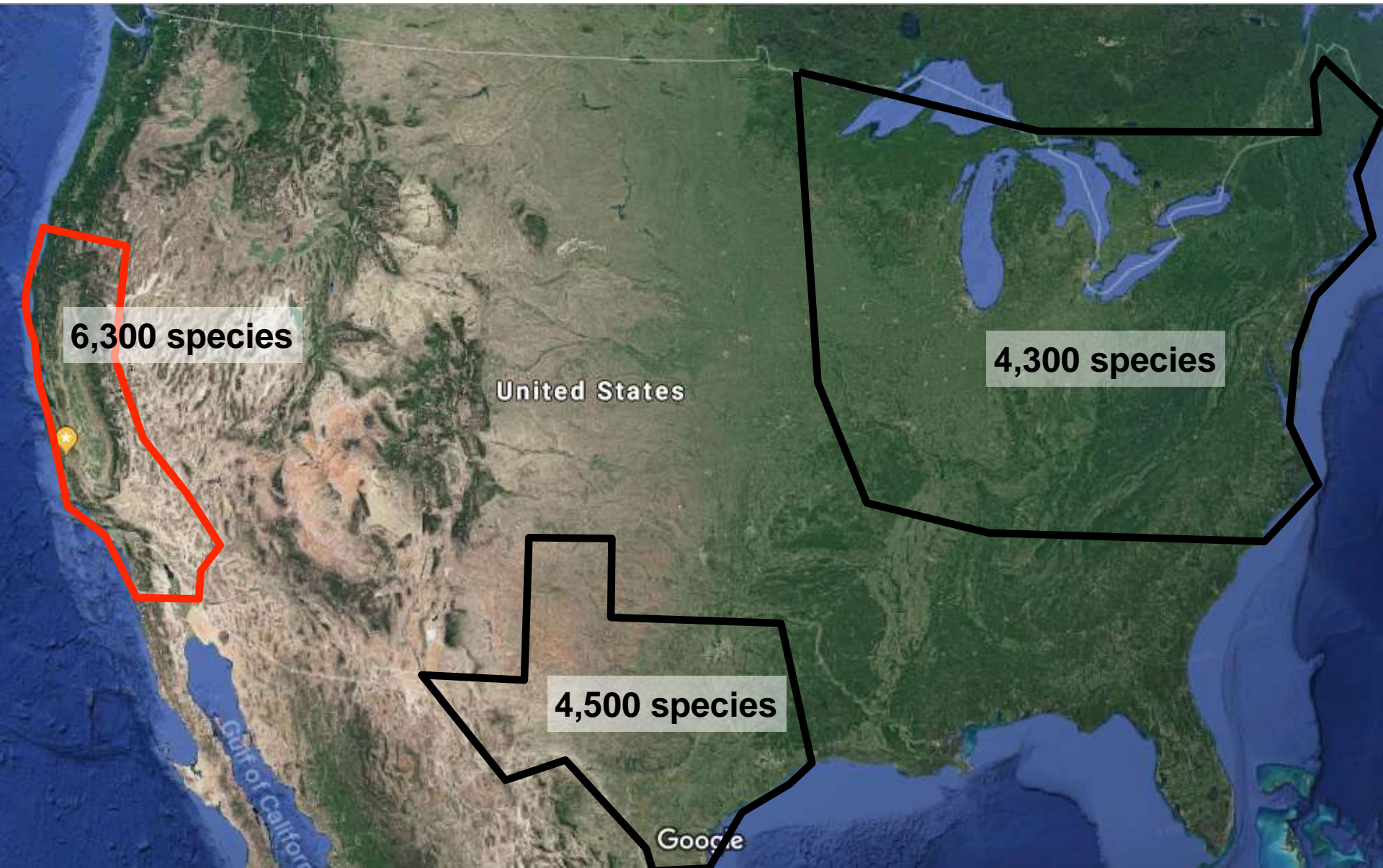
Jenn Yost,
Cal Poly State University, San Luis Obispo

California Phenology CAP-TCN

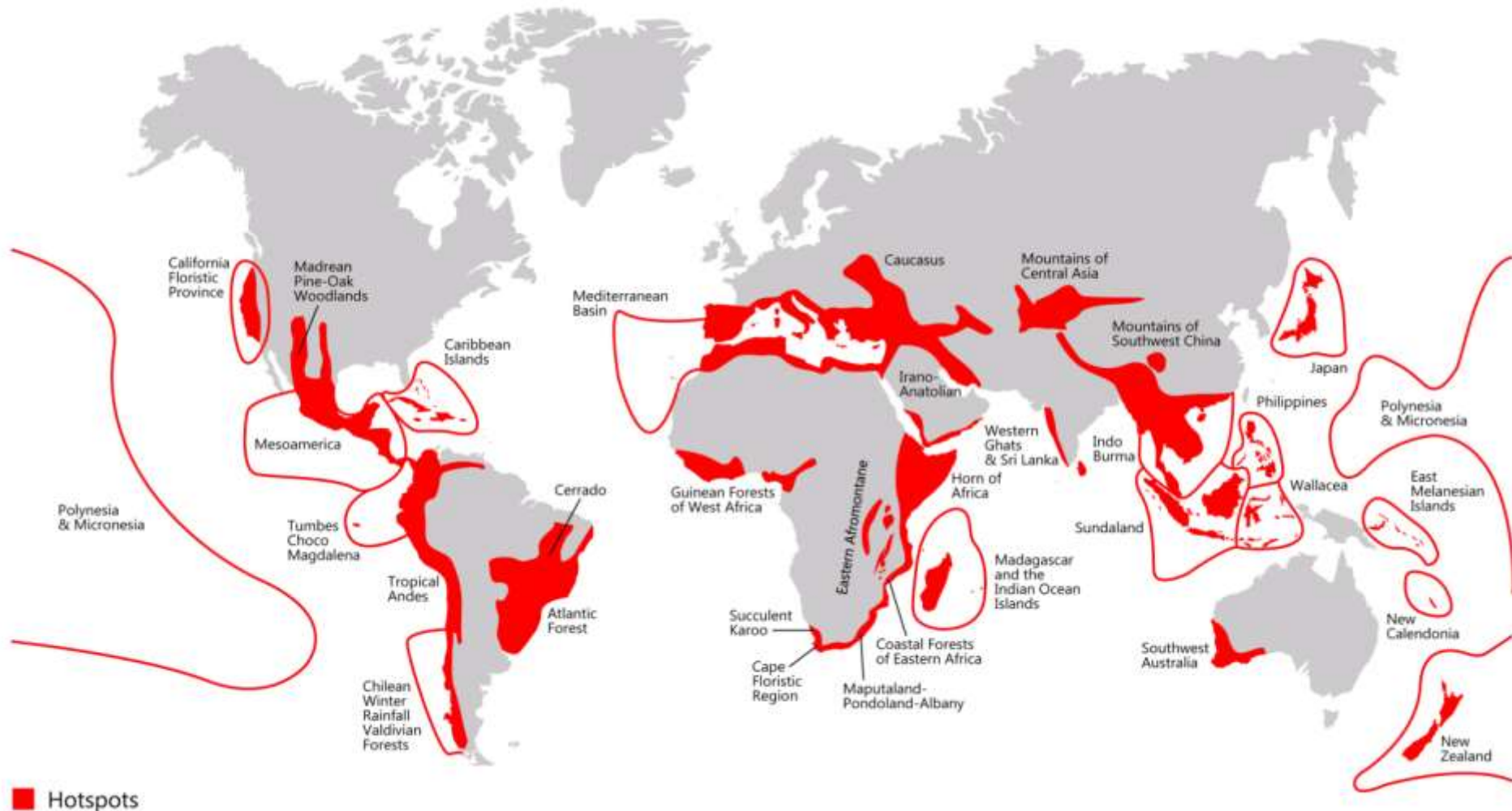
Capturing California's flowers: Using digital images to investigate phenological change in a biodiversity hotspot



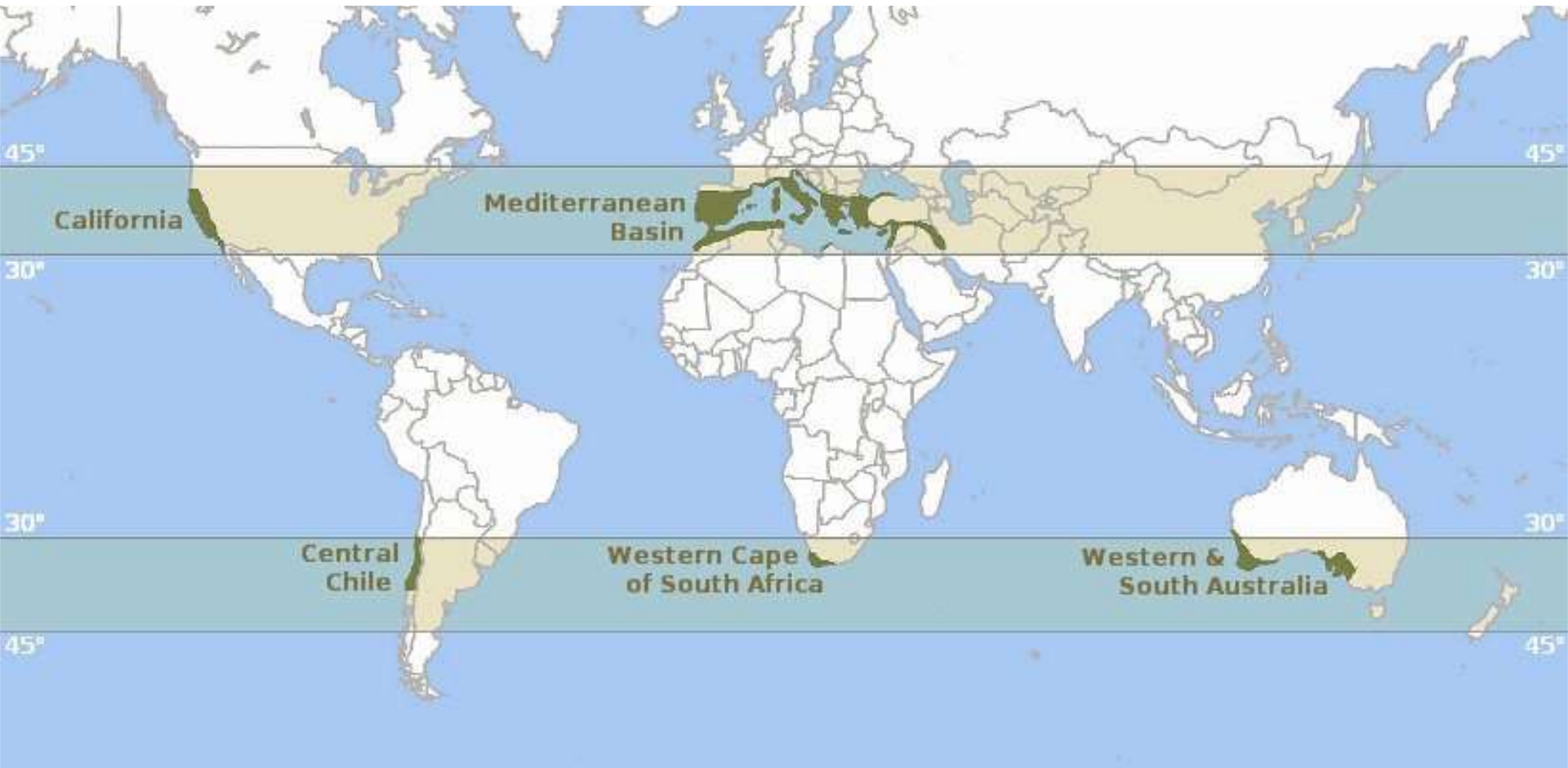
Plant Diversity



Biodiversity Hot Spots



California Climate



California Floristics

- ~6,300 native plant species
- ~30% are endemic
- > 3/4 of the original habitat has been lost
- Population: >40 million
- Half of the food of the nation is grown
- Still one of the most biodiverse places outside the tropics



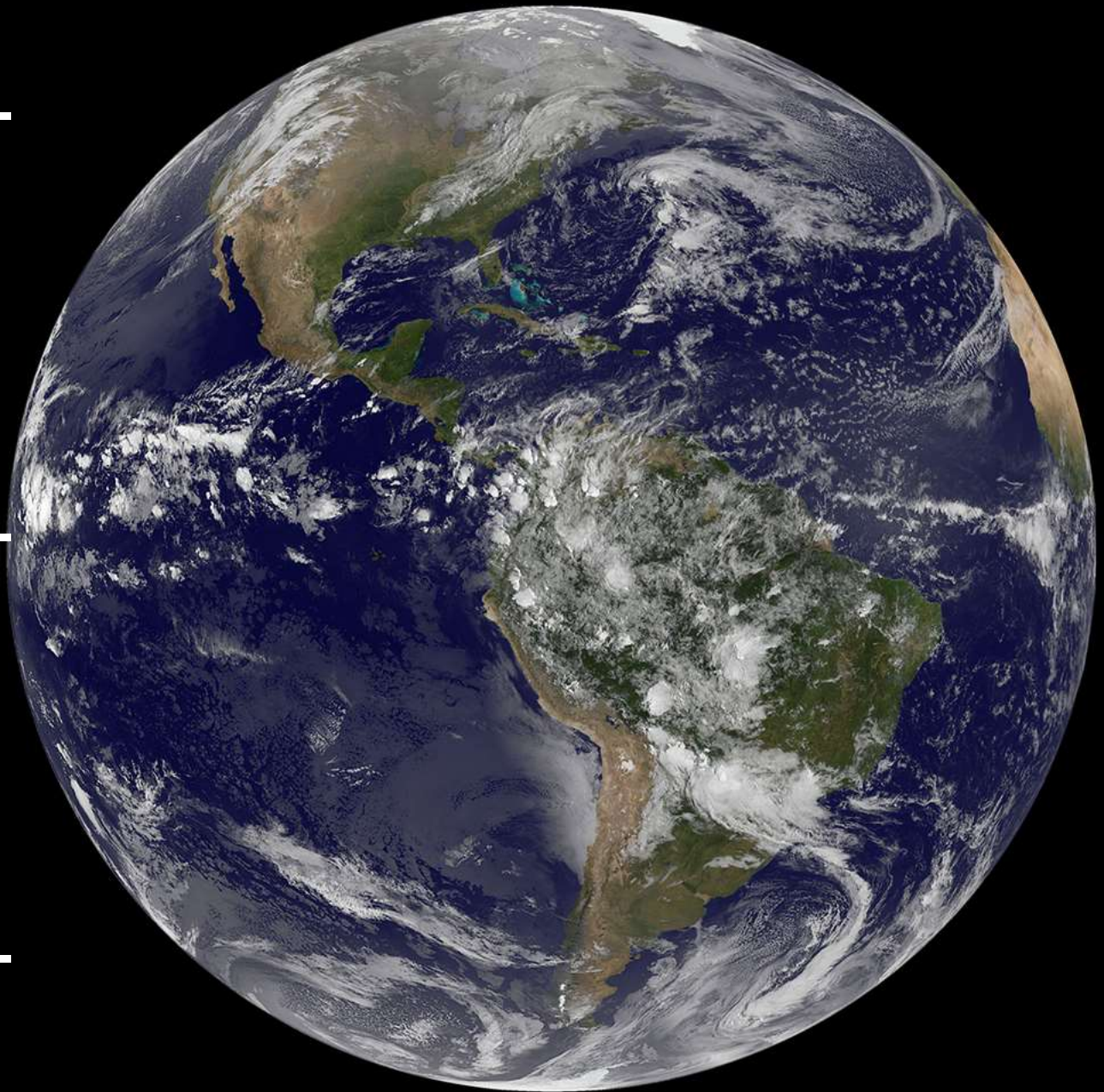
Perennials —

Annuals —

Perennials —

Annuals —

Perennials —



University of California Publications

BOTANY
Volume 72

**Origin and Relationships
of the California Flora**

by Peter H. Raven and Daniel I. Axelrod

University of California Press

A Flora of Annuals

	Species/ Genus	Ten Largest Genera	Mono- cotyledons	Asteraceae	Annuals
California	5.7	16.1%	18.1%	12.2%	28.6%
California Floristic Province	5.6	15.2%	19.2%	13.6%	27.4%
Alaska	3.8	26.0%	28.6%	10.0%	2.1%
Barro Colorado Island	1.9	12.1%	27.4%	2.9%	< 3.9%
British Isles	2.65	18.2%	25.0%	8.7%	21.6%
Cape Peninsula	4.2	17.5%	34.6%	11.5%	9.6%
Carolinas	3.5	14.5%	23.6%	10.4%	3.8%
Galápagos Islands	2.8	14.6%	17.0%	6.3%	19.5%
Gray's Manual Area	5.2	21.8%	28.2%	12.7%	8.7%
Guatemala	4.3	?	22.3%	7.7%	?
Hawaii	7.5	42.1%	8.5%	11.4%	0.04%
Japan	3.7	14.6%	28.0%	8.5%	7.3%
New Zealand	7.4	26.3%	27.3%	12.5%	6.0%
Sonoran Desert	3.3	12.8%	12.1%	15.0%	21.4%
Texas	3.9	10.2%	24.4%	13.4%	20.4%
World	18.7	~6%	25.4%	7.8%	13.0%



California poppies in Antelope Valley grassland



Grassland and Wildflowers, Temblor Range Eastern SLO County

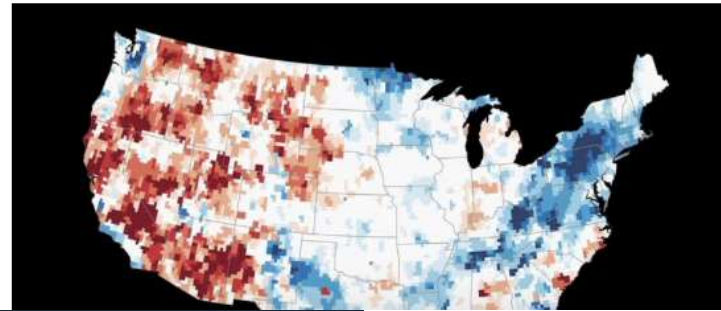


Climate Chaos

NEWS | December 15, 2014

Analysis: 11 trillion gallons needed to replenish California drought losses

By Steve Cole, NASA's Headquarters,
and Alan Buis, NASA's Jet Propulsion Laboratory



Measuring drought from space

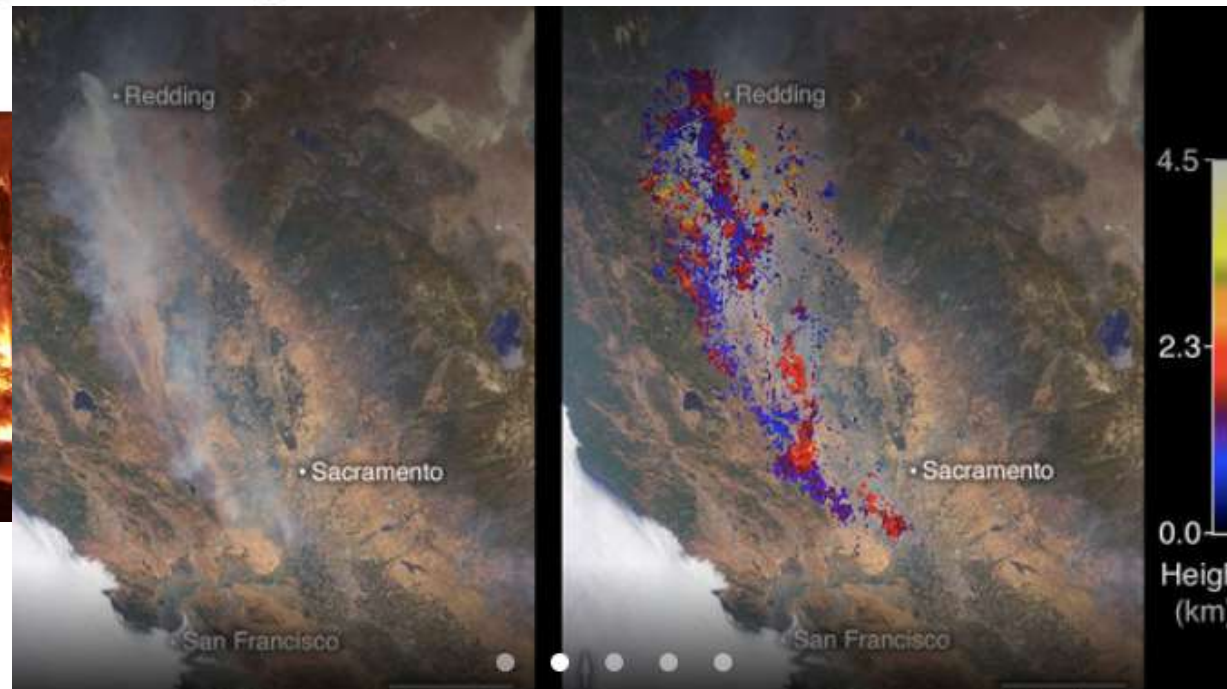


 **GLOBAL CLIMATE CHANGE**
Vital Signs of the Planet

NEWS | July 27, 2015

Study: Fire seasons getting longer, more frequent

By Adam Voiland,
NASA's Earth Observatory



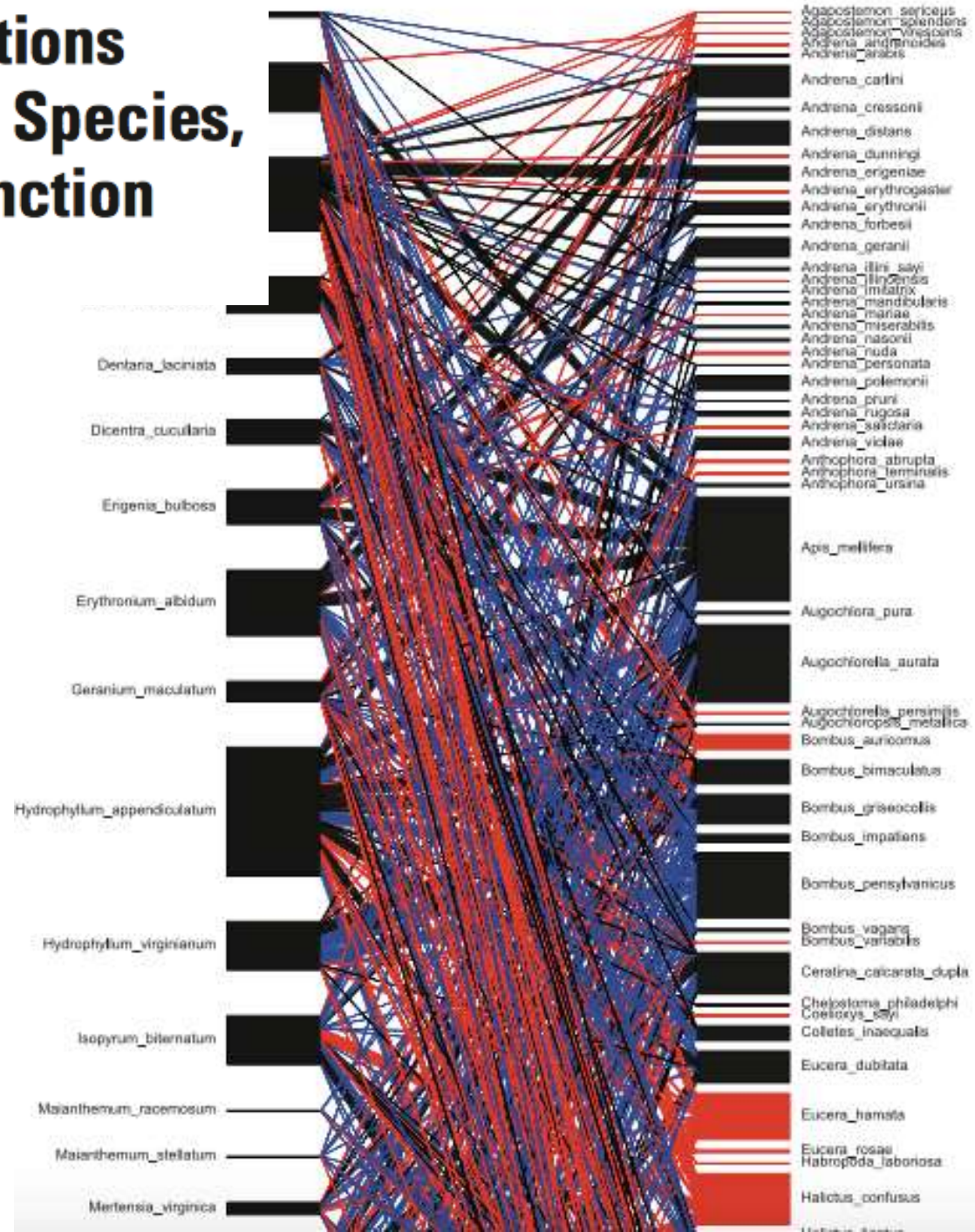
How will plants respond?

- Which species are in the most danger of phenological shifts?
 - What are the impacts of these shifts?
 - Agricultural plants, pollinators, pathogens, and pests
- Which habitats and vegetation types are most phenologically sensitive?
- What is the effect of both precipitation and temperature?

Plant-Pollinator Interactions over 120 Years: Loss of Species, Co-Occurrence, and Function

Laura A. Burkle,^{1,2*} John C. Marlin,³ Tiffany M. Knight¹

- Phenology can effect the stability and structure of complex interaction networks



Building a historical record of flowering time



Collaborators



CAL POLY
SAN LUIS OBISPO



(BSCA) Colorado Desert District,
California Dept. of Parks and Recreation

(CHSC) CSU, Chico

(CSLA) CSU, Los Angeles

(CSUSB) CSU, San Bernardino

(DAV) UC, Davis

(FSC) CSU, Fresno

(HSC) CSU, Humboldt

(IRVC) UC, Irvine

(LA) UC, Los Angeles

(LOB) CSU, Long Beach

(MACF) CSU, Fullerton

(OBI) California Polytechnic State
University, San Luis Obispo

(RSA) Rancho Santa Ana Botanic
Garden

(SBBG) Santa Barbara Botanic Garden

(SD) San Diego Natural History
Museum

(SDSU) San Diego State University

(SFV) CSU, Northridge

(SJSU) CSU, San Jose

(UC/JEPS) UC, Berkeley

(UCSB) UC, Santa Barbara



HUMBOLDT
STATE UNIVERSITY



California Department of
Parks and Recreation



SAN DIEGO STATE
UNIVERSITY



Building a record of flowering time

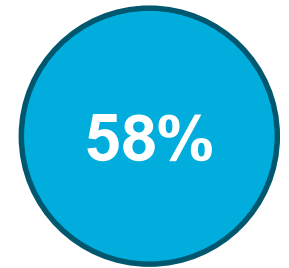
From 22 California institutions:

- Image 904,200 specimens
 - All with label capture
 - Georeference
 - Phenological status

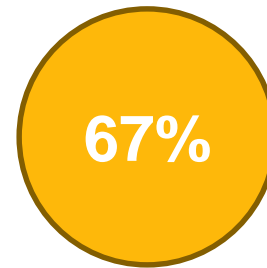


Taxonomic Extent

- 22 target families
 - Oldest records
 - Most diverse families
 - Most endemic and threatened families
- 250 additional taxa



Native species



Endemic species





Specimen Details

[Report a Problem](#)

Species: *Acacia angustissima* var. *hirta*
Collection Date: June 2, 1989
Bar Code ID: 000027046
UUID: ee815114-857c-4b75-8c51-63274085c594
Collectors: Loran C. Anderson
Collector's Identifier: 12045
Flowers Present?: True
Country: United States
State or Province: Florida
County or Parish: Dixie
Plant Morphology Observations: Filaments prominently white, perianth light green
Local Abundance Observations: Frequent



[View Image](#) [View JPEG](#)
[Download JPEG \(1.59 MB\)](#)

BRITISH COLUMBIA CONSERVATION DATA CENTRE - Flora of British Columbia -

ramineum Lej.

TY: Carnation Creek estuary, ca. 14 km NE of Bamfield
T: Dominant on tidal mud flats with *Plantago maritima*, *Honkenya peploides*, *Spergularia*, and *Salicornia virginica*; slope 1%; asp W
NG: 10U 353300 5419600 NAD 83
 48°10'/125°00' ELEV 0 m
CTOR: G.W. Douglas, J.L. Penny & N. Alexander
COLL NO: 13298 **COLL. DATE:** 98-06-30
PLOT NO.: **DET.:** GWD/98
NOTES: ca. 500 plants/ha.; flowers reddish-tinged

PLANTS OF CONNECTICUT

Rubus flagellaris Willd.

Connecticut: Litchfield Co., Sharon
 Litchfield Co. Forest, Housatonic State Forest
 petals - white; trailing

Leslie J. Mehrhoff 8030 23 JUN 1983

TORREY HERBARIUM OF THE UNIVERSITY OF CONNECTICUT
 CONNECTICUT STATE MUSEUM OF NATURAL HISTORY

SAN DIEGO MUSEUM OF NATURAL HISTORY BAJA CALIFORNIA, MEXICO SIERRA JUÁREZ

Lasthenia coronaria (Nutt.) Ornduff

Heads yellow.

Common on grassy steep north slope,
 San José, 6 km east of Tecate.

Near 32° 33' N, 116° 34' W Elevation 600 m
 Reid Moran 28481 10 May 1989



PLANTS OF THE HOPLAND FIELD STATION

University of California
Mendocino County

Rosa californica Cham. & Schldl.

Location: S-1, app .25mi SE of James Cabin.

Site: Edge of pond.

Elevation: 1,600 ft,

Date: 6-9-97

Plant Number: #2031

Collected by:

Kerry L. Heise



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Developing Standards

- Establish the framework for which trait-based data can be shared via Darwin Core Archives



Dig
frc

Coding Phenological Data from Herbarium Sheets

Jennif
Charle
Brian.
Mishle

March 12-13, 2016

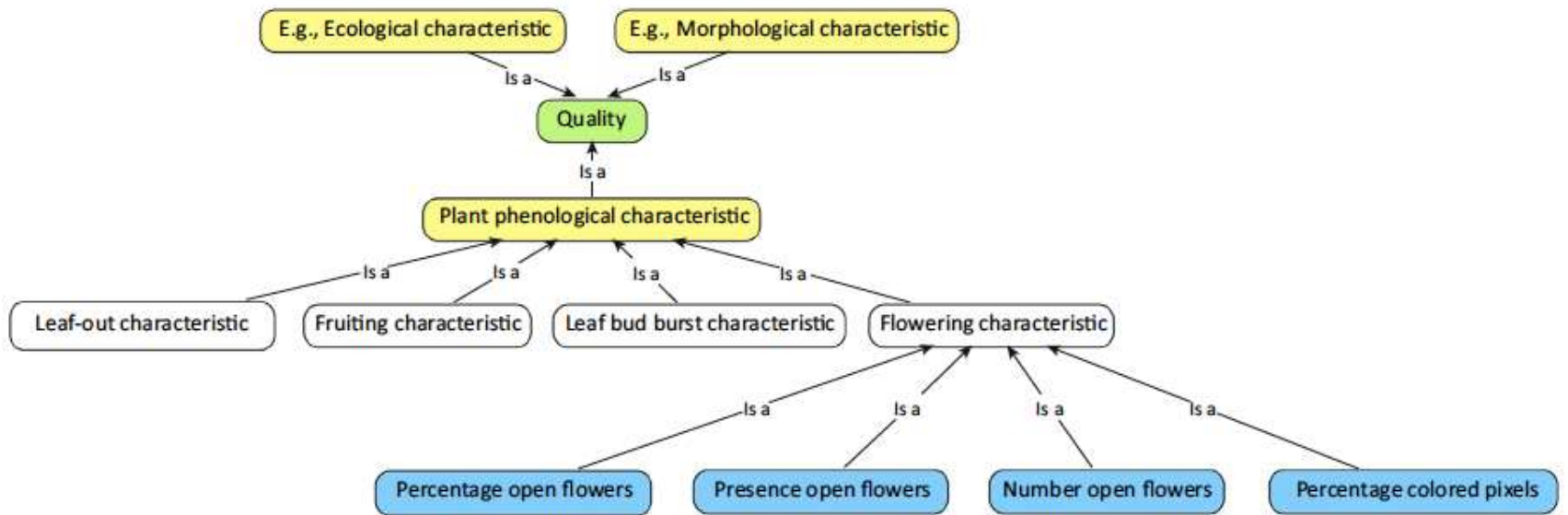
Presented by iDigBio, the central coordinating unit at the University of Florida and Florida State University) for Advancing Digitization of Biodiversity Collections (ADBC) in collaboration with Cal Poly, UC Berkeley, and UC Santa Barbara.

Biodiversity
Information
Standards
TDWG



Plant Phenology Ontology

- Using the Plant Phenology Ontology to integrate many data types



Trends in Ecology & Evolution

- Ramona Walls, Rob Guralnick, Brian Stucky, John Deck

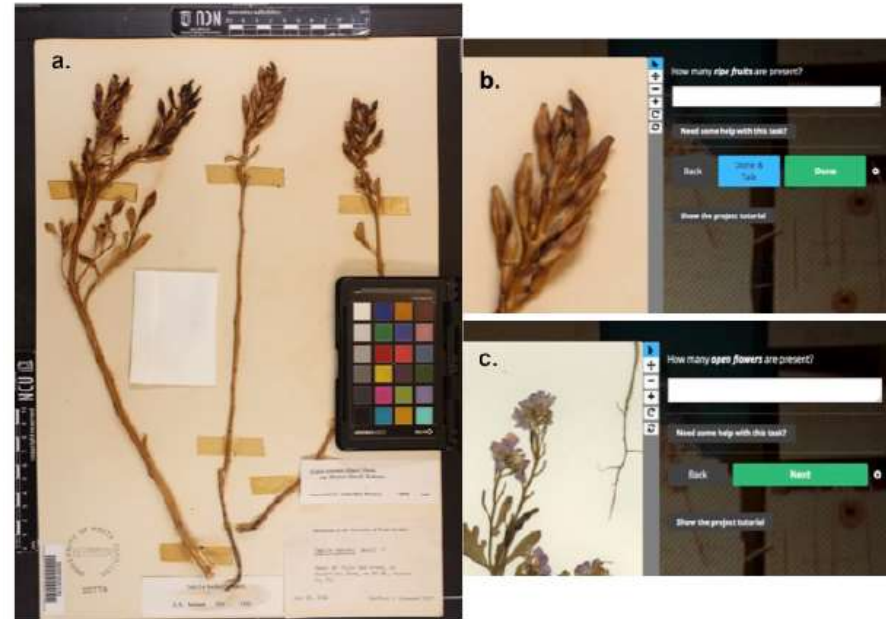
Data Standards: Advisory Team

- Katharine Gerst (USA-NPN)
- Gil Nelson (iDigBio)
- Patrick Sweeney (Yale, TCN: NEVP)
- James Macklin (AppleCore, Agri-food Canada)
- Liz Matthews (US-National Park Service)
- Ramona Walls (Plant Phenology Ontology/CyVerse)
- Ed Gilbert (Symbiota/SEINet)
- John Wieczorek (Darwin Core)

Developing Standards

- Phenological scoring workflows

- During digitization
- From images
 - Institutional
 - Citizen science
 - Deep learning
- From label data
 - Attribute mining tool
 - Image attribute tool



Rob Guralnick & Michael Denslow



NEVP: Attribute Mining Tool

Harvesting Filter

Occurrence trait: Phenology (ver 1.0) ▼

Verbatim text source: Reproductive Condition ▼

Filter by text (optional): Late

Filter by taxon (optional):

Get Field Values

Reproductive Condition

Select Source Field Value(s) - hold down control or shift buttons to select more than one value

- late flower; seed. - [1]
- late flowering (male) - [1]
- late flowering (much pappas) - [1]
- late flowering - [28]
- late flowering stage - [1]
- late flowering/early fruiting - [3]
- late flowering/fruit/shattering. - [1]
- late flowering/fruiting - [3]
- late flowers - [1]
- late flowers in fragment packet. no leaves. - [1]
- late flowers; fruit - [2]
- late flowing - [1]
- late flrs - [1]
- late fruit (berries gone) - [1]
- late fruit - [3]

☐ Reproductive

☒ Flowering

☐ Reproductive

☒ Flowering

☐ Mostly buds

☐ Mostly open

☒ Mostly old

☐ Fruiting

☐ Budding

☐ Sterile

☐ Not scorable

Notes:

Status: ----- ▼

Batch Assign State(s)

NEVP: Image Attribute Editor



Filter

Taxon:

Phenology (ver 1.0) 

Target Specimens: 12

Action Panel - Phenology (ver 1.0)

☒ Reproductive

☒ Flowering

☐ Mostly buds

☐ Mostly open

☐ Mostly old

☐ Fruiting

☐ Budding

☐ Sterile

☐ Not scorable

Notes:

Status: 



New Occurrence Record

Collector Info

Catalog Number ?	Other Cat. #s ?	Collector ?	Number ?	Date ?	Dupes? <input type="checkbox"/> Auto search
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
Associated Collectors ?		Verbatim Date ?			
<input type="text"/>		<input type="text"/>			
Exsiccati Title				Number	
<input type="text"/>				<input type="text"/>	

Latest Identification

Scientific Name ?	Author ?
<input type="text"/>	<input type="text"/>

Modify the occurrence data entry form to accommodate the phenological scoring fields

<input type="text"/>				
Substrate ?				
<input type="text"/>				
Associated Taxa ?				
<input type="text"/>				
Description ?				
<input type="text"/>				
Notes (Occurrence Remarks) ?				
<input type="text"/>				
Life Stage ?	Sex ?	Individual Count ?	Sampling Protocol ?	Preparations ?
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Phenology ?	Establishment Means ?		<input type="checkbox"/> Cultivated	
<input type="text"/>	<input type="text"/>			

Develop the ability to query and display phenological characters in the Symbiota interface



CCH2

Featuring Data From the California Phenology TCN

[Home](#) [Search Collections](#) [Map Search](#) [Image Search](#) [Browse Images](#) [About CCH](#)

[Log In](#) [New Account](#) [Sitemap](#)

Welcome to the Consortium of California Herbaria Portal (CCH2)

CCH2 serves data from specimens housed in CCH member herbaria. The data included in this database represents all specimen records from partner institutions. The data served through this portal are currently growing due to the work of the **California Phenology Thematic Collections Network (CAP-TCN)**. This collaboration of 22 California universities, research stations, natural history collections, and botanical gardens aims to capture images, label data, and phenological (i.e., flowering time) data from nearly 1 million herbarium specimens by 2022. Data contained in the CCH2 portal will continue to grow even after this time through the activities of the CCH member institutions.

For more information about the California Phenology TCN, visit the project website:

<https://www.capturingcaliforniasflowers.org>

For more information about the California Consortium of Herbaria (CCH) see:

<http://ucjeps.berkeley.edu/consortium/about.html>

The California Phenology TCN is made possible by the National Science Foundation Award 1802312. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the



Project Team



Project manager:
Katelin (Katie)
Pearson,
Cal Poly



Susan Mazer
UCSB



Data manager:
Jason Alexander
UC Berkeley



Jenn Yost
Cal Poly

Understanding Phenology Across Scales



Mobilizing New England Vascular Plant Specimen Data



to Track Environmental Changes

Stay Tuned!

www.capturingcaliforniasflowers.org

 [@CalPhenologyTCN](https://twitter.com/CalPhenologyTCN)

Jenn Yost: jyost@calpoly.edu

Katie Pearson: kdpearso@calpoly.edu

Jason Alexander: jason_alexander@berkeley.edu



[CAP](#) [About](#) [Resources](#) [Meetings & Talks](#) [Education & Outreach](#) [Media](#)

CALIFORNIA PHENOLOGY

Education and Outreach

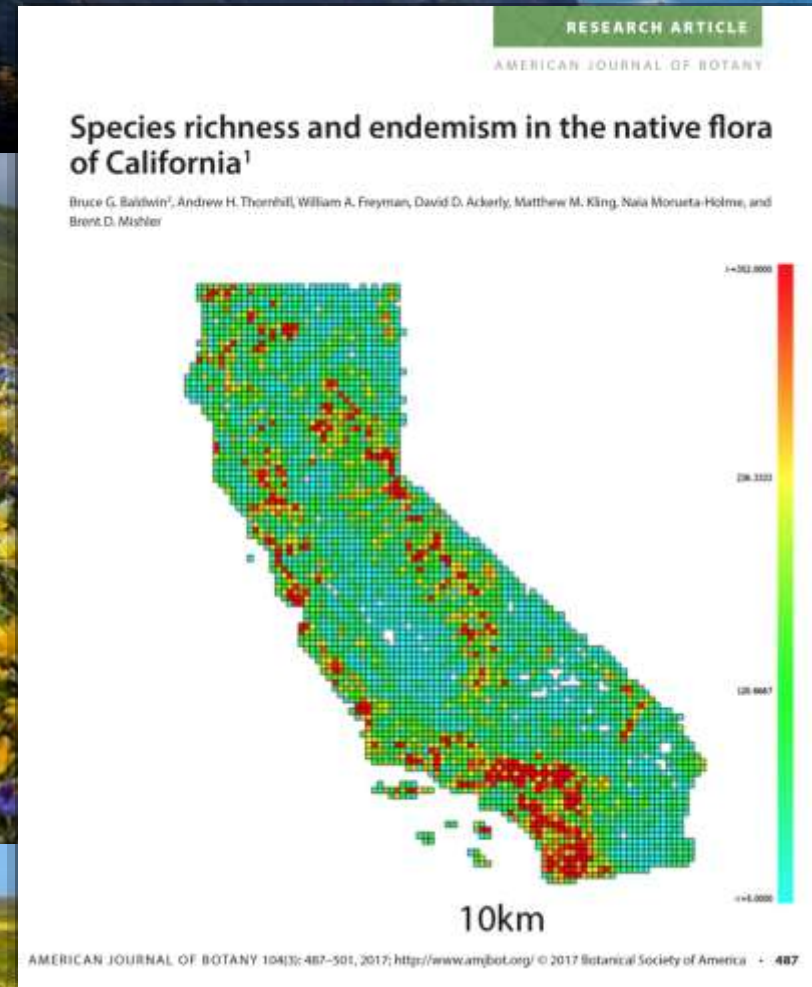
- K-12 phenology lesson plans



- Undergraduate courses at OBI and UCSB
- UCSB School of Education internships
- Citizen science: phenology expeditions
- Public phenology workshops at UCSB, SBBG, RSA and/or UCB

California's Plants

- Total native species: 5,094
- Total native taxa (subspecies and varieties): >6,500
- Largest native families:
 1. **Sunflower Family**
Asteraceae (733 species)
 2. **Legume Family**
Fabaceae (307 species)
 3. **Forget Me Not Family**
Boraginaceae (295 species)
 4. **Grass Family**
Poaceae (252 species)
 5. **Buckwheat Family**
Polygonaceae (215 species)



Implementation

- Phenology portal (Symbiota)



Symbiota

*Promoting
Bio-Collaboration*



- Imaging stations for 19 institutions



Timeline

