




Lecture #2
Coordinated Phenological Research Networks: Nuts, Bolts, and Roles

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University of California, Santa Barbara

USGS science for a changing world

USA npn National Phenology Network









Phenology is the science of the seasons

Spring wildflowers

Foliage color change

Migration patterns






"*Phenology… is perhaps the **simplest process** in which to track changes in the ecology of species in response to climate change.*" - IPCC 2007



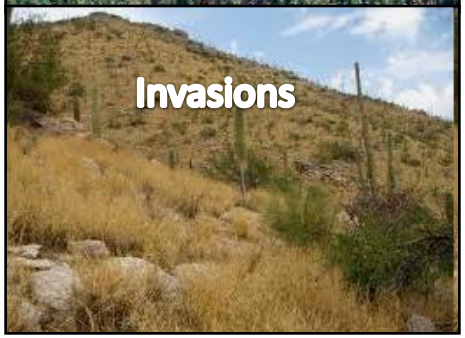






Concrete benefits of monitoring phenology over time

Predict and address hazards

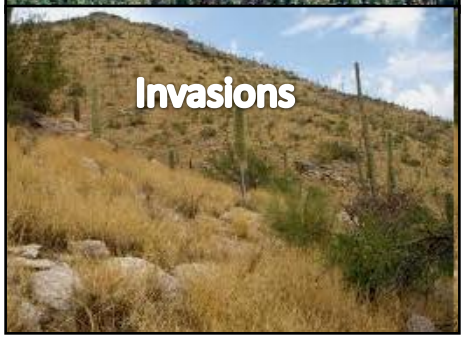


Plan cultural and recreational events

Understand human health and food security issues

Concrete benefits of monitoring phenology over time

Predict and address hazards



Plan cultural and recreational events

Understand human health and food security issues

What are the challenges of monitoring phenology over long time periods and over different ecological scales?

Coordinated Phenological Research Networks

Collaborative partnerships between researchers, government agencies, non-government agencies, educators, and citizen scientists

Coordinated phenological monitoring: the benefits

- Engages people with different but complimentary areas of expertise
- Can engage participants at many levels of expertise
- Uses **standardized methods** for large-scale data collection
- Results in larger data sets than a single researcher can obtain
- Centralized database management can facilitate data archiving and analysis

Outline

I. Coordinated research networks

- What are they? Who collaborates in these networks? What can we learn from coordinated research?

II. Coordinated phenological research in the United States:

Clonal lilac monitoring (northern U.S.)

the USA National Phenology Network

III. Phenological at the state level:

the California Phenology Project

IV. Phenological at the regional level

Examples: **Northeast Regional Phenology Network**

University of California, Santa Barbara Phenology Stewardship Program

Coordinated Phenology Networks

Phenological information has numerous practical applications. Phenological research networks have been established in numerous countries.

Some examples (there are <u>many</u> more):

- Nature's Calendar UK
- Nature's Calendar Ireland
- Climate Watch Australia
- Swedish Phenology Network
- de Natuurkalender in the Netherlands

In the **United States**, phenological research is coordinated by the **USA National Phenology Network**

USA npn National Phenology Network

www.usanpn.org

<u>Key Goal</u>: To understand how plants, animals, and landscapes respond to environmental variation and climate change

- Comprises a national biological science and monitoring program
- Provides a phenological data management system
- Enforces standard protocols for plants, animals, landscapes
- Engages government agencies, non-government agencies (NGOs), academia, the public
- Partners with other monitoring networks
- Offers web-based tools & services
- Provides on-line education & training tools

The Clonal Lilac Project:

Long-standing Coordinated Phenological Monitoring

The common lilac

- A non-invasive garden plant that grows in many regions of the United States
- Easy to propagate and grow clonal fragments

USA npn National Phenology Network

Common lilac and its phenophases

Breaking buds

Young leaves

Open Flowers

Full Flowering

Time

USA npn National Phenology Network

The Clonal Lilac Project: Long-standing Coordinated Phenological Monitoring

- The first phenological monitoring effort in the U.S.
- 1950's – 1990's: ~3500 **backyard scientists** monitored **cloned lilac plants** in backyards and gardens
- Each year, they sent postcards reporting the **date of first bloom** to **Dr. Joe Caprio** at Montana State University

The Clonal Lilac Project: Long-standing Coordinated Phenological Monitoring

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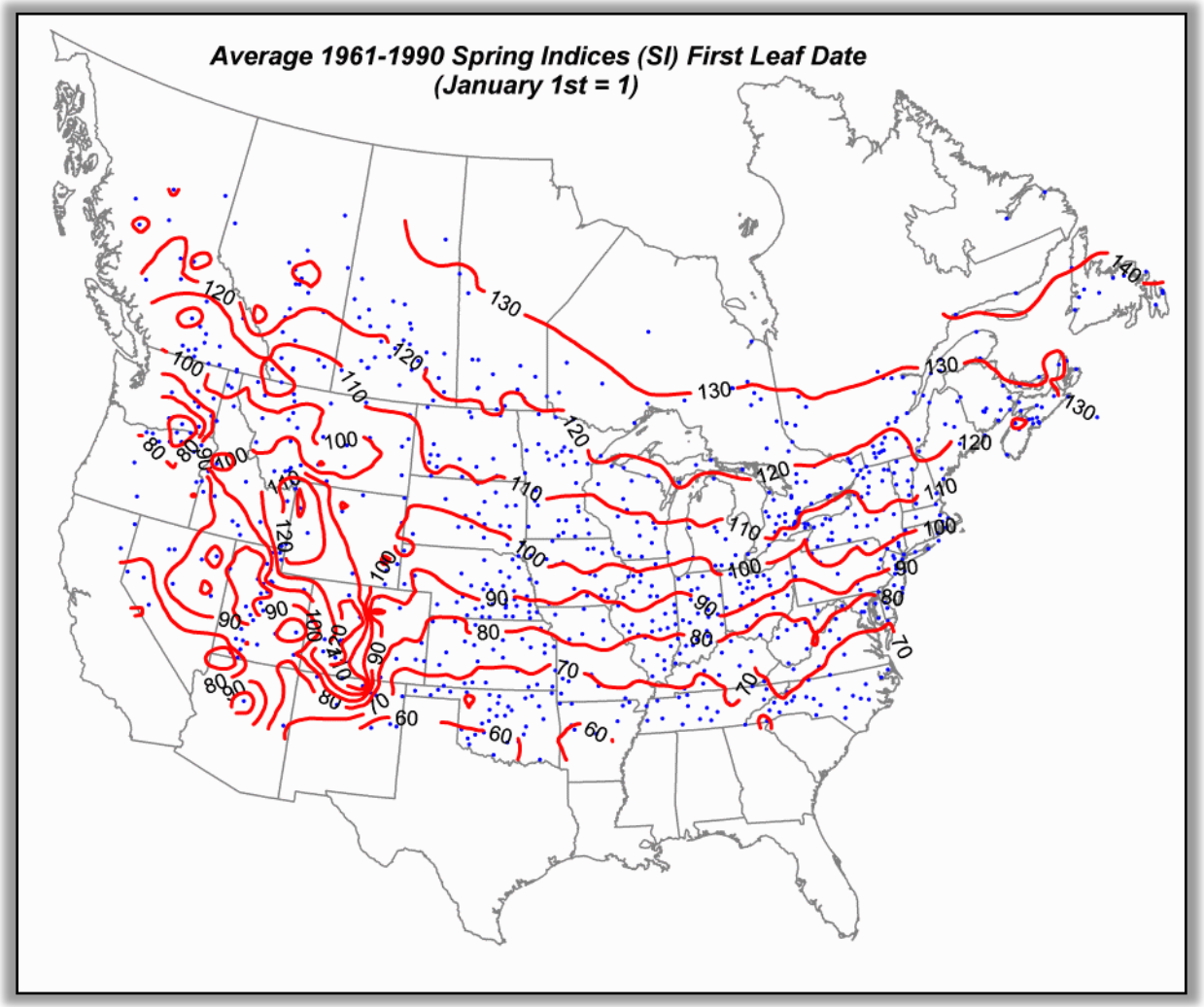
- 1950's – 1990's: ~3500 **backyard scientists** monitored **cloned lilac plants** in backyards and gardens
- Each year, they sent postcards reporting the **date of first bloom** to **Dr. Joe Caprio** at Montana State University
- First flowering dates dates of these lilacs have been used:
  - ✧ To show the effects of elevation and latitude on the onset of spring
  - ✧ To assess climate change throughout the U.S.

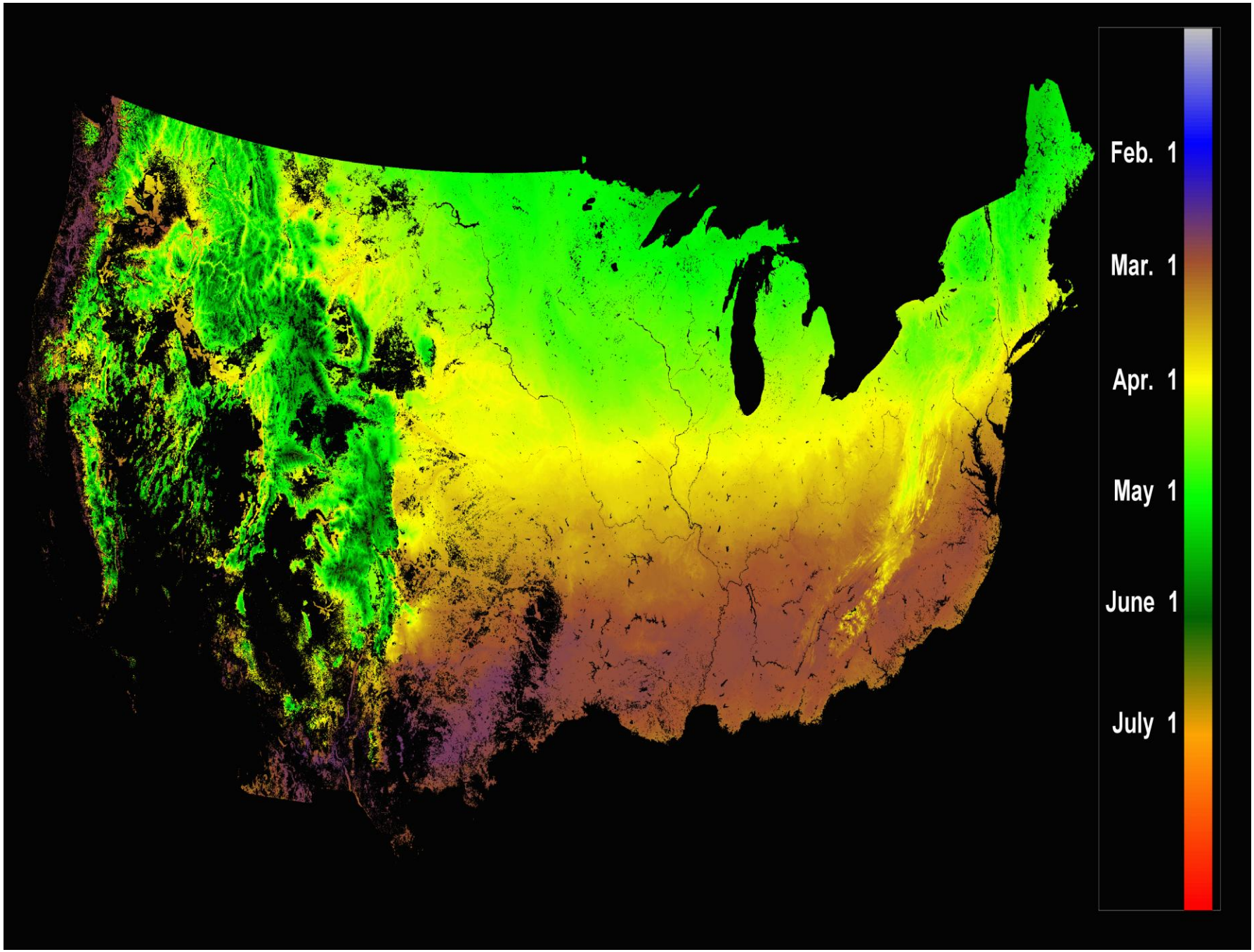
The Clonal Lilac Project:

Coordinated Phenological Monitoring



= Lilac phenology monitored for several decades

= Average # days after Jan-1 that Lilac leafs out

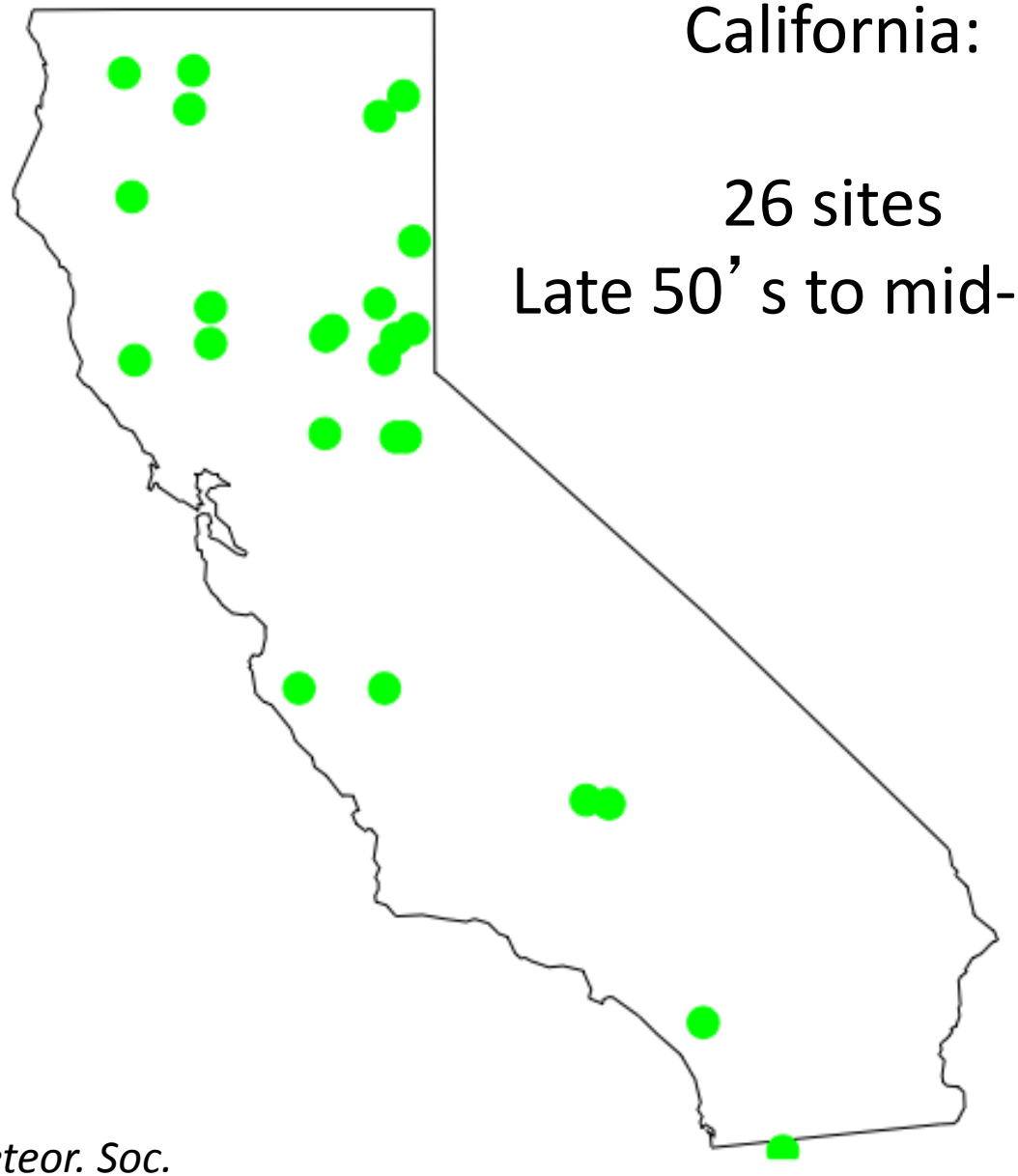


Mean SI First Leaf 1990-1993 & 1995-1999, Courtesy M. Schwartz

First bloom of Common Lilac in California

Volunteer network for Lilac monitoring in California:

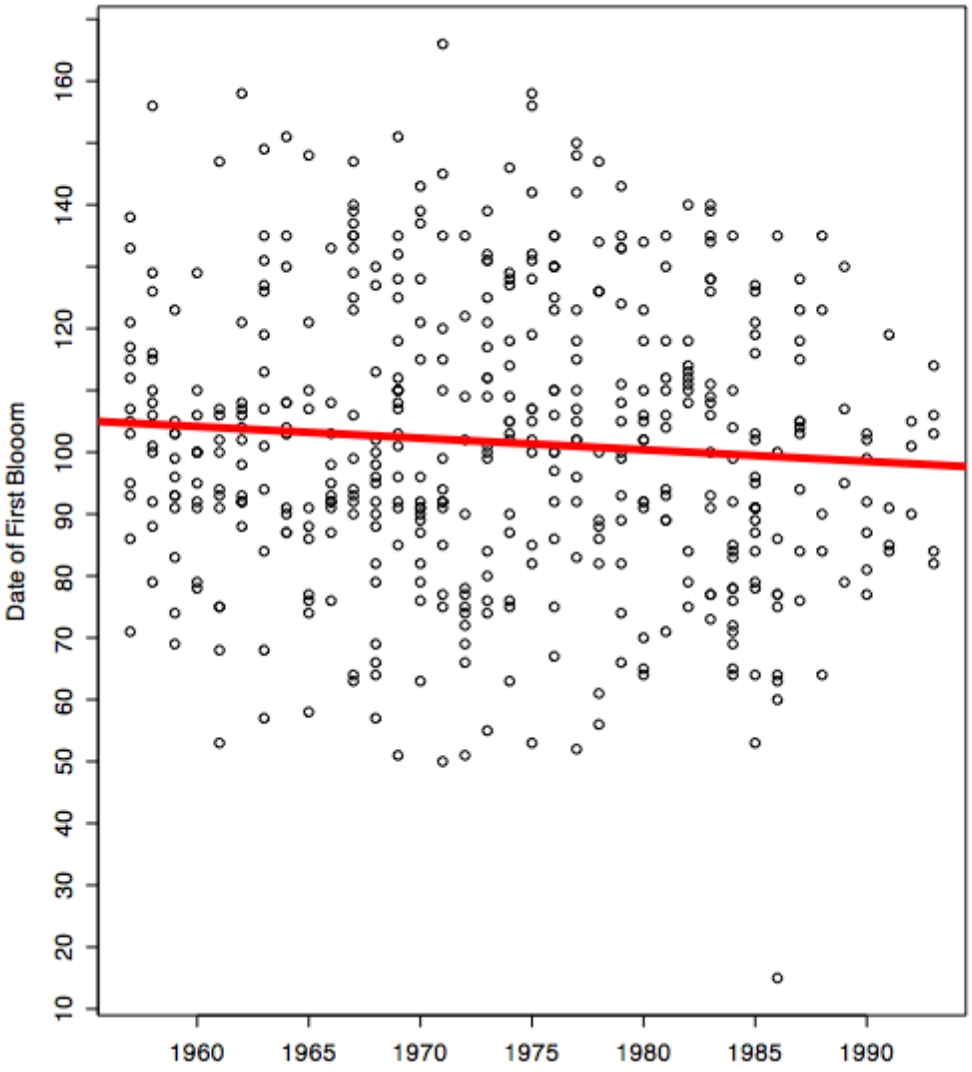
26 sites
Late 50's to mid-90's



Cayan et al. 2001, *Bull. Amer. Meteor. Soc.*

First bloom of Common Lilac in California

1.8 days earlier per decade



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IV. Phenological at the regional level

Examples: **Northeast Regional Phenology Network**

University of California, Santa Barbara Phenology Stewardship Program

USA npn National Phenology Network

www.usanpn.org

<u>Key Goal:</u> To understand how plants, animals, and landscapes respond to environmental variation and climate change

- A national biological science and monitoring program
- A national phenological data management system
- Standard protocols for plants, animals, landscapes

nature's notebook
a project of the USA-NPN

nature's notebook

a project of the USA-NPN

Go to **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

USA npn National Phenology Network

www.usanpn.org

Several ways to participate

- Observe plant & animal phenology
- Register a data set
- Rescue historical data

nature's notebook
a project of the USA-NPN

1 Search plants & animals

2 Learn how to observe

3 Register yourself

4 Start reporting

USA npn National Phenology Network

www.usanpn.org

nature's notebook
a project of the USA-NPN

participation

Each brown dot represents the location of a NPN citizen scientist (as of Aug 2011)

USA npn National Phenology Network

www.usanpn.org

nature's notebook
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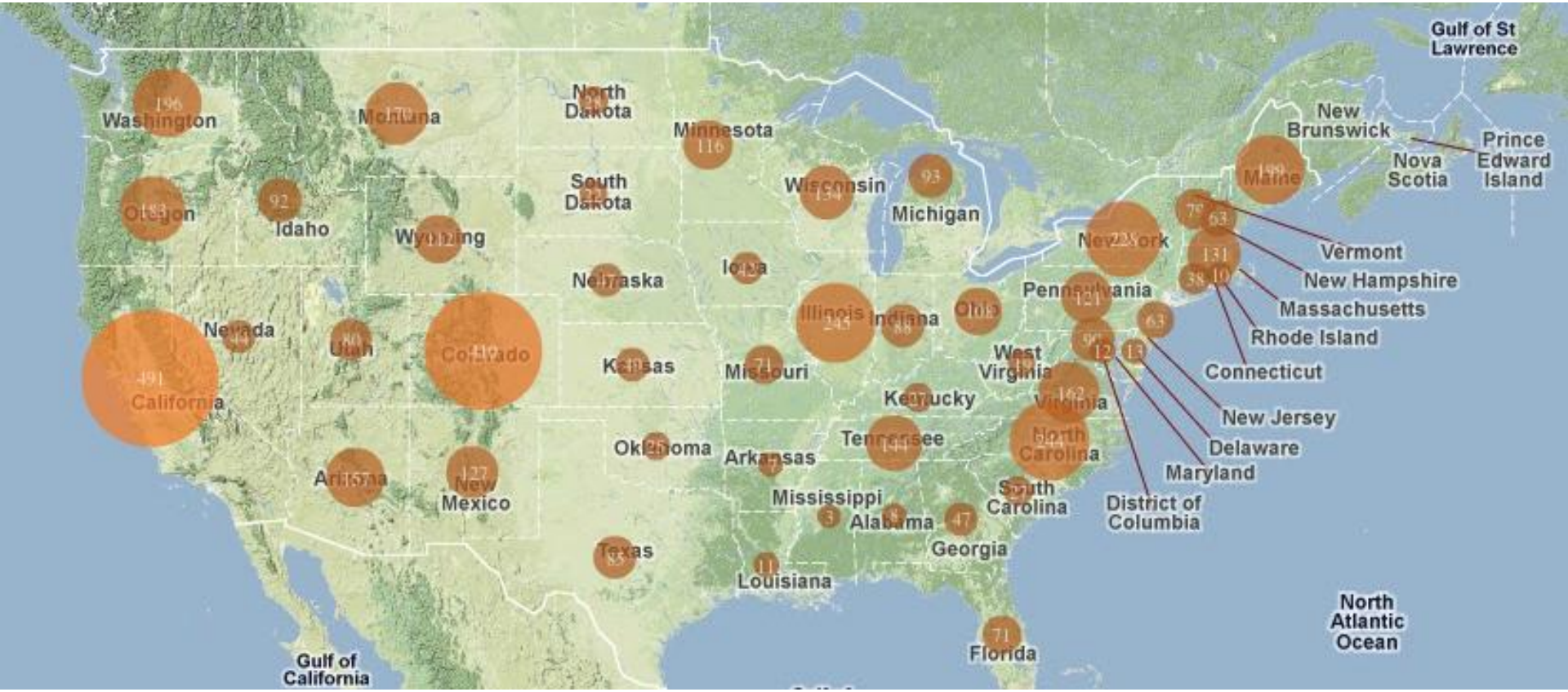
participation



National Phenology Network: Nature's Notebook

Standard protocols for plants, animals, and landscapes

Protocols for different plant life forms:

- Evergreens
- Cacti
- Conifers
- Deciduous
- Forbs
- Grasses
- Sedges

National Phenology Network: Nature's Notebook

Liz Matthews

Eschscholzia californica
California poppy

Forbs

nature's notebook

Species: _____
Plant Nickname: _____
Site: _____
Year: _____
Observer: _____

Do you see...?	Date:	Date:	Date:		
Initial growth	y n ? ____	y n ? ____	y n ? ____		
Leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Flowers	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Open flowers	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Ripe fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Recent fruit drop	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Check when data entered online:	☐	☐	☐	☐	☐

Comments:

National Phenology Network: Nature's Notebook

Do you see...?	Date:	Date:
Initial growth	y n ? ____	y n ? ____
Leaves	y n ? ____	y n ? ____
Flowers	y n ? ____	y n ? ____
Open flowers	y n ? ____	y n ? ____
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Ripe fruits	y n ? ____	y n ? ____
Recent fruit drop	y n ? ____	y n ? ____
Check when data entered online:	☐	☐

Comments:

Initial growth
New growth of the plant is visible, either from above-ground buds with green tips, or new green or white shoots breaking through the soil surface. Growth is considered "initial" on each bud or shoot until the first leaf has fully unfolded.

Leaves
One or more live fully unfolded leaves are visible on the plant. For seedlings, consider only true leaves and do not count the one or two small, round leaves (cotyledons) that are found on the stem almost immediately after the seedling emerges. Do not include dried or dead leaves.

Flowers
One or more fresh flowers or flower heads (inflorescences) are visible on the plant. Flower heads include many small flowers that usually do not open all at once. Do not include wilted or dried flowers that remain on the plant, or heads whose flowers have all wilted or dried.
How many fresh flowers or flower heads are present? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Open flowers
One or more open fresh flowers are visible on the plant. Flowers are considered "open" when the reproductive parts (male stamens or female pistils) are visible between unfolded or open flower parts. Do not include wilted or dried flowers that remain on the plant.
How many fresh flowers are open? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Fruits
One or more fresh fruits are visible on the plant.
How many fresh fruits are present? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Ripe fruits
One or more ripe fruits are visible on the plant.
How many fruits are ripe? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

National Phenology Network: Nature's Notebook

Sambucus nigra
black elderberry

Trees *and* shrubs
Deciduous

nature's notebook

Species: _____
Plant Nickname: _____
Site: _____
Year: _____
Observer: _____

Do you see...?	Date:	Date:	Date:	Date:	
Breaking leaf buds	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Increasing leaf size	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Colored leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Falling leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Flowers	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Open flowers	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Ripe fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Recent fruit drop	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____

National Phenology Network: Nature's Notebook

Sambucus nigra
black elderberry

Do you see...?	Date:	Date:
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Fruits	y n ? ____	y n ? ____
Ripe fruits	y n ? ____	y n ? ____
Recent fruit drop	y n ? ____	y n ? ____

Breaking leaf buds
One or more breaking leaf buds are visible on the plant. A leaf bud is considered "breaking" once a green leaf tip is visible at the end of the bud, but before the first leaf from the bud has unfolded to expose the leaf stalk (petiole) or leaf base.
How many buds are breaking? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Leaves
One or more live unfolded leaves are visible on the plant. A leaf is considered "unfolded" once the leaf stalk (petiole) or leaf base is visible. New small leaves may need to be bent backwards to see whether the leaf stalk or leaf base is visible. Do not include dried or dead leaves.
What proportion of the canopy is full with leaves? Less than 5% (<5); 5-24%; 25-49%; 50-74%; 75-94%; 95% or more (95+)

Increasing leaf size
A majority of leaves on the plant have not yet reached their full size and are still growing larger. Do not include new leaves that continue to emerge at the ends of elongating stems throughout the growing season.
What proportion of full size are most leaves? Less than 25% (<25); 25-49%; 50-74%; 75-94%; 95% or more (95+)

Colored leaves
One or more leaves (including any that have recently fallen from the plant) have turned to their late-season colors.
What proportion of the canopy is still full with green leaves? 95% or more (95+); 75-94%; 50-74%; 25-49%; 5-24%; Less than 5% (<5)

Falling leaves
One or more leaves are falling or have recently fallen from the plant.

National Phenology Network: Nature's Notebook

Sambucus nigra
Black elderberry

Do you see...?	Date:	Date:
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 ? ____
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Flowers	y n ? ____	y n ? ____
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Flowers
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Open flowers
One or more open fresh flowers are visible on the plant. Flowers are considered "open" when the reproductive parts (male stamens or female pistils) are visible between unfolded or open flower parts. Do not include wilted or dried flowers that remain on the plant.
How many fresh flowers are open? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10); Peak flower (P): The plant has a large number of flowers and one half (50%) or more are open and still fresh.

Fruits
One or more fresh fruits are visible on the plant.
How many fresh fruits are present? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Ripe fruits
One or more ripe fruits are visible on the plant.
How many fruits are ripe? Less than 3 (<3); 3 to 10 (3-10); More than 10 (>10)

Recent fruit drop
One or more fresh mature fruits or seeds have dropped or been removed from the plant since your last visit. Do not include obviously immature fruits that have dropped before ripening, such as in a heavy rain or wind.

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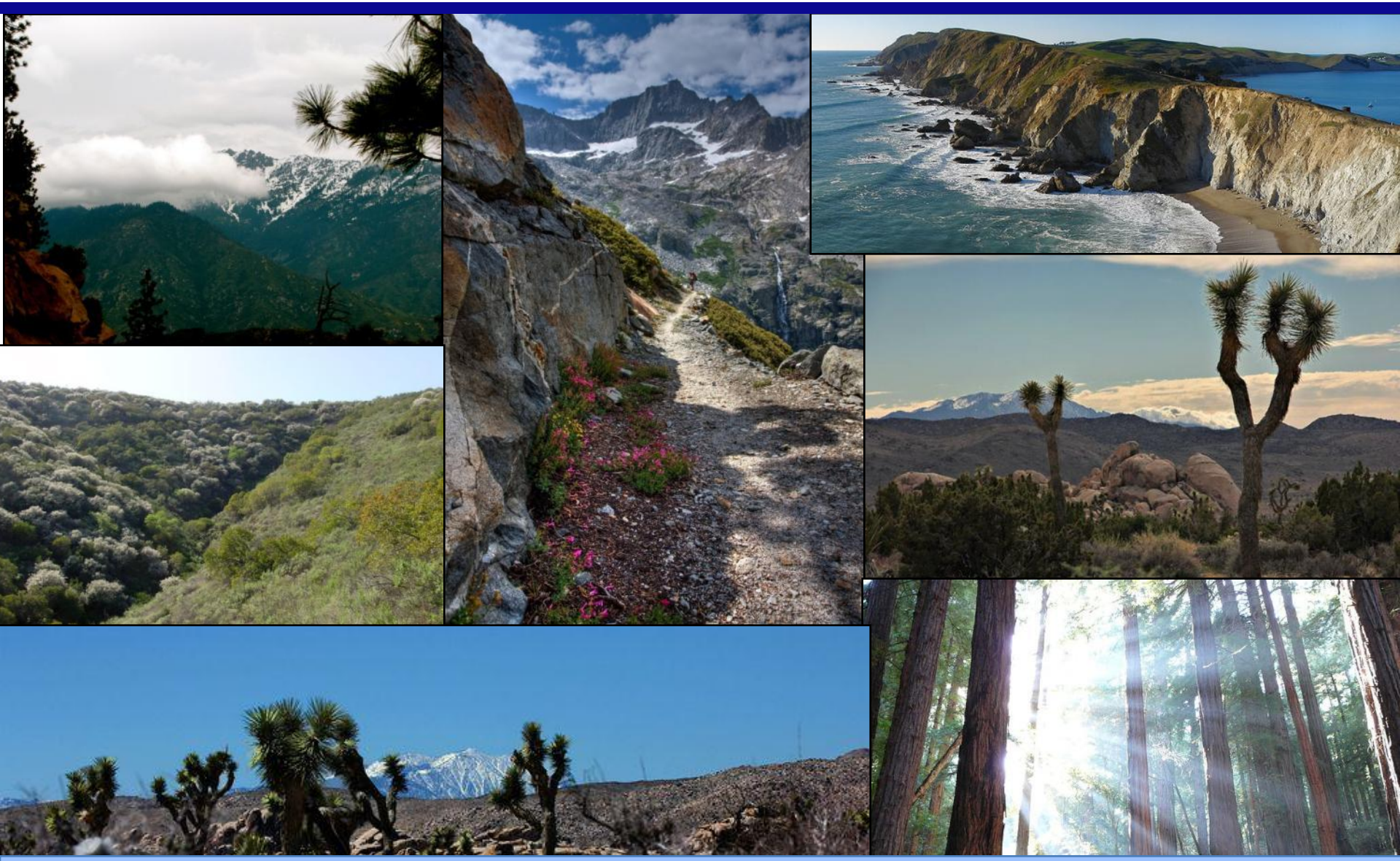
University of California, Santa Barbara Phenology Stewardship Program

California Phenology Project



Intro to Coordinated Research | National Level | **State Level** | Regional Level

California Phenology Project Sites: pilot parks

- Redwood National Parks
- Lassen Volcanic National Park
- Golden Gate National Recreation Area
- Joshua Tree National Park
- Santa Monica Mountains National Recreation Area
- Sequoia and Kings Canyon National Parks

California Phenology Project

CPP goals

To establish a phenological monitoring network across California

To monitor across a large geographic area and along key environmental gradients

To address key scientific questions and resource management challenges

COLLABORATORS

USGS science for a changing world

UCSB Phenology Stewardship Program

USA npn National Phenology Network

FUNDING

NPS Climate Change Response Program 2010

Scientific Questions Addressed by California Phenology Project: examples

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

California Phenology Project

www.usanpn.org/cpp

In 2011 & 2012, training botanists, ecologists, and education specialists at **six** pilot national parks in CA.

They are learning how to conduct phenological monitoring (using USA-NPN protocols and online tools).

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University of California, Santa Barbara Phenology Stewardship Program

Northeast Regional Phenology Network

ne-rpn

Photo credits

www.nerpn.org

- Located in the northeastern United States and eastern Canada
- Coordinates phenological monitoring and facilitates data sharing and synthesis

- Collaborates with the USA National Phenology Network
- Collaborates with the **Phenocam Network**, which is a network of phenological monitoring that incorporates remote sensing webcams

Image: http://klima.sr.unh.edu/gallery.html

Phenology at the Regional Level:
UC Santa Barbara in Southern California

UCSB Phenology Stewardship Program

UCSB Phenology Stewardship Program

Research

- Historical phenology (herbarium)
- Wild populations & communities

PHENOLOGICAL LITERACY

UNDERSTANDING THROUGH SCIENCE & STEWARDSHIP

Phenology Gardens & Trails

- Schoolyard native plant gardens
- Community native plant gardens

Education, Outreach, Training

- Formal & informal science education
- Training workshops – scientists, educators

Nature Sleuths

Young scientists exploring & observing outdoors

PHENOLOGICAL LITERACY

UNDERSTANDING THROUGH SCIENCE & STEWARDSHIP

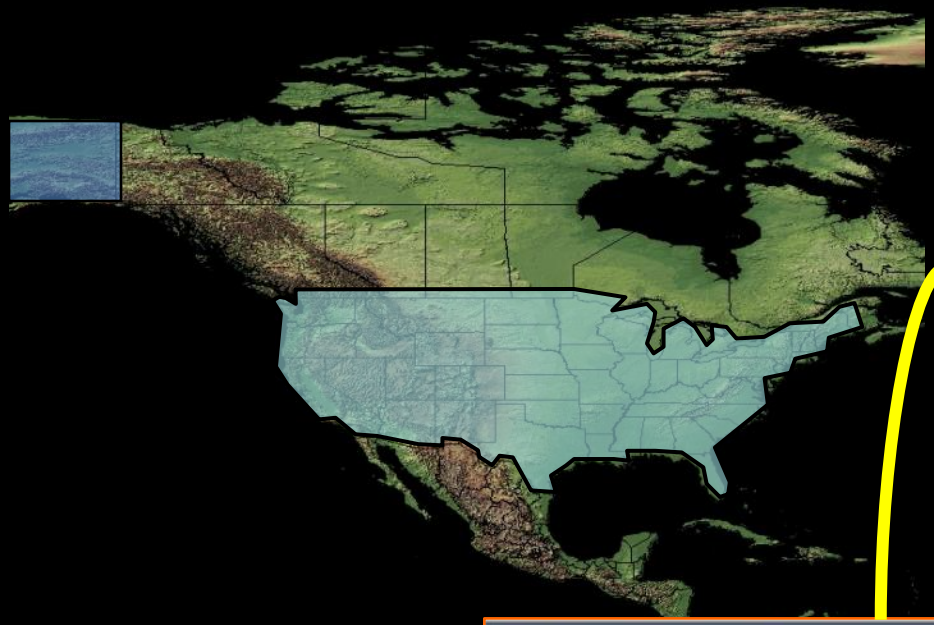
UCSB Phenology Stewardship Program

USA npn National Phenology Network

Unite existing scientific networks

NASA · U.S. Fish & Wildlife Service · Forest Service, U.S. Department of Agriculture · USGS science for a changing world · National Park Service

Facilitate and promote phenological monitoring by citizen scientists & educational institutions



California Phenology Project

UCSB Phenology Stewardship Program

Northeast Regional Phenology Network
ne-rpn