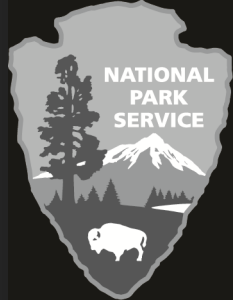


Pulse of the Planet

Sequoia and Kings Canyon National Park Interpretive Program



Type of Program:

Interpretive Walk

Setting:

Foothills of the western Sierra Nevada mountains

Audience:

All Ages

Duration:

45 minutes

Universal Concepts:

Change
Survival
Interconnectedness
Time

Vocabulary:

adaptation, bud burst, nurse tree, phenology, phenophase

Theme:

The study of species response to environmental change is called phenology. Phenological changes are regular and seasonal, and can therefore be used to measure long-term trends, such as climate change.

Goal:

To inform visitors of the importance of timing in an ecosystem and how they can become citizen scientists by monitoring phenology, which will provide insight into our changing environment.

Objectives

After completing this program participants will be able to:

1. Name three plant phenophases
2. List two examples of how phenology applies to animals
3. Explain one way climate change may affect a species
4. Access the California Phenology Project or Nature's Notebook website

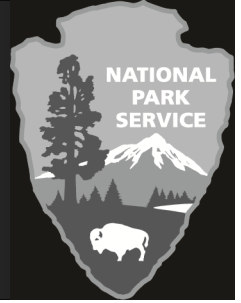
Materials:

1. Pictures of a buckeye throughout the seasons (attached)
2. Lilac monitoring trend sheet (attached)
3. Nature Notebook plant monitoring sheet (attached)
4. Oak Woodlands Food Web activity (attached)



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Introduction:

How do you know when it's time for school to start or when it's time to put on boots and a coat? Humans have lots of tools like clocks, thermometers, and calendars to indicate the changing seasons.

Each year, plants and animals experience seasonal changes. We can observe plants year after year and see that cyclical patterns arise. Maybe you've noticed that berries ripen in the summer, and that some trees have leaves that change color and drop in the fall. The study of these changes is called phenology.

Today, we are going to take a look at oak woodlands, because they are an ideal ecosystem for understanding the importance of phenology. By looking at a small part of this ecosystem, we will reveal patterns in nature and gain a deeper sense of how timing is everything.

I. What is phenology?

A. Phenology is the study of plant and animal responses to the seasons. Can you name some examples of how the weather changes with the seasons?

1. Examples: changing temperatures, changing amounts of rain or snow, changing levels of humidity.

2. Who has ever heard that April showers bring May flowers? Flowers blooming are an example of phenological change.

a. Can you name other plant and animal reactions to changing seasons? Examples: Bears come out of hibernation in the spring, some trees lose their leaves in the fall.

b. Humans change their clothing type depending on the temperature. Because animals and plants cannot do this, they need adaptations like shedding fur or leaves to survive the changing seasons.

II. Let's pick a common species of the oak woodlands ecosystem and discuss its phenology. The California buckeye is found throughout the foothills of California.

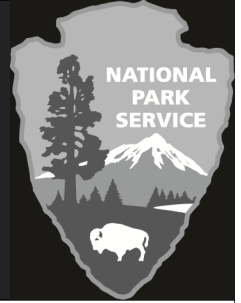
A. If we could look at a buckeye right now, what would it be doing? If it's fall they may have fruits forming, in winter the leaves may be growing, in spring the flowers are blooming, and in the summer the leaves are changing color and dropping. All these events are examples of phenophases.

B. When we monitor phenology, we are recording the timing of phenophases. Every plant and animal, including the buckeye, has phenophases, which are distinct seasonal events in the life of a species.

C. Take out photos of California buckeye phenophases (attached). Show them as you

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explain the buckeye's phenophases.

1. Summer Phenophase.
 - a. Why do buckeyes drop their leaves in the summer and not the fall?
 - b. Is anyone feeling thirsty now? Will you visit a water fountain today, or fill up a water bottle? The buckeye cannot do that. They have to rely on ground water, which is scarce in the summer.
 - c. The buckeye leaves are large and lack the waxy coating that other plants have to keep water from evaporating. Instead they drop their leaves to conserve water.
2. Fall Phenophase
 - a. Without leaves, buckeyes use stored energy to grow fruits.
 - b. These fruits will ripen in time for the fertile rainy season.
3. Winter Phenophase
 - a. During the winter rainy season
Buckeye seeds sprout.
Leaf buds burst and grow into new leaves.
4. Spring Phenophase
 - a. Showy buckeye flowers bloom and are pollinated by insects.

III. The oak woodland ecosystem drives the survival of hundreds of plant and animal species, including the trees that are the foundation of that ecosystem...the oaks!

- A. Oak trees also have phenophases, which other species rely upon.
- B. In California alone, there are 20 species of oaks, upon which thousands of insects and animals rely on for some aspect of survival.
 1. The primary reasons oak woodlands support such a variety of species are that they provide plants and animals an abundant supply of food, shelter, nesting sites, and shade.

Activity: Show the photographs of plants, animals, and microinvertebrates provided. Ask attendees to name the featured species' relationship to oak trees.

- Black bears, woodpeckers, squirrels, and humans eat acorns.
- Insects (gall wasps, oak twig borer, ambrosia beetle) live in oak wood, on oak bark, and in acorns. Birds eat these insects.
- Animals such as cougars use oaks as a safe place to sleep. The shade under oak trees creates good conditions to grow plants like the manzanita. When an oak helps another plant to grow, it is called a nurse tree.
- Oak leaves fall to the ground and decompose into soil, with the help of fungi, bacteria, and invertebrates. These organisms are known as decomposers (formicid ants, bdelloid rotifers, fungi). Oak leaves provide the food for these species.
- What would happen if the timing of the seasons changed in the oak

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woodlands?

IV. Plants and animals rely on seasonal cues to know when to change.

A. Climate change is one of the important reasons why we monitor phenology.

B. Plants, such as the lilac, have helped us track changes in our climate for over 50 years.

1. Here is a graph of lilac blooming and leafing dates at a site in Vermont that was monitored in the 1960s through the early 2000s. (attached)

a. We can see with the black trend line that lilacs have steadily bloomed and leafed earlier and earlier since monitoring began.

b. While each consecutive year does not give us much information, the long term trend shows us what we might expect for the future. If lilacs are blooming earlier each year, we can expect to see similar trends in other plants.

c. Is climate changing timing in the oak woodlands? We don't know

C. In a warming climate, more than just plants may be affected.

1. Many pollinators in nature hatch depending on the length of the days, which will not change in a warming climate.

2. If plants begin blooming earlier and pollinators have not yet hatched, the insects will miss the bloom and not be able to pollinate.

a. What do you think happens when plants are not pollinated? No fruits or seeds will grow.

V. Humans would also be affected if pollinators could not pollinate our food.

A. Does anyone have a favorite spring or summer fruit? Many people love the variety of California berries and enjoy picking the ripe fruits.

1. If berry plants are not pollinated, then we won't have delicious berries to eat.

B. Medical professionals use phenology to estimate how much demand there will be for anti-allergy medications each year. Many Americans are allergic to plant pollen. Phenology monitoring ensures there will be enough medication to relieve coughing and sneezing during allergy season.

C. Historically, early U.S. settlers monitored phenology without even realizing it. They had a saying that went: "If the oak is out before the ash, 'Twill be a summer of wet and splash; If the ash is out before the oak, 'Twill be a summer of fire and smoke." The settlers used phenology to determine if the summer season would be wet, or dry with a high risk of fire.

1. These days we still use phenology to predict the likelihood of wildfires during the dry season, which greatly affects the communities of California.

VI. You can help by becoming a citizen scientist and participating in the California Phenology Project (CPP).

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- A. Citizen scientists are monitoring the changes of a wide range of plants listed on the CPP website. Chances are you have one or more in your backyard.
- B. The plants are regularly monitored and the data is uploaded to the CPP website.
- C. By having citizens like you monitor and record the phenophases of plants scientists can use the data to determine how seasonal patterns are changing.

VII. How to participate at home

- A. You can pick a plant—whether in a park or in your backyard—and record its phenology. The CPP has a list to help you decide which plant to choose. Upload your findings to Nature's Notebook via the California Phenology Project
 - 1. To access the phenology monitoring database, visit:
<http://www.usanpn.org/participate/observe>
 - 2. If you do not live in the U.S. many countries have their own phenological databases.
- B. Let's practice identifying and recording a plant's phenology for Nature's Notebook. (Pass out copies of attached monitoring sheet)
- C. What sort of phenophases do you think we will see? (Find a shrub or tree and fill out the monitoring sheet)
 - 1. Step in to help if they are incorrectly filling out the sheet.
(Instructions on how to fill out the monitoring sheet are online at http://www.usanpn.org/node/2246#record_plants).

Conclusion:

Thank you for helping monitor today! Now you have the tools to recognize phenophases and to record them on your own. If you decide to become a citizen scientist and to participate in the California Phenology Project, the information you collect will help paint a complete portrait of the way plants are changing across the United States. The data does not only give insight into climate change, but also how our environments and ecosystems will vary in future years. Through long-term monitoring, conservation managers can be more proactive about the changes occurring in our world. With your help we can be better equipped to keep ecosystems like our oak woodlands healthy. As the seasons change, remember how important timing is, not only in our own lives, but in all of nature.

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Vocabulary

Adaptation: A change in form or behavior that helps an organism live successfully in a particular environment.

Bud Burst: The emergence of new leaves at the beginning of each growing season.

Nurse Tree: A tree that protects or fosters the growth of other smaller trees.

Phenology: The study of the timing of seasonal changes in nature.

Phenophase: A specific seasonal change for a species. For example: Oaks have bud burst, increasing leaf size, leaves, flowering, fruiting, colored leaves, and leaves falling.

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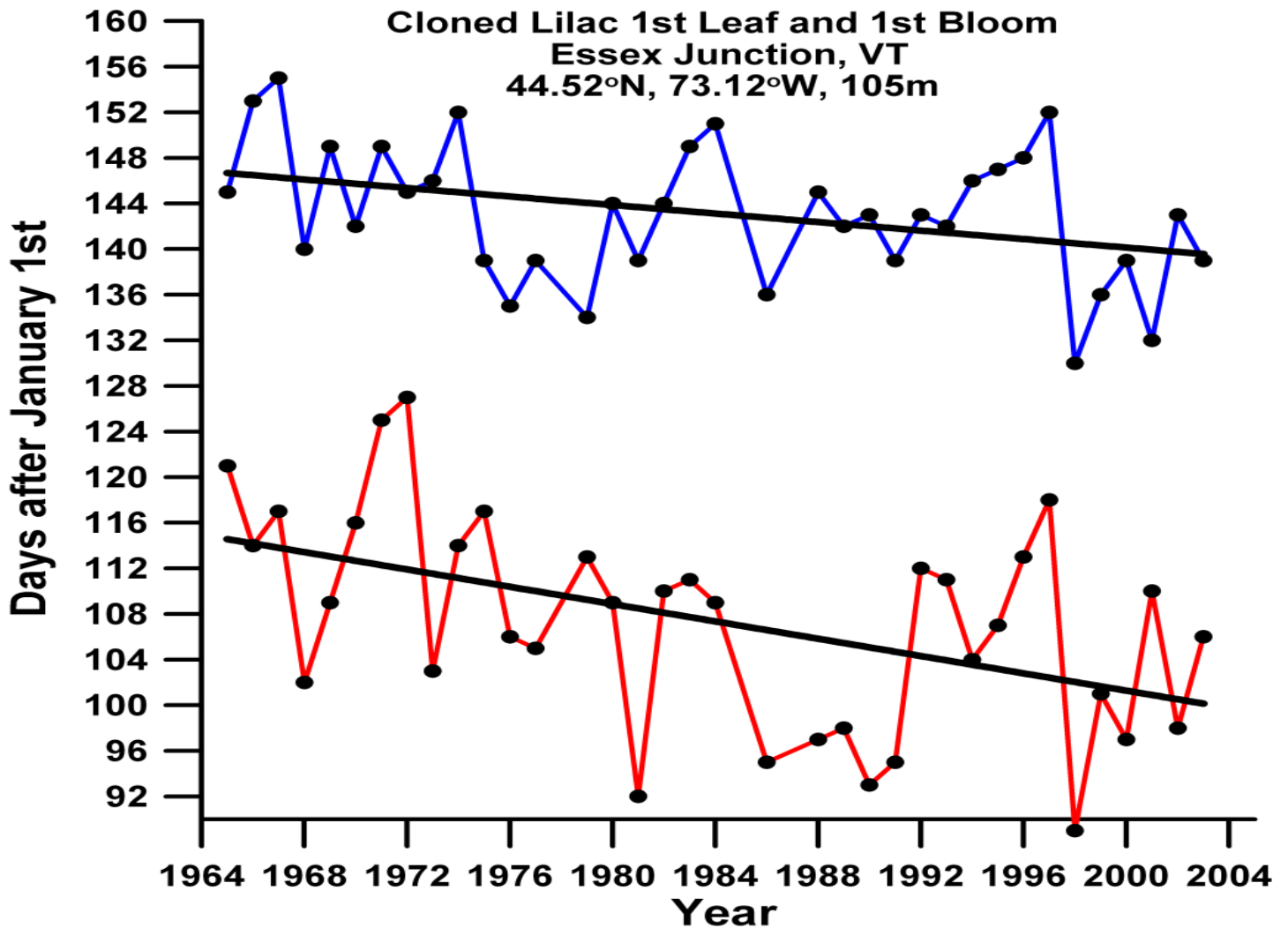
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Appendix:



Lilac Graph

Phenology is an indicator of environmental change

Blue Line= Date of First Flower

Red Line=Date of First Leaf

Trees and Shrubs *Deciduous (with pollen)*



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: red maple-1
 Species: red maple
 Site: test
 Year: 2012
 Observer: _____

Do you see...	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:
Breaking leaf buds	y n ? _____	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 ? _____	y n ? _____
Increasing leaf size	y n ? _____	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 ? _____	y n ? _____
Falling 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: <input type="checkbox"/>								
Comments:								



Mountain Lion



Whiteleaf Manzanita



Gall Wasps

Oak Twig Borer



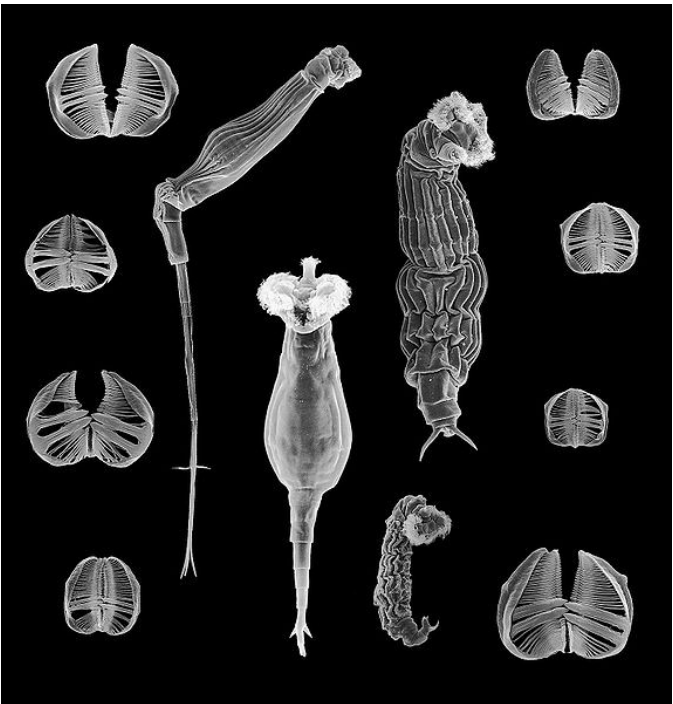
Ambrosia Beetle



Formicid Ant



Fungi



Bdelloid Rotifers



Bud Burst (the beginning of new leaf growth)



Blooming Flowers



Forming Fruits



Increasing Leaf Size



Dropping Leaves