



Activity 3.2: Seasons of a Plant

Grades 7 – 9

Description: Students are introduced to the concept of phenology—the timing of periodic life-cycle events. Students begin by distinguishing between biological and environmental events in an ecosystem (first snow vs. first flower). They place their events on a calendar and then brainstorm what might happen if these biological events didn't happen one year. Students then go outdoors and individually or in small groups make observations of actual phenological events.

Time: Two sessions

Materials:

Part 1

- Copies of blank Phenology Calendar handout
- Paper or journal for students to list ideas
- Large display for class discussion (chalkboard, whiteboard, projector and screen, etc.)

Part 2

- Copies of blank Phenology Checklist handout
- Clipboards or journals, so students can write while outside
- Completed Phenology Calendars
- Large display for class discussion (chalkboard, whiteboard, projector and screen, etc.)

National Science Education Standards

C3.A All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.

5D/E4 Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful.

AAAS Benchmarks

5D/E4 Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful.

5D/E1 For any particular environment, some kinds of plants and animals thrive, some do not live as well, and some do not survive at all.

5F/H6c When an environment, including other organisms that inhabit it, changes, the survival value of inherited characteristics may change.

Guiding Questions

- What is the difference between biological and environmental events?
- What is phenology?
- What natural occurrences illustrate phenology?
- What happens if phenology changes?

Assessment(s)

- Phenology calendar
- Phenology checklist

Background

The study of phenology is something that people have done since they first walked on Earth, and all of us still make phenological observations today in one way or another. By taking note of the relationship between climate and life-cycle events for plants and animals, people have been able



to better understand the world they live in. This information, in turn, has equipped humans for generations with information they use to manage the resources they need to thrive. For example, did you know that some people:

- plant corn when oak leaves are the size of a squirrel's ear
- plant peas when forsythia blooms
- plant potatoes when the first dandelion blooms
- plant bean, cucumber, and squash seeds when lilacs are in full bloom?

Is there a real connection between the blooms of a dandelion and planting potatoes? Not specifically. But when the dandelion is blooming, that tells us that growing conditions are good for other things to grow too. Phenological events such as birds migrating, earthworms becoming active again, flowers blooming, and fruits ripening, happen in response to a combination of physical, chemical, and biological conditions. With careful observations, Native American Indians, landowners, farmers, and gardeners recognized such patterns in life-cycle events for different species.

Today, an increasing number of people are becoming interested in phenology again. But now it is not so that we can better understand when to plant certain crops or how to predict harvest dates. Instead scientists, citizen scientists, and many other groups are using life-cycle events of plants and animals to help understand impacts of climate change, to help manage pest outbreaks, to guide urban and cultural planning, and more.

Today people are using records from the past to provide insights into current and future conditions. They are also collecting new data and creating new phenological records that will be more complete and more widespread than those of the past. The science of phenology enables people to creatively examine obvious events and information all around us, and then use that information to tackle diverse challenges.

Additional Resources:

<http://phenology.cr.usgs.gov/> (USGS remote sensing and phenology website, overview, methods, data, and vegetation indices)

<http://budburst.org/phenology;jsessionid=y-vzCOHvC-nNW2u2OunIWaNM.dmz-portal-web-1> (basic information about plant phenology and its responses to climate change)

<http://www.aldoleopold.org/Programs/phenology.shtml>

<https://www.pwrc.usgs.gov/bpp/> (North American Bird Phenology Program)

http://gcmd.nasa.gov/records/GCMD_GLCF_GIMMS.html (NASA vegetation data sets)

<http://sites.bu.edu/cliveg/> (Boston University Climate and Vegetation Research Group)

Part 1: Periodic Life-Cycle Events—Studying Phenology

Procedure

1. Begin with some general questions to the group to get them thinking about things they observe and use as sources of information without really thinking about it.
 - What do you expect when the sky darkens from thick clouds?



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- What season is it when you are walking through a grove of maple trees and notice drips of liquid coming from a broken limb of one of the maples?
 - What are some things you observe that indicate that spring is coming?
 - If you see insects emerging, what season (or seasons) is it likely to be?
 - If you want to plant a garden would you do so when leaves are brown and falling or when they are just budding out?
2. Ask students: What makes a plant start growing in the spring season? (Plant growth may be triggered by daylight hours, precipitation, freeze/thaw cycles, in addition to warming temperatures). If they are having trouble, ask, How do you know when its spring? What do you notice?
 3. Point out to the students that we use many different signals to tell us about our world and to help us anticipate things like weather, temperature, and timing of things we need to do.
 4. Ask students to work in small groups to list natural events they expect to happen or see over the course of a year. The list can include **biological** and **environmental** events. Divide them according to these two categories. Examples of things students might list include:

Biological	Environmental
• First flower blooms	• First snow
• Leaves budding on trees	• First ninety-degree day
• Hear locusts	• Able to ice skate outdoors
• See first butterfly	• Hurricane season
• Leaves change color	• Rainy season
• Leaves fall	• First frost
• See birds flying north	• Frequent thunderstorms
• Find tadpoles	• Windows frost over
• See first honeybees	• Too cold to go barefoot
• Pick apples from trees	• Too hot to wear a coat
• Find seeds from trees on ground	• Warm in the day, cool at night

5. Work as a class to compile a single list on large display (paper, chalkboard, computer screen, etc.). Make sure the observations are placed in the proper categories.
6. Next, ask students to place each of the **biological** events on the Phenology Calendar handout provided below at the time of year they expect those things to take place. There will be variability in their answers.
7. Explain to students that everything they listed in the biological category is part of the study of phenology.



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8. Now ask students to imagine that one year these biological events did not happen at the right time. Have them make a list of factors that might cause them to occur at a different time than they normally do.
9. Discuss their lists as a class. Many of the things on the list should be related to climate and weather. Some may also be biological (disease) or human-caused events (habitat loss, chemical use, etc.).
10. Explain that the other part of phenology is understanding the relationship between biological events and seasonality or climate.
11. Based on what they have done so far, have students come up with their own definition of phenology and write it on the top of the phenology calendar they made. Take student ideas and write them on the board.
12. Share this somewhat technical definition of phenology with students: “The study of periodic plant and animal life-cycle events and how these are influenced by seasonal and inter-annual variations in climate.” Explain that they will be looking at the timing of events in the plant life cycle—like a plant’s first leaf and first flower. You may want to use this opportunity to review the plant life cycle with students.
13. Phenological events also shape our cultural practices. Ask students to look back over their calendars and insert traditional events that happen through the year that are linked in some way to phenological events (e.g., fall festivals, Thanksgiving).
14. Explain to students that people have always made phenological observations because of how they inform us about weather and climate. The project they will be studying for the next many weeks is designed very specifically to examine the relationship between climate and phenology.

Part 2: Field Observations—Looking for Life-Cycle Events

Procedure

1. After students have completed their own phenology calendar and talked briefly about their ideas on climate change, they will go outdoors and practice making field observations.
2. With the Phenology Checklist handout provided below, pencils, and their phenology calendars, ask students to make as many life-cycle observations as they can. Depending on the time of year that they do this activity, they may or may not be able to find the first flower blooming or first leaf budding out. Instead they may observe plants in mid-bloom or leaves changing color.
3. After working individually, walk around the site together pointing out and sharing observations.



4. Use the discussion questions below to talk with students about methods for collecting data, making careful inferences, and other needs for gathering meaningful data.

Discussion Questions

- If you make phenological observations only one time, how will that be different from someone who makes observations once every year? Or once a month? Or weekly? Explain why the frequency of observations makes a difference in what it tells you.
- Select one of the observations you made today and imagine that you collected information about that particular trait over the course of a year. How would you expect it to be different the following year if winter lasted a month longer? How do you think it might be different if winter ended a month earlier?
- Do you think all species respond the same way to changes in climate? In other words, do you think a warmer winter will cause all plants, all pollinators, all herbivores, and all carnivores to adjust their life-cycle stages at the same time and in parallel ways? Explain your answer and why you think it might matter for ecosystems.
- If you expect to see particular animal life-cycle events, but you don't see them, does that mean that the climate must have affected them? Explain some of the pros and cons of studying plants vs. studying animals.

Part 3: Closure—Phenology in Nature

Have a general discussion about how changes in climate might affect some of the things they have on their phenology calendar. If you have already covered ecosystem interactions, you may want to make connections between plant bloom times, pollinator life cycles, and food webs. In some cases, a plant is cued by temperature and an animal by day length. Ask students:

- How do plants know when to bloom?
- How do insects know when to hatch, or change from larvae to adults?
- What effects might changes in phenology have on species' (plant or animal) survival?
- If all plants and animals in an ecosystem are connected, what might happen to the ecosystem if the phenology of some organisms changes and the phenology of others doesn't?

EXAMPLE: The English oak blooms two weeks earlier than it used to. The moth larvae that feed on their leaves hatch two weeks earlier as well. The pied flycatcher used to arrive when the larvae hatched to feed on them. However, the birds are migrating at the same time as they always have, so when they arrive, the larvae population has already hatched and started to pupate. The bird population is declining as a result.

Extension:

You might suggest having students research other phenological sayings pertinent to their region, and trying to figure out if they are still in use, and whether or not they are valid.



Name: _____ Date: _____ Room: _____

Phenology Calendar

Phenology is:

January

February

March

April

May

June

July

August

September

October

November

December



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Name: _____ Date: _____ Room: _____

Checklist for plant or animal life-cycle events. Do you see...

Phenological event	Check if you see it
Leaves budding out	
Leaves fully mature	
Leaves changing color	
Leaves falling	
Flower buds developing	
Half of flowers in full bloom	
Plant in full bloom	
Flowers dropping	
Seeds or fruits	
Mature seeds and fruits/falling or ripe	
Butterflies feeding on nectar	
Butterflies laying eggs	
Caterpillar feeding	
Bees collecting pollen	
Hear insects singing	
Insects	
Birds flying in V-formation north	
Birds flying in V-formation south	
Robins or other early spring birds	
Birds nesting (carrying or gathering nesting materials)	
Birds singing to attract mates	
Birds learning to fly (fledging)	
Hear birds signing	
List other observations:	