Phenology Gardens – lesson plan II

Learning how to observe, classify, and record the phenological status of native plants for the USA National Phenology Network

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In this 60-minute activity in the native plant phenology garden, students first learn or review the basic vegetative and reproductive structures and functions of plants. They continue to learn how to observe, classify, and record the phenological (seasonal) status of these structures. Activity leaders and docents help students to make connections between the phenological status of the plants and local and regional climate patterns. It is possible, and simple, to link these phenology garden activities with other classroom activities and lessons in STEM, Humanities, and Fine Arts subjects. Students later contribute their observations to the USA National Phenology Network (USA-NPN), which is a biological monitoring program that brings together citizen scientists, government agencies, non-profit groups, educators, and students of all ages to monitor the impacts of climate variability and climate change on plants and animals in the United States. The network harnesses the power of people and the Internet to collect and share information, providing researchers with far more data than they could collect alone.

Objectives

1. Students learn that all structures on a plant can be classified as vegetative or reproductive.
2. Students learn to identify and classify vegetative and reproductive structures, both conceptually and in practice with plants in the phenology garden.
3. Students learn that the status of the vegetative and reproductive systems defines the phenological status of a plant, and that the phenological status of a plant is closely linked with the environment and the climate.
4. Students learn to classify a plant by its life form (herb, grass, deciduous shrub/tree, or evergreen shrub/tree, etc.).
5. Students, having "adopted" two native plants in the phenology garden previously, use their knowledge of vegetative and reproductive structures to classify and record the phenological status of their two plants using data sheets from the USA National Phenology Network.
6. Students gain an understanding of how the phenological status of their two adopted plants, as well as the other native plants in their garden and other schoolyard plants, will change over the seasons.

Photos by Brian Haggerty and UCSB's *Kids In Nature* environmental education program

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Phenological Literacy

Understanding through Science & Stewardship

California science standards

This lesson plan was designed for 5th grade, but is easily adaptable for other grades. Some standards may not be addressed directly in this lesson plan but were integrated easily into docents' conversations with students.

Grade 1

Life Sciences (2a, 2b, 2c, 2e)

- Plants and animals meet their needs in different ways.

Earth Sciences (3a, 3b, 3c)

- Weather can be observed, measured, and described.

Investigation and Experimentation (4a, 4b, 4d)

- Scientific progress is made by asking meaningful questions and conducting careful investigations.

Grade 2

Physical Sciences (1a)

- The motion of objects can be observed and measured.

Life Sciences (2a, 2b, 2c, 2d, 2e, 2f)

- Plants and animals have predictable life cycles.

Earth Sciences (3c, 3e)

- Earth is made of materials that have distinct properties and provide resources for human activities.

Investigation and Experimentation (4d, 4f, 4g)

- Scientific progress is made by asking meaningful questions and conducting careful investigations.

Grade 3

Life Sciences (3a, 3c, 3d)

- Adaptations in physical structure or behavior may improve an organism's chance for survival.

Investigation and Experimentation (5a, 5c, 5d, 5e)

- Scientific progress is made by asking meaningful questions and conducting careful investigations.

Grade 4

Life Sciences (2a, 2b, 3b, 3c)

- All organisms need energy and matter to live and grow.
- Living organisms depend on one another and on their environment for survival.

Investigation and Experimentation (6b, 6c, 6f)

- Scientific progress is made by asking meaningful questions and conducting careful investigations.

Grade 5

Life Sciences (2a, 2e, 2f, 2g)

- Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials.

Earth Sciences (4c)

- Energy from the Sun heats Earth unevenly, causing air movements that result in changing weather patterns.

Investigation and Experimentation (6a, 6f, 6g)

- Scientific progress is made by asking meaningful questions and conducting careful investigations.

Grade 6

Life Sciences – Ecology (5a, 5b, 5c, 5d)

- Organisms in ecosystems exchange energy and nutrients among themselves and with the environment.

Investigation and Experimentation (7b, 7d, 7g, 7h)

- Scientific progress is made by asking meaningful questions and conducting careful investigations.

Background for educators: The Phenology Stewardship Program at UC Santa Barbara, in collaboration with the UCSB *Kids In Nature* (KIN) environmental education program, established native plant gardens in 2008 at two elementary schools in Santa Barbara, California. We since have been developing and implementing phenology education activities in these gardens for several 5th grade classes, though we also have adapted these activities for a variety of other audiences including: after-school programs at Boys & Girls Club in Santa Barbara and Oxnard-Port Hueneme; university classes at UCSB; adult education courses and instructional workshops for teachers; and interpretation programs at several National Parks in California. For the *Kids In Nature* phenology garden activities, UCSB undergraduate students ("Docents" in this activity) who are enrolled in an UCSB Education Practicum course help test educational activities in the phenology garden, in addition to other activities they run for the KIN program. Phenology garden activities are designed for student participation with the USA National Phenology Network. We also integrate activities on species identification, morphology & anatomy, plant-animal interactions, plant-climate interactions, soil ecology, ethnobotany, photography, and other ecology-related themes. Garden activities have been complemented by docent-led in-class herbarium activities designed to teach students collection, preservation, and labeling skills. As a result of these combined activities, students begin to integrate several subjects through a single phenology framework, including math, writing, biology, climatology, geography, computer science, fine arts, and social/cultural history.

Procedure

Materials:

- Writing utensil and writing surface (clipboard or notepad)
- 1-page worksheet for students (see last page below for example)
- Data sheets, phenophase definitions, and life form definitions from the USA National Phenology Network (for the *Kids In Nature* program, these sheets were adapted and printed into each student's *Kids In Nature Journal* that they used year-long for phenology garden and other environmental education activities and field trips*)*.
- Suggested: plant identification guide or homemade plant identification flashcards, coloring pencils, magnifying glass, metric ruler, digital camera

1. **5 minutes.** Fifth grade students are escorted from the classroom to the Phenology Garden by their undergraduate docents. Activity leader (Brian) delivers an introduction about the activities, making connections with: previous garden activities; recent weather patterns and plant requirements of water, sunlight, and temperature; soil properties; and the overall status of plants and animals in and around the phenology garden. Students split into groups of 4 and work with their docents on the following activities.
2. **15-20 minutes.** Students learn/review that all structures on a plant can be classified as vegetative or reproductive, and they learn the names and functions of vegetative and reproductive structures.
   - If students have not adopted two plants during previous activities, then docents are to help the students identify and adopt two plants in the garden (following procedure of previous lesson plan).
   - Once in small groups, docents sit with their students in a small half-circle at the garden's edge, near any of the native plants that can serve as a good demo plant (i.e., large leaves, long petioles, obvious axillary buds, several phenophases visible). All groups are distributed around the garden separate from each other.
   - Docents provide each student with the following list of vegetative and reproductive structures (see last page below for the handout):

Vegetative structures	Function
Root	
Stem	
Vegetative bud	
Leaf	
Leaf blade	
Petiole	

Reproductive structures	Function
Flower bud	
Open flower	
Spent flower (wilted)	
Immature developing fruit	
Ripe fruit with seeds	

- Docents ask students to point to these structures on the demo plant, making sure each student does so (roots probably not visible, but students should know where to find them). Docents make sure each student can pronounce each term correctly while identifying it on the plant.

- Docents pose questions to the students about the function of each structure, and use the opportunity to discuss distinctions between vegetative and reproductive structures
  - Generally, vegetative structures mainly function to capture, create, store, and distribute energy; reproductive structures mainly function to reproduce the next generation via seed production.
  - Energy is created in the leaves by the process of photosynthesis, where carbon dioxide (CO_2) and energy from sunlight interact to build molecules of sugar, releasing oxygen during the process.
  - Energy created in the leaves is transported through the entire plant body in the phloem (pronounced “flow-um”) to regions of growth, where cells break down the sugars to obtain energy. Water and minerals are absorbed by roots in the soil and transported through the entire plant body in the xylem (pronounced “zy-lum”).
  - Docents help students see that as plants undergo vegetative growth, their size increases and this may have several consequences including: blocking the light environment for other nearby plants, and providing increased leaf biomass to herbivores in the community.

    Note: remember that some plants in the native plant phenology garden can reproduce via vegetative structures (e.g., wild giant rye and mugwort send out underground stems called rhizomes that grow into new aboveground stems nearby). It’s ok to discuss this, but remember that it may be confusing to the students why some plants do this and others don’t. Call over Brian to help explain/discuss if this comes up.

- Once docents lead students through identifying vegetative and reproductive structures on the demo plant, docents have students draw that plant and label each of these structures. More time can be spent on this activity depending on the teacher’s time constraints. Docents encourage students to draw as biologically accurate as possible, and guide them on improving their illustration skills by providing tips as follows:

- slow down and use few lines instead of scribbles
- count leaves on the stem and then draw that same number of leaves in the same arrangement
- measure or estimate the length of leaves and internodes along the stem and represent that in the drawing (leaf size and internode length should decrease toward the stem tip)

- Once the drawing is complete, docents have students apply that knowledge by identifying the vegetative and reproductive structures on other plant species around the garden. Depending on time constraints, docents can have students work in pairs, play a scavenger hunt game, or otherwise be creative with this time.

3. **30 minutes.** Students use their knowledge of vegetative and reproductive structures to observe and record the phenological status of their two adopted plants.
   a. Students locate their adopted plants and identify the vegetative and reproductive structures, reinforcing the knowledge gained in the above activity.
   b. Docents help students identify the life form of their plant (following USA National Phenology Network categories of herb, grass, deciduous shrub/tree, evergreen shrub/tree, etc.). Docents discuss definitions of these terms with the students.
   c. Docents help students find and complete the appropriate phenology data sheet from the USA National Phenology Network (for the *Kids In Nature* program, USA-NPN data sheets were printed in each student's *KIN Journal* phenology garden chapter p19-36). Specifically:
      i. Locate the correct data sheet in the *KIN Journal* (p32-36) – herb, grass, deciduous shrub/tree, evergreen shrub/tree.
      ii. Record plant name (common name only is OK for now), student name, location.
      iii. Insert date in appropriate cell, then answer "Do you see…" questions about phenological status of each vegetative and reproductive structure. Students will need to look up each phenophase definition before circling one of the "Y/N/?" options (definitions on the associated page in the *KIN Journal* for herb, grass, deciduous shrub/tree, evergreen shrub/tree). Be sure that students take a *close* look both at the plant and the exact definition.
   d. If possible, groups will be split in half for the above exercise. Thus, two students and one docent will achieve the above goals (3a-3c).
4. **10 minutes.** All groups gather into one large group. Brian calls on students to share experiences and observations. Brian wraps up the session by pointing out phenology of surrounding trees (especially Liquidambar trees in fall/winter or spring phases) and discusses the weather forecast. Brian revisits the guesses students made during previous garden visit about when the Liquidambar trees will be at USA-NPN's "all leaves colored" and "all leaves fallen" stages. Students can revise their guesses for future visits. Brian takes a photograph to be used in a time-lapse sequence developed over subsequent visits.

Throughout the activity…

Students are in groups of 4, with 1-2 docents per group. Each group has a digital camera to document observations, methods, and interesting things. Brian visits each group throughout the session to encourage students and docents to share their observations, to introduce specific knowledge about plants and year-long goals for monitoring the phenology garden, and to engage the students in "pop-quiz" activities.

Preview of the next phenology garden activity

During all future garden visits for the school year, phenological monitoring (activity 3 above) will take place the first 15 minutes followed by an activity designed to reinforce knowledge gained during that activity. Activities to reinforce phenological literacy include *Flight of the Pollinator*, *Ethnophenology*, *Phenology Relay Race,* and various drawing/labeling and photographing activities. Students will continue to use USA-NPN protocols and data sheets to observe and record the phenology of their two adopted plants. Option: At the end of the year, students help upload their data to the USA-NPN online database and receive a "Junior Phenologist" certificate.

More phenology activities and lesson plans are available online, including guides to establishing phenology gardens and activities that can be run in phenology gardens, school yards, back yards, or National Parks. To learn more and to download materials, visit the Education section of the California Phenology Project website (www.usanpn.org/cpp/education) or the USA National Phenology Network (www.usanpn.org/education).

Phenology & Plant Parts!

Every structure on a plant can be categorized as vegetative or reproductive. Do you know the function of these structures? Complete the following tables in your native plant phenology garden.

Vegetative structures	Function
Root	
Stem	
Vegetative bud	
Leaf	
Leaf blade	
Petiole	

Reproductive structures	Function
Flower bud	
Open flower	
Spent flower (wilted)	
Immature developing fruit	
Ripe fruit with seeds	

Draw it!

In the space below, draw part of a native plant from the garden and label its vegetative and reproductive structures. Draw carefully and be as accurate as possible!

From others' eyes! **Discuss this with your Docent:**

If you were a pollinator, which structures would you visit and why? What if you were an herbivore, or a frugivore?