Harvard Forest Schoolyard Ecology
Buds, Leaves, and Global Warming

Autumn Protocol: Foliage Color and Leaf Drop

Dr. John O'Keefe, Pamela Snow, Emery Boose, Clarisse Hart
Revised November 2016

I. The Basics:

A. Schoolyard study questions:

1. Big Ideas: "*How long is the growing season in our schoolyard? How is the length of the growing season related to climate?"*

2. Concrete Concepts: *"When does the growing season for trees in our schoolyard end this autumn, and when does the new growing season begin in the spring?"*

B. Review *Project Introduction*: Frameworks, objectives, site preparation, materials, data instructions, and supplementary activities are outlined in the *Project Introduction* which is included in your teacher notebook in the protocol section and is posted on our website at: phenology-overview_0.pdf

C. What is the focus of the fall study? Students will record the progression of leaf color and leaf drop to monitor the end of the local growing season. The beginning of the growing season is monitored in the spring for this project. This means if you do this annually, one class will pass on data to be used by next year's class.

1. Leaf drop is determined by monitoring a consistent set of leaves regularly in order to record the date when each of these study leaves have fallen off the tree.

II. Data Collection:

A. Begin and End dates: Autumn Data collection should begin about the second week of September and continue until all leaves have either dropped or turned brown, which should happen in November.

B. Data Collection Schedule: Collect data about once a week during study time for a minimum of 4 field visits. It is also possible to begin going out one time a week until it is getting closer to leaf drop, and then twice a week until most leaves have dropped.

Note that oak and beech often have leaves that remain on tree all winter, which is why you should consider the study complete when all leaves are brown.

C. Observe the specific branch assigned. Focus on the 6 leaves closest to the branch tip, not counting those at the terminal bud (the bud at the very tip). These leaves should be labeled prior to data collection (see section E in "Site Preparation" above, including diagram and photograph). It is highly recommended to bring branches cut from other trees of the same species as in study, to practice measuring leaves inside classroom prior to going out.

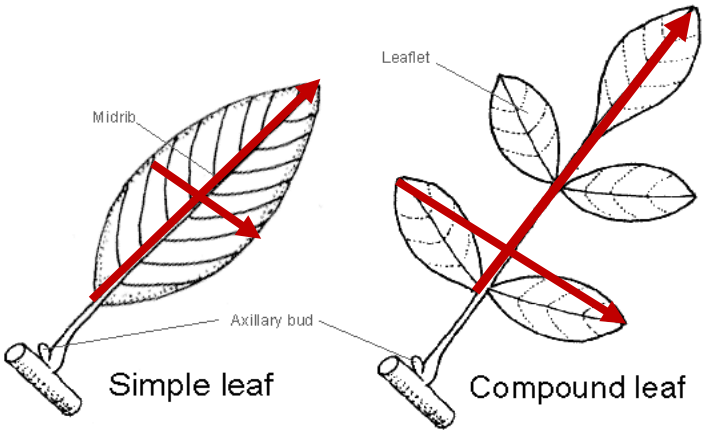
D. Measure the length of leaf blade (not including leaf stem/petiole) and width in cm. of each of the 6 leaves, and record on the data sheet. These measurements only need to be done during the first session to see how large the leaves grew during this growing season, and will be useful to estimate leaf development in the spring.

Note: Advise students to be careful not to remove leaf from tree accidentally. We recommend that a teacher and/or another group of students double check accuracy of each measurement.

Leaf Length

If the leaf is compound (multiple leaflets are attached to a main leaf stem/petiole), measure from the tip of the entire leaf down to the base of the lowest leaflets where they meet the leaf stem for the leaf length.

Diagram provided by Maryann Postans



E. Observe leaf colors of the six leaves, and record the approximate fraction of the leaf that has changed color (is no longer green). For example, leaf #1 may be more than half orange and yellow. This would be recorded with an X in 1/3-2/3 box to show that a little less than 2/3 of the leaf is colored (non-green) as follows:

Leaf Number	Fraction Colored (Not Green)		
	Less than 1/3 (1)	1/3-2/3 (2)	Greater than 2/3 (3)
1		X	

F. Whole tree color: Look at the entire tree and record approximately what fraction of the tree has changed color (is not green). Use the same fraction table as used for leaf color. For example if over ¾ of the tree has changed to yellow and orange, record an x in the 3/4-4/4 box of chart as follows:

Leaf #	Fraction of Leaf Color (not green)				Leaf Drop
	Less than 1/4	1/4- less than 1/2	1/2-3/4	3/4-4/4	0-not fallen 1- fallen
1					
2					
Whole Tree				X	

G. Leaf Drop: Look to see whether any of the six leaves closest to branch tip, not counting the one at the terminal bud, have dropped/fallen or turned completely brown. (Brown leaves should be recorded as fallen) Record how many have fallen (0-6).

H. Field Notes/Observations: This part of data collection is optional. We have included it to model the kinds of field notes "professional scientists" use when collecting data. If you have time, you may have the students record temperature in degrees Celsius and % humidity. Students can include notes about field conditions –climate, wildlife, what is happening with other plants, moisture, snow…or human activity that you notice while collecting data. As time allows, you may discuss this optional data with students.

III. Data Management:

A. Data Submission: All participants of the Forest Ecology in the Schoolyard Summer Institute for Teachers are required to submit data to Harvard Forest. The deadline for fall data submission is January 1st.

B. Data Instructions: Reminder to convert all data from the branch level data reported on field sheets to Whole tree level data prior to inputting your data on our online database. Further instructions regarding this conversion and data submission and analysis are available on the *Project Introduction*.

IV. Supplemental Activities: See *Project Introduction* for recommended activities to complement the Phenology study and deepen student understanding.

Contact Pamela Snow, Schoolyard Coordinator, at psnow@fas.harvard.edu or (978) 724-3302 x246 to begin your schoolyard research project.