



Harvard Forest Schoolyard Ecology Buds, Leaves, and Global Warming

Project Introduction

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I. Schoolyard Study Questions:

Big Ideas- Questions for Long Term Study: ***"How long is the growing season in our schoolyard? How might the length of the growing season be related to climate change?"***

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

II. Related Research:

Forest ecologist, **Dr. John O'Keefe**, is studying how our growing season might be affected by climate change. See Dr. O'Keefe's research abstract and long term data set at: [Dr. J.O'Keefe Phenology Abstract and Data](#)

III. Field Time:

A. Minimum number of data collection field visits: **8 field sessions** total.

1. **Autumn: 4 times-** weekly for 4 weeks beginning in mid to late September.
2. **Spring: 4 times-** weekly for 4 weeks beginning in early to mid- April

B. Recommended number of data collection field visits:

1. **Autumn:** Begin data collection in September and continue until all study leaves have turned brown or dropped (early November at most locations).
2. **Spring:** Begin data collection in early-mid April until all study buds have burst and leaves have mostly developed (mid-May at most locations).

IV. Project Objectives:

- A. Students learn how to do field research by participating in a program associated with the Harvard Forest Long Term Ecological Research (LTER) Site.
- B. Teacher and students collect field data seasonally.
- C. Data is given to HF to post online and share with other participating schools, HF scientists, and the public.
- D. The autumn and spring protocols should be combined in order to monitor the length of the growing season at your schoolyard. When you do this project annually, and compare with other long term studies on a larger scale, you can begin to see how a changing climate may affect the length of the growing season in your local area and how your local area compares with other areas.

V. Connections to Science Frameworks: See a specific list of the frameworks addressed in Our Schoolyard projects at: [Mass. State Frameworks connections HF-sLTER](#)

VI. Materials:

Flagging and/or metal tags	Tree Field ID guides
Data sheets	Centimeter ruler
Clipboards/pencils	Permanent marker

Optional Materials:

Light colored electrical tape
Thermometer
10X hand lenses

VII. Choosing a Schoolyard Study Site: Teachers choose and flag research sites based at a location within walking distance to school. Sites with a variety of native trees with branches in easy reach of students, located in an easily monitored area, are best for this project.

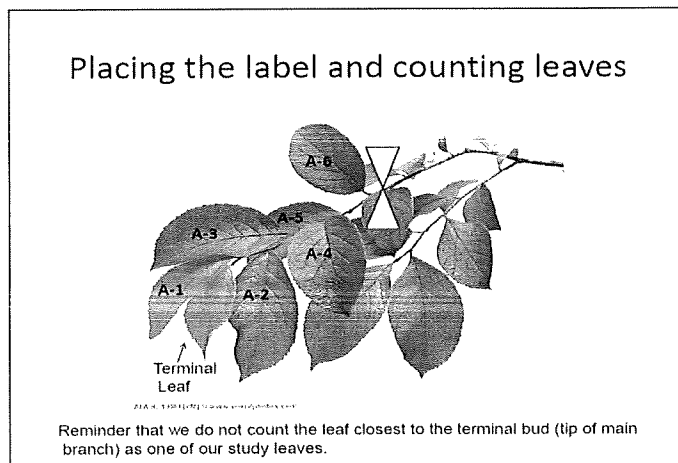
A. Guidelines for Choosing Study Trees:

1. **Trees in reach:** Ideally each tree in your study site will have two or more branches that allow students to reach at least 6 leaves on each branch.
2. **Trees that will last the duration:** These are the same trees you will study in the autumn and the spring, as well as in future years.
3. **Variety is the Spice of Life:** The greater variety of native trees included in the study the better. If you aren't sure which trees are native, double check with a project coach to be sure.

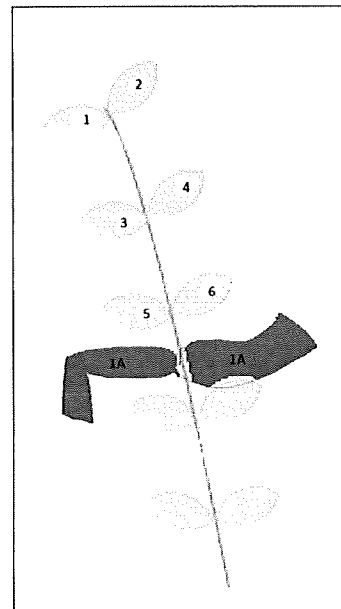
- broken, etc., label the branch on the new tree, 11A if you had already labeled and studied 10 trees, and so on.
- c. To substitute trees, try to find a tree of the same species and relative size if possible and assign it a new number. If you previously had 5 trees in study, label this one 6, and so on (assuming 6 was not used by another class).
- d. If there are no trees of the same species, choose a new tree of a different species.
- e. Change your field site key accordingly.

E. Mark the leaves/buds: It is best to mark the study leaves/buds in addition to the branches in order to allow for consistency in data collection. To mark the leaves, you can wrap small pieces of flagging or electrical tap at the far end of the last of your 6 study leaves. In other words, locate the terminal bud/leaf of your branch (i.e. the bud/leaf at the very end/tip of the branch). Do not use this leaf as one of your study leaves. The leaf closest to the terminal leaf is leaf#1 and label accordingly. The next leaf down the branch is leaf#2, etc. There are many trees/branches that will have side branches close to the leaf tip. In this case, use the terminal leaf on the next side branch as the next leaf in your study.

See Diagrams below for clarification:



Alternate Leaf Species Figure 1 created by Lise LeTellier



Opposite Leaf Species

4. **Number of branches and trees to include:** Use enough trees to provide at least 1 branch per student research team. Based on the number of classes, class size, team size, and number of branches studied per team, you can determine the amount of trees to include in your study. Discuss with your coach the appropriate team size for your students and whether you have time for your teams to study one or two branches each. Be sure to use at least 2 branches per tree for replication. An example of how this may work for "the average class" of 20 students would be to divide into 10 teams of 2. In that case, you would mark 2 branches on each of 5 trees included in the study site, to allow for a total of 10 study branches. Each team of 2 would focus on one branch in the study.

VIII. Site preparation:

- A. **Labeling branches:** Choose, flag, and identify Individual trees. At least two branches on each tree will be flagged and labeled. Assign each tree a unique identifying number (integer) to each branch on each tree, and a letter to each branch. For example a branch may be labeled 1A (where 1 is the number of the tree, and A is the branch you are studying). Another tree will have a branch marked 5B, which shows it is tree 5, branch B. Please note: each tree at your school must have a unique number. If you add a tree, please make sure that its number has not been used before by your class or any other class at your school. To keep numbers separate, different classes might use numbers in the 100s, 200s, etc.
- B. **Make a key:** Be sure to make a key to show the species of each tree by number. Store the key in your HF project notebook. See sample key below:

Site/School Name: _____

School Year: 20__-20__

Tree #	Tree Species	Species Code
1	Sugar Maple	SM
2	Sugar Maple	SM
3	Scarlet Oak	SO
4	Black Cherry	BC
5	Witch Hazel	WH
6	Black Cherry	BC
7	Paper Birch	WB
8	American Beech	BE
9	American Chestnut	CH
10	White Ash	WA

Tree #	Tree Species	Species Code
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

C. Field Site checklist: Below is a sample checklist (Elizabeth Duff, Mass. Audubon) also downloadable at: phenology-checklist.pdf

Assemble Materials

- _____ Flagging and/or metal tags
- _____ Data sheets clipboards/pencils
- _____ Tree Field ID guides
- _____ Centimeter ruler
- _____ Light colored electrical tape
- _____ Permanent marker

Choosing Study Tree Checklist:

- _____ 1. Each tree has at least two branches that students can reach, with at least 6 leaves.
- _____ 2. The trees will survive into future years.
- _____ 3. Identify the trees. Check and note which are native and non-native.
- _____ 4. Choose trees are native (as much as possible.) and include a variety.
- _____ 5. Select enough trees to provide at least one branch per student research team.

Labeling Branches checklist:

- _____ 1. Choose and flag the trees you are working with. Assign each individual tree a number. (Write the number on the flagging).
- _____ 2. Make a table recording the tree number and what species it is.
- _____ 3. Designate the 2 or more branches on each tree that will be studied, A, B, etc. Using electrical tape or flagging, label the branches A and B.
- _____ 4. Using electrical tape or flagging, and permanent marker, put a label on the twig just above (closer to main tree trunk) the 6 leaves being observed. This will remain after the leaves are gone, marking their location, and indicating the buds that will be observed in the spring.

D. If a branch or tree is removed / destroyed: Sometimes the inevitable hand of change strikes your study site, and that means you may find a branch or even a tree has died, been cut down, vandalized, or struck by lightning... In these cases, you need to identify a substitute branch or tree to include in your study.

1. To substitute branches, follow these steps:

- a. Locate a different branch on the same tree in reach of students and assign it the same tree number and the next letter. For example if 4A broke off, and you already have a branch 4B, label the new branch "4C".
- b. If there is no other branch in reach on that tree, try to find an additional tree of the same species, with a branch in reach of students, and assign it a unique tree number and appropriate letter. For example if you have labeled branches on tree 3 as branches A and B, and then B falls off/is

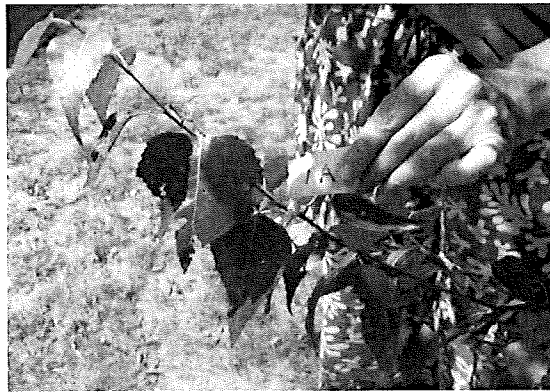


Photo by John O'Keefe

Please note: the specific 6 leaves/buds being studied may change each year as trees grow. You should check labels and change/update labels as needed.

IX. Data Coordination:

The Schoolyard LTER Database allows you to share your data with scientists, other students, and citizens who are interested in finding out about how the length of the growing season is related to climate. Data submission is required of all participants of the Forest Ecology in the Schoolyard Summer Institute for Teachers.

You may submit data, download data, graph data, and view other pertinent information such as site elevation/lat./long./address, etc. at: [HF schoolyard Database](#)

A. Data Submission:

1. Data Submission Deadlines:

- a. **Fall:** Teachers must submit autumn data by January 1st
- b. **Spring:** Data is by June 1st

2. Convert branch level to Whole Tree level Data:

Please remember to submit whole tree data, NOT branch level data. Your students will have collected both branch level data (for branches A, B, etc.) and whole tree data on their field data sheets. We feel it's important for students to have the experience of observing and recording the information of each of the six leaves per branch but if we posted data for each branch, it would be too much data to manage and analyze over time. For that reason we ask that you combine data for all branches/leaves for each tree and submit it as the total number of leaves for each study tree. Teacher, Louise Levy developed the following **worksheet to help you make this conversion:**
[worksheet to help you make this conversion.](#)

3. To Submit Data:

- a. Click the Submit Data link

Note: You will need to login to view this page. If you do not have a login and password, you will need to create them at this point. If you already have an account, simply login as usual. Upon submission of your contact information, your password will be sent immediately to the e-mail address provided. Please be aware that the message containing your password may be blocked by your spam filter. It will be sent from the following address: hfweb@fas.harvard.edu.

- b. Select your **Project**. (The options include Fall Phenology, Spring Phenology, etc.)
- c. Select your **School** from the dropdown menu (If your school does not appear contact Pamela Snow at psnow@fas.harvard.edu to add your school to the system)
- d. Select your **Last Name** (if your name does not appear contact Pamela Snow at psnow@fas.harvard.edu to add your name to the system).
- e. At this point, you will have access to a page containing metadata for your selected project.
- f. Click **Add a New Observation**.
- g. Enter the **Date** of the observation in the format shown.
- h. Enter the requested information. Reminder to convert branch level to whole tree level before entering data here.
- i. Click **Submit**.

Please Note: Data will be reviewed by HF staff before being uploaded to the database to be available for downloading and graphing. We expect data to be available for downloading and graphing within a week of submission.

D. Data Storage: Save the original data sheets. Often, questions about the data will arise months or years later when someone goes to graph or otherwise analyze the data. It's important that you have the original data to refer to when needed.

E. Data Download: To get an electronic copy of your data, or if you'd like to graph project data, documents can be downloaded in a spreadsheet form in a program such as Excel, at: [Downloading Data Link](#).

X. Data Analysis: Teachers may choose to analyze data in a number of ways.

- A. **Analysis Questions:** No matter which activities are used, the main thing is to ask students:
 - i. What can we learn from the data?

- ii. Do you think we have enough data to answer our *Big Idea* study questions: "How long is the growing season in our schoolyard? How is the length of the growing season related to climate change?"
- iii. Do you think we have enough data to answer our Concrete Concepts study questions: "When does the growing season for trees in our schoolyard end this autumn, and when does the new growing season begin in the spring?"
- iv. What predictions can we make about the future of the growing season in our region? What can you tell about different kinds of trees in relation to budburst or leaf drop?
- v. What can you tell about different kinds of trees in relation to leaf growth?
- vi. How do this year's data compare with previous years' data?
- vii. Do you think you have enough data to contribute to the overall study?

B. Graphing: Students can graph their own data to see if they can find patterns in the data.

1. **Online Graphing Tool:** Once your data have been uploaded to the database, the online graphing tool may be used to create time series graphs of one or more trees as a function of date or of one tree as a function of day of the year. Graphs can be downloaded to your computer as jpeg files. To use the online graphing tool, please see: [Online Graphing Tool](#)
2. **Graphing Manual:** Dr. Betsy Colburn has published a [graphing manual](#) and related [Graphing Exercises.pdf](#) that provide specific examples and instructions for creating a variety of graphs, using Harvard Forest Schoolyard Data, in addition to what can be created on our online graphing tool.
3. **Harvard Forest Ecologist Data:** Students can graph over 20 years of data from HF scientist, Dr. John O'Keefe – data is available online: [O'Keefe Phenology Study](#).
4. **Data Workshops for Teachers:** Harvard Forest hosts teacher workshops to support analyzing and graphing project data. Come and try your hand at graphing with the support of professionals. Email Pamela Snow for dates and information.
 - a. **Level I Data Workshop** provides an introduction to data management and use of the online database. Time is spent practicing data input, creating simple graphs, and working with HF Information Manager and Project Ecologist.
 - b. **Level II Data Workshop** provides an introduction to graphing Schoolyard project data. Workshop content is largely based on the Graphing Manual and Exercises listed above.

- c. **Level III Data Workshop** allows teacher with multiple years of data to make use of HF mentors as they work to develop graphs based on their own educational objectives.

XI. Optional Supplemental Activities: Teachers may choose to supplement this field research study with a number of related activities depending on their time available and curriculum needs. Below are some suggestions:

- A. **Field trip to Harvard Forest:** Students see what an ecological research forest/institution looks like. An indoor slide show and dioramas tell the story of HF and the changing forests of our region. Outdoors, students can tour our regular nature trail or choose to visit the research site of Dr. O'Keefe's study.
- B. **Sketching Branches:** This is both extremely simple and extremely effective. You can have students either sketch cut branches in the classroom or branches on trees outside. This activity gets students to focus attention on the way branches are formed and raises questions and awareness about buds, leaves, and branch structure and functions.
- C. **Teacher developed Curriculum Materials:** Teachers know best what kinds of related activities are needed to provide students with an understanding of concepts related to project themes. Many of our experienced Schoolyard teachers have generously shared their materials on our website: schoolyard/lesson-plans
- D. **HF Ecologist developed Resources:** Ecologists have also developed materials and shared their presentations online: schoolyard/presentations
- E. **Other HF-sLTER Resources:** teacher-resources