

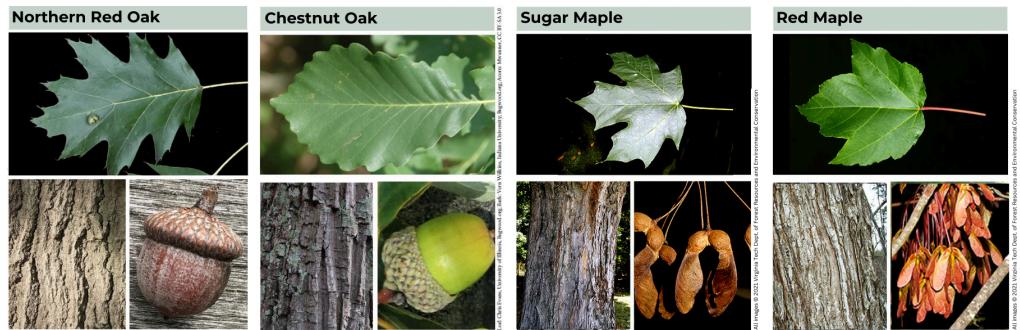
# Leaf Phenology Citizen Science Project

Project lead: Hanna Makowski, Ecology Postdoctoral Fellow at Black Rock Forest  
Education Support: Emilie I. Dion, Science Educator

<u>Timing</u> :	<u>Overview</u> :
<u>NGSS S&amp;E Practices</u> → :	Have you ever marveled at the brilliant reds, oranges, yellows hues of fall? Or wondered why not all trees change color at the same time? Studying the timing of such biological patterns is called phenology.  The timing of this colorful precursor to winter dormancy is under investigation in this project.
<u>Materials</u> :	Globally, shifts in climate across decades have advanced the onset of spring and delayed fall, which can lead to a longer growing season and higher net carbon uptake. However, the benefit of a longer growing season is only realized if tree phenology tracks the shift and is not fixed. Understanding the factors that underlie variation in leaf phenology can improve predictions of temperate forest response to a changing climate.
	<u>Student Research Options</u> :
	Depending on the scope of your class and age group, you and your students can engage with this project in different ways.
	<b>Citizen scientists (Grades 4-12)</b> Engage in real scientific research and learn how to collect data in a reliable and replicable way. Contribute directly to Hanna Makowski's postdoctoral work by submitting your data online. Receive updates from Hanna as she analyzes the data. Observations can be completed by different students and different groups.
	<b>Junior researcher (Grade 6-12)</b> Have your students develop their own research questions about your trees and survey site. Use the methodology to collect the data for Hanna's project and add other variables based on your student interest. Over the course of the survey period) students will collect their data, develop a strong sense of ownership and a better understanding of the time scale of science. You can assign students to specific trees or work as a group. They will then be able to apply analysis skills, build graphs and draw conclusions from their data.
	Student questions could be framed as the following:  Does X influence tree phenology?  Where X can be any environmental gradient students are interested in such as elevation, tree size, distance to nearest water source, distance from forest edge, sun exposure, etc.  Students can produce a poster, a presentation, a full lab report, or even a zine. Sharing scientific information is a very important part of the scientific process.

## Focal species

Red Oak (*Quercus rubra*), Chestnut Oak (*Quercus montana*), Red Maple (*Acer rubrum*), and Sugar Maple (*Acer saccharum*).



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## Method

1. Select your survey area and identify trees
  - a. Pick an area you can easily visit every 3 days that contains at least 10 individuals one of the focal species (Red oak, chestnut oak, red maple, and sugar maple)
    - i. Description: What type of environment is your survey site? Is it a forest? A schoolyard? A tree lined street? Are the trees close together or far apart? etc.
  - b. Repeat the following for each tree
    - i. Select trees that are one of the four focal species.
    - ii. For each selected tree take a pictures of the tree, and close ups of the eaves and bark
    - iii. Use google earth to find its GPS coordinates (location) and elevation (Appendix 1 Figure 1)
    - iv. Measure the diameter at chest height (DCH) - roughly 4ft from the base of the tree (Appendix 1 Figure 2)
    - v. Measure the approximate height of the tree (See Appendix 1 Figure 3)
    - vi. Identify the crown class (See Appendix 2)
    - vii. Number the tree and mark it with a piece of flag tape or a sign that will last at least a year
  - c. Submit your site survey on the Project Google Form
2. Autumn Tree Survey
  - a. Make a copy of the tree survey spreadsheet and print out the *Tree Survey sheet* (you may need more than one for the season)
  - b. Start your survey at the end of September
  - c. Every 3 days, visit your trees and use the rating criteria (Appendix C) to visually assess the phenological stage of the tree.
  - d. Transfer your data from the survey sheet to the spreadsheet
  - e. Submit your data through the Project Google Form once all your trees have reached winter conditions

### 3. Spring Tree Survey

- a. Print out the *Tree Survey* sheet (you may need more than one for the season)
- b. Start your survey in early April
- c. Every 3 days, visit your trees and use the rating criteria (Appendix C) to visually assess the phenological stage of the tree
- d. Transfer your data from the survey sheet to the spreadsheet
- e. Submit your data through the Project Google Form once all your trees have reached summer conditions

## Resources

- Coop, J. and Cahill, M. (2024). How to Measure Trees. [online] www.mass.gov. Available at: <https://www.mass.gov/how-to/how-to-measure-trees> [Accessed 15 Aug. 2024].
- Ward, Jeffrey & Anagnostakis, S. & Ferrandino, Francis. (2006). Stand dynamics in Connecticut hardwood forests: the old series plots (1927-1997).

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## Site Survey Sheet

Group Name:

Date:

### Description:

Slope (Check one): *How steep is your survey site?* : [ ] None [ ] Slight [ ] Moderate [ ] Steep

### Trees

#	Species	Longitude	Latitude	Accuracy (m)	Elevation (m)	Diameter (cm)	Height (m)	Crown class
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

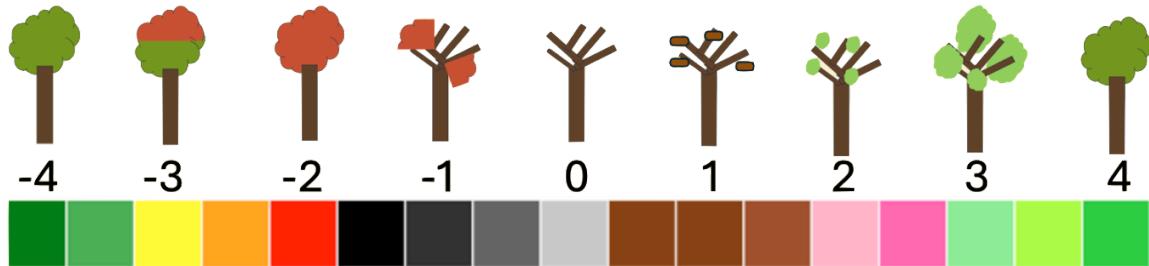
Notes:

# Tree Survey Sheet

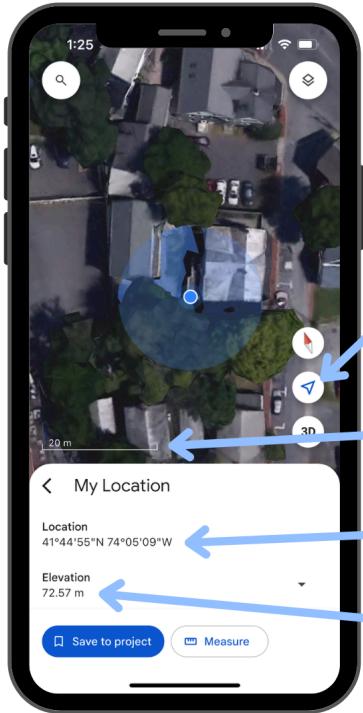
Survey sheet # \_\_\_\_ of \_\_\_\_

Time of Survey: [ ] Autumn [ ] Spring

Group Name:



## APPENDIX A - Measurements

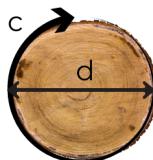


- Download the Google Earth App and enable Location Services 
- When standing next to the tree, click on the “Show your location” arrow
- Record the accuracy of the reading
- Record the location
- Record the elevation in meters

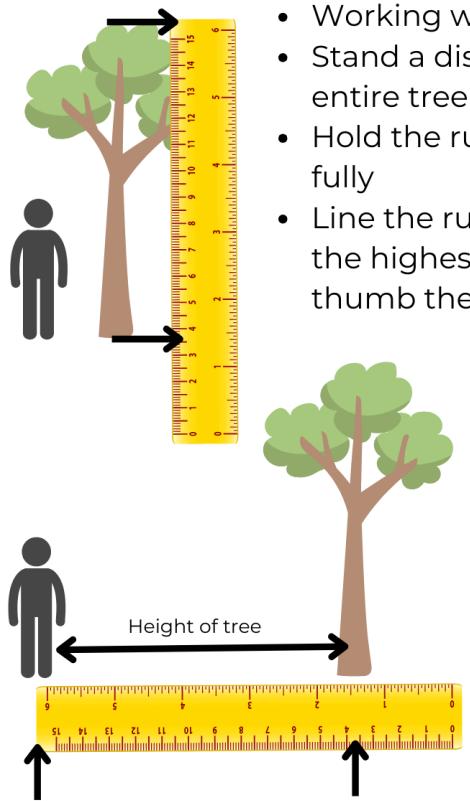
**Figure 1:** Using Google Earth to find location and elevation data for each tree.



- The standard DCH is measured 4ft from the lowest part of the base of a tree
- A DCH tape is a specialized tool that is scaled to measure the diameter as you wrap the tape around the circumference of the tree trunk
- If using a regular measuring tape, use the following formula to calculate the diameter from the circumference:

$$d = c/\pi$$


**Figure 2:** Measuring the Diameter at chest height (DCH) of a tree.

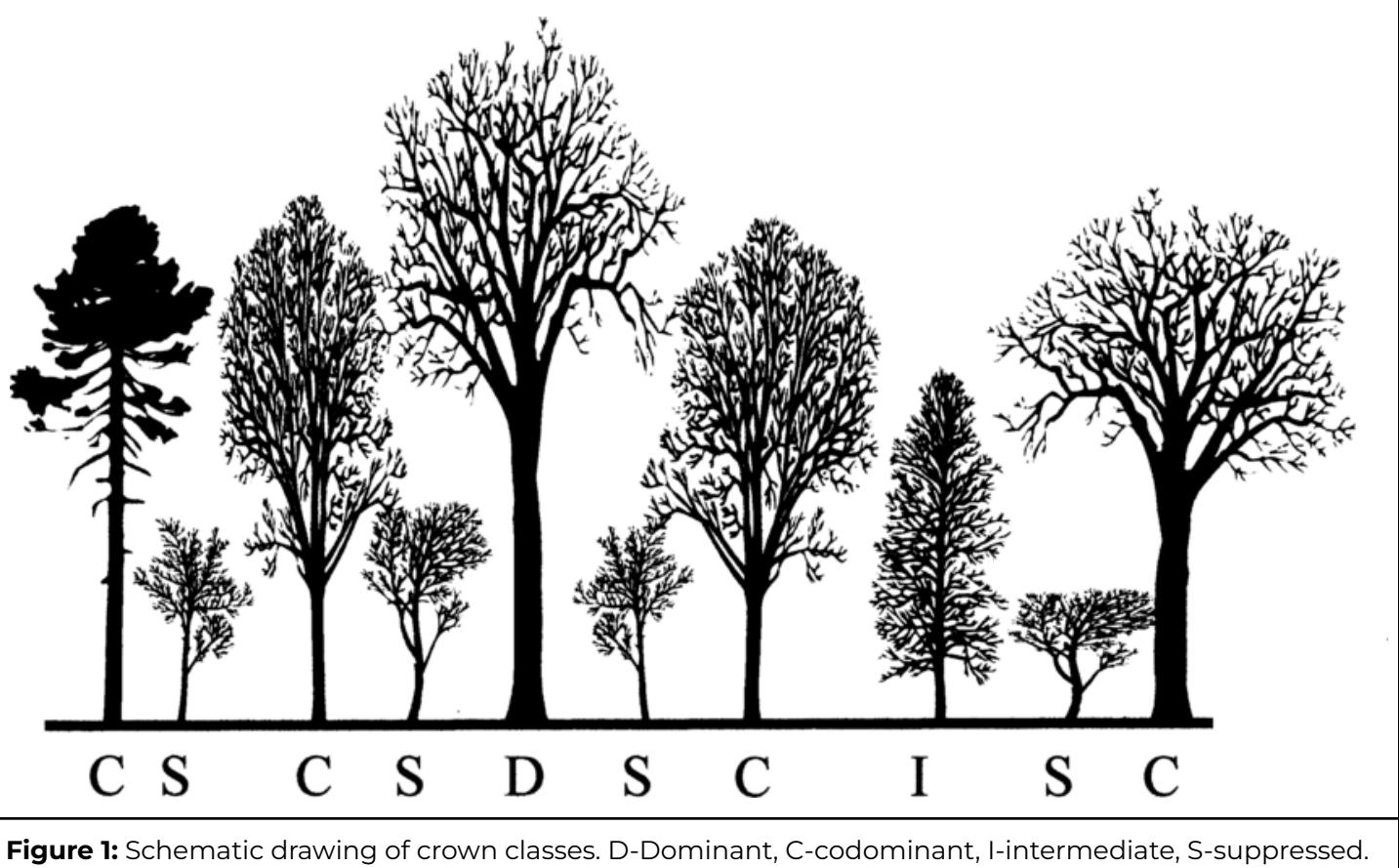


- Working with a partner
- Stand a distance away from the tree where you can see the entire tree
- Hold the ruler upright in your hand with your arm extended out fully
- Line the ruler up with the tree so the top of the ruler aligns with the highest point of the tree and mark on the ruler with your thumb the tree base

- Keeping your arm extended, turn the ruler 90 degrees
- Have your partner stand at the point on the ground out from the tree where you see the ruler end
- Measure the distance from your partner to the tree base
- This distance is equivalent to the tree's total height

**Figure 3:** Measuring the height of a tree using a ruler. Adjusted from the Massachusetts Legacy Tree Program.

## APPENDIX B - Crown Classification



**Figure 1:** Schematic drawing of crown classes. D-Dominant, C-codominant, I-intermediate, S-suppressed. Reprinted from Ward, Jeffrey & Anagnostakis, S. & Ferrandino, Francis. (2006). Stand dynamics in Connecticut hardwood forests: the old series plots (1927-1997).

Crown class is a description of a tree's position in the canopy compared to its neighbors. Dominant and codominant trees make up the upper canopy while the intermediate and suppressed trees make up the lower canopy. The classes can be described as follows:

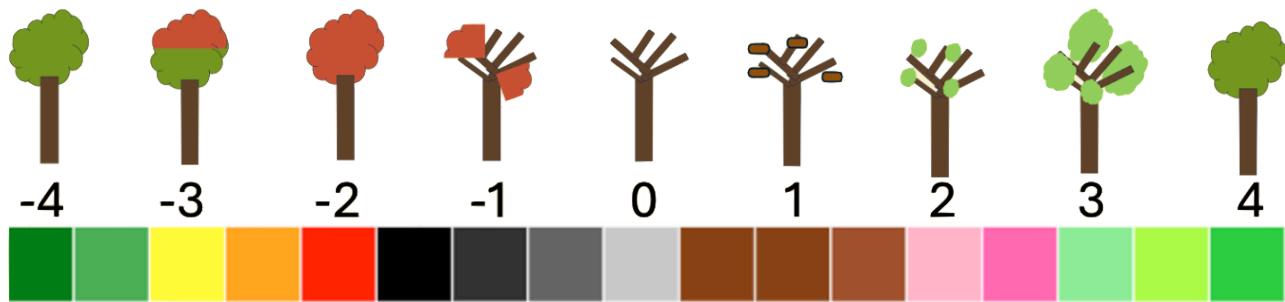
- **Dominant Trees (D):** These trees generally have the largest and fullest crowns in the stand. Their crown receives direct sun from above and some light from the side. crowns extend above the general level of the canopy.
- **Codominant Trees (C):** These trees are generally shorter than the dominant trees, Their crowns receive direct light from above and little no light from the side.
- **Intermediate Trees (I):** These trees are shorter than the upper canopy trees. Their crowns are sometimes narrow or one-sided. They may be growing in an opening left by a fallen upper canopy tree. They receive some direct light from above and no light from the sides.
- **Suppressed Trees (S):** These trees are shorter than the upper canopy trees. Their crowns are well below the general canopy and are sometimes short, sparse, and narrow. They receive no direct light except the occasional sunflecks.

## APPENDIX C- Rating criteria for spring and fall phenology

Spring index Values	Description
0	No change from winter conditions, unexpanded buds only
1	Bud swelling noticeable
2	Small leaves or flowers visible, initial stages of leaf expansion, leaves about 1 cm long
3	Leaves $\frac{1}{2}$ of final length, leaves obscure $\frac{1}{2}$ of sky as seen through crowns
3.5	Leaves $\frac{3}{4}$ expanded, sky mostly obscured through crown, crowns not yet in summer condition
4	Canopy appears in summer condition, leaves fully expanded, little sky visible through crowns

Autumn index Values	Description
-4	Canopy appears in summer condition. Fully green leaves
-3	Many leaves have noticeable reddening or yellowing, much green still present
-2	No more green in canopy, leaves still obscure most of the sky as seen through crown
-1	Half of the leaves have fallen, leaves still obscure half of sky as seen through crown
0	All leaves fallen except remnants on beech, winter condition



## APPENDIX D - Sugar maple results from 2023-2024

