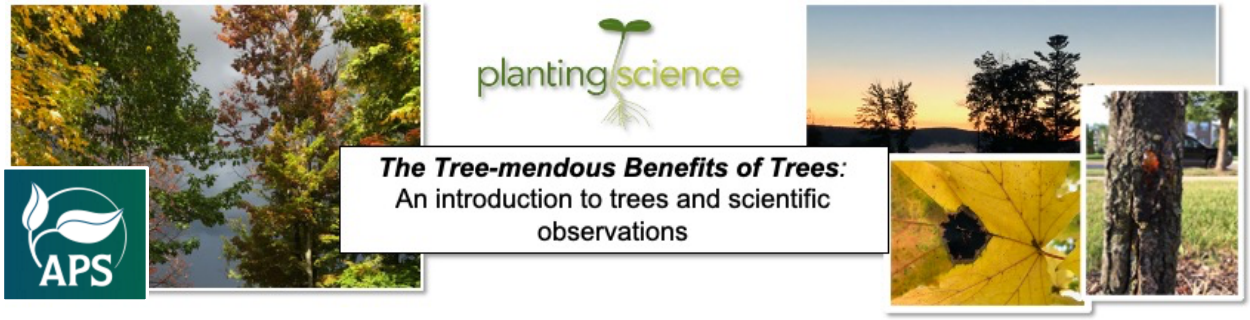


Student Guide/Step-by-Step Instructions

Overview

Premise: Trees are an important and recognizable part of landscapes and forests, but most people don't think about the importance of trees and their value to the landscapes. Furthermore, most people don't notice the condition of trees – that is, whether the trees are healthy, diseased, or in a state of decline – but tree health is crucial to a landscape.

Why is all of this important? Trees add beauty, but they also contribute shade, help mitigate stormwater runoff and soil erosion, and improve air quality by providing oxygen, filtering out particulates in the air and storing carbon. Trees also provide food (fruits and nuts, for example) and are home to wildlife, fungi, insects and microorganisms.

However, optimal benefits come from large, healthy trees. Many things can impact the health of trees in an urban setting. The wrong planting location, poor soil conditions, drought or flooding, not enough or too much sun, wounding, and diseases and insects are some of the things that can cause tree decline. The mortality rate for urban trees is very high – some studies suggest that "40-60% of urban trees die within the first 10 years," (Ness 2015).

The value of trees. How do we place a "value" on trees? Examining and quantifying tree health can be a challenge, but it's an important question. City managers, homeowners and property owners must make important economic decisions on whether to purchase and add trees to a landscape and cut down unhealthy trees.

It is hoped by through this activity, students will become more aware of the condition of plants in their surroundings. More specifically, students will learn to 1) recognize visible indications of healthy versus unhealthy trees, 2) collect data and make observations to assess tree health, and 3) use an online tree benefit calculator to approximate the benefits, in dollars, of their selected trees in terms of stormwater mitigation, property value, energy savings, air quality, and atmospheric carbon.

How *The Benefits of Trees* Module works

This module contains guidelines for developing research or inquiry-type questions pertaining to tree health in an urban setting - on the school grounds, in a garden, yard or landscape. We encourage teachers to incorporate a section of the school landscape as part of the study, but students can also be directed to evaluate trees at home or another off-campus site.

Over-arching goal

The aims of this module are to encourage students to become more aware of the plants in their city landscape, understand the importance of trees and tree health, connect observations about plant growth and form with function, and connect tree health data and observations with the benefits and value of trees in a landscape.

Guiding principles:

- Why are trees beneficial to our landscapes and cities?
- What characteristics are important in determining the value of a tree?
- What are some indications of good tree health? Of poor tree health?
- What can we do to maintain tree health?

Learning Goals:

- Describe the role and function of trees
- List the benefits of trees in a city
- Describe observable characteristics of healthy and unhealthy trees
- Formulate a research question and determine the data and information needed to investigate the question
- Take measurements and make observations that are important in evaluating tree health
- Be able to use an online Tree Benefit Calculator to estimate benefits such as stormwater mitigation, property value, energy savings, air quality, and atmospheric carbon reduction

Materials you will need:

1. Computer and internet access
2. Notebook and pencil
3. Measuring tape to measure tree circumference (alternate: string or yarn)
4. Ruler
5. Calculator
6. Excel for data analysis (but we might not get to that step)
7. Websites and books on tree identification (PlantSnap Plant ID is really good, and it's a free App on your phone)
8. Camera (from your phone is fine, but you would be recording anyway)
9. Optional: magnifying glass

What you will do:

Note: If you have family members who you live with and can help, have them record you during this process… if you don't, record it yourself, while talking. It might take a couple tries! Have patience, and have fun!

- Conduct an outdoor walk in your backyard or neighborhood to take some initial observations on the trees and landscape. Choose between 6 trees, and **discuss** why you are choosing them (choose a mix of typical trees around, for example, a lot of people

around here have trees for beautification (i.e. all the flowering trees right now), and some for shade (i.e. different types of maples, sweet gums, ash trees), and pines.

- Explain, as you are walking around observing trees, why you selected the 6 trees you did. Maybe choose one or two that have examples of some biotic (i.e. cankers on the trunk, or spots, blights, blotches on petals or leaves) and abiotic (i.e. exposed roots that likely get hit with the lawn mower blade; broken branches from lightening or storms, etc.), and point these out for later (a good scientist is observant).
- Become familiar with standard tree measurements: *Before you record, make sure you step through the process detailed below on at least one or two trees, so you are comfortable… it's quite straightforward.*
  - **Tree diameter (4.5 ft above ground)**
    i. Tree diameter, often called tree breast height, is a common measurement of tree size for tree surveys. Tree diameter can be used to estimate tree volume or tree age, and a tree's diameter can be compared over a period of years to determine growth rate.
    ii. When you are recording, take multiple measurements (minimum 3) for a given tree to establish consistency in taking measurements. The National Tree Benefit Calculator is based on tree diameter measurements in ***inches***. The measurements for each tree can then be averaged, which provides more robustness.
  - **Calculating tree diameter by measuring tree trunk circumference**:
    i. Using a ruler or measure tape, determine the point on the tree trunk 4.5 feet from the ground
    ii. Measure the circumference of the tree trunk at the 4.5-foot mark with a measuring tape (inches). Alternatively, students can use a piece of string or yarn to determine the diameter of the tree, and then measure the length of the string. (it's good if you can mix it up a little… some younger, thinner trees, and a few older, thicker trees).
    iii. Calculate the tree diameter with the following formula:

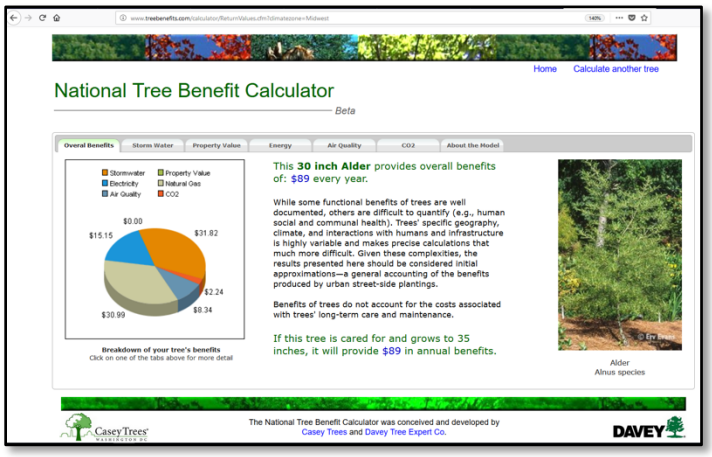
$$\frac{Tree\ circumference\ (inches)}{\pi\ (3.14)} = Diameter\ (inches)$$

- **Trouble-Shooting if needed:**

  What about odd shaped trees? The following website has some good diagrams of the process, as well as instructions for measuring trees on a slope, multi-branched trees and trees with unusual forms:

  - City of Portland, How to Measure a Tree www.portlandoregon.gov/trees/article/424017
  - Portland Parks and Recreation, How to Measure Trees: youtu.be/R9eQ9qFrSVs
- **Use the National Tree Benefits Calculator website:**
  - www.treebenefits.com/calculator/

- To use the Tree Benefit Calculator website, you will need to enter a zip code. Alternatively, you can select a zone from the U.S. map in the link provided (www.treebenefits.com/calculator/mapselect.cfm) to explore another part of the U.S.
- Input examples into the Tree Benefit Calculator. Using the drop-down menus, select a tree species ("Unknown" is an option), tree diameter (4.5 feet from the ground), and the land-use type (e.g. residential, small or large commercial business, etc.). To test the site, you don't need actual data, you can try different tree species and numbers.



- For a school yard, for the land-use type, you may want to select either the small or large commercial business, or a park. Use your judgement to determine what best describes the setting for your site (you will likely be using residential, which is an option on the drop-down menu).
- The tree calculator will give you an output for each of the following parameters (**it is so cool!!)**:
  - Storm Water (gallons of stormwater runoff intercepted)
  - Property Value (in dollars)
  - Energy (kilowatt hours of electricity)
  - Air Quality
  - CO_2 (reduction in atmospheric carbon)
- For each of these parameters, read the explanations on each tabbed webpage. You can adapt the use of this information to your class. Explain to the students that these benefits are approximations, not exact amounts.

- **Tree Health Discussion**:
  - Talk to the camera, or if you are seeing your class/team/mentors, talk with them about what you learned. A discussion about tree health be connected to a discussion about human health. Plants can get diseases, be infested with insects, and suffer wounds. (see the next two pages for Discussion Points to cover).
  - Trees can also be impacted by drought, flooding or water-logged soil conditions, road salt, high and low temperatures, and too much or not enough sun. For an interesting article on the topic of tree health, read, "Getting to the root of urban health" (dl.sciencesocieties.org/story/2015/dec/thu/getting-to-the-root-of-urban-tree-health).
  - If you have a huge, old maple in your yard, and the Tree Calculator tells you it has really amazing benefits, what would be the loss if it got sick and you had to cut it down? How do you feel about people cutting down older trees just

because they are “inconvenient” (i.e. Sweet gums drop monkey balls and people don’t like these in their yards; consider home owners who may be older and decide they didn’t want to rake leaves anymore, so they cut down all the nice trees in their yard except one.)

- For many plants, there are few options once a plant gets a serious disease or insect pest. If the problem isn't too bad, it may be best to do "nothing" as the tree may be able to tolerate a low level of disease.
- These are some abiotic and biotic examples of tree and stress damage:
    - Dead branches, dead wood (many causes: injury or wounds caused by humans, wind, snow, or insects, diseases)
    - Leaning tree trunk
    - Broken branches
    - Wounds (cankers) in the bark or cracks in the bark
    - Exposed roots (possibly caused by improper planting or bad planting site; sidewalks or other impediments to tree growth)
    - Suckers at base of tree (general indication of tree stress)
    - Damage from equipment
    - Vandalism (graffiti)
    - Animal damage
    - Condition of the leaves: dying leaves or needles, spots or lesions (dead areas) on leaves (examine healthy leaves; note that leaf color may depend on the time of year or season. It is imperative to determine what a "healthy" leaf looks like.
- **Other organisms**
    - Other organisms associated with trees insects or indications of insect damage, birds, mushrooms on or around the tree, lichens on the tree bark, galls (tumor-like growths caused by insects or other organisms). These organisms may or may not be beneficial or harmful to the tree.
- **Other notable observations:**
    - Rotted tree parts, evidence of decay
    - Mistletoe, vines or other plants growing on the tree

Module Resources:

- Forest Health Detectives, an Inquiry and Investigation by Tara L. Bal, published in the American Biology Teacher (Vol. 76, Oct. 2014) has good diagrams and photos, as well as ideas for research investigations and data collection.
- Diagnosing Sick Plants, Ohio State University Extension, by S.D. Williams, M.J. Boehm, J. Chatfield, J. Boggs and E. Draper. ohioline.osu.edu/factsheet/plpath-gen-2

Additional Web Resources for Doing Research in the Field:

- Biodiversity in Your Backyard, by the Nuffield Foundation. This lesson plan describes a field experiment to measure species diversity on school grounds. It could be easily modified for use in a nearby park. A plant identification key is provided, but it primarily covers common UK species. http://www.nuffieldfoundation.org/practical-biology/biodiversity-your-backyard
- Discover Life, by The Polistes Foundation. Here you can search for specific species, identify sites where a species has been found, and learn to identify an organism from photos based on its location and traits. Some educational resources are also available. http://www.discoverlife.org/
- Encyclopedia of Life. This resource, which was first thought up by the well-known biologist E.O. Wilson, is a searchable knowledge base that aims to include all species living on Earth. Search for a species by its scientific or common name and find photos, a scientific description, and its conservation status. http://www.eol.org/
- Project BudburstSM: Timing is Everything! by the National Ecological Observatory Network, Inc., and the Chicago Botanic Garden. Here you can learn about phenology, the study of the timing of natural events. Project Budburst is an ongoing project, so you can map your own field observations here and find out what other "citizen scientists" have seen. http://budburst.org/
- Tree of Life, by the Tree of Life Project. This is a good resource for identifying relationships among different species based on current science on evolution. This site also includes photos and descriptions of biological families and genera. http://tolweb.org/tree/phylogeny.html
- The C.V. Starr Virtual Herbarium, by the New York Botanical Garden. This site shows plant samples from the NYBG's William and Lynda Steere Herbarium; it currently has about 225,000 images from over 1.3 million specimens. A glossary of botanical terms is included. http://sciweb.nybg.org/science2/VirtualHerbarium.asp
- Field Techniques Used by Missouri Botanical Garden, by R. Liesner. This page lists a set of articles describing the methods professional field botanists use to find and collect plant specimens, then prepare them for storage in an herbarium. http://www.mobot.org/MOBOT/Research/Library/liesner/tpage.htm
- Backyard Tree Identification Guide contains the basics of classifying & IDing different trees with some helpful pictures. https://www.homeadvisor.com/r/backyard-tree-identification-guide/

- iNaturalist is a great app to help identify local flora and fauna simply by sharing images, and fellow naturalists will help confirm or adjust your identifications. https://www.inaturalist.org/
- The LeafSnap plant identification app is an excellent resource to help identify plants. https://plantidentifier.info/