TREE MEASUREMENT

Overview

To make sound forest management decisions, foresters collect a great deal of information about trees and forests. Much of this information comes from evaluating a tree's physical characteristics. In this exercise students will learn about the different measurements that foresters take, how to take measurements and the importance of accurate measurements.

Subjects
Math, Science

Concepts
Plant and animal populations exhibit interrelated cycles of growth and decline.

Biological diversity results from th interaction of living and nonliving environmental components such as air, water, climate and geological factors.

Objectives
Students will: (1) discuss the importance of tree measurements, (2) determine a tree's age, growth pattern, life history and general health by observing tree cross-sections and by using an increment borer, (3) study various tree measuring instruments, (4) calculate the timber volume of a tree using a Biltmore stick, (5) calculate the impact of their homes and communities on the forest, (6) learn the basics of timber estimation (cruising) and how it produces data that is crucial to resource management decisions.

Materials Needed
A sheltered area for the discussion part of class located near a wooded area or edge of woods where the tree tops are clearly visible at a distance of 66 feet from the base of the tree.

Tree cross-sections

Increment cores or borer

Easel and markers

30 Biltmore sticks

Diameter tape

Tree calipers

Clinometer

Log tape

Posters showing boards cut from a log

Different shaped boards representing 1 board foot

Time Required
Class can be taught in 1 hour. Allow time to set up 1-chain course, 10 minutes for introduction, 15 minutes for tree cross-sections, 30 minutes for Biltmore sticks and 5 minutes for wrap up.

Background

To make sound management decisions, foresters need detailed data on a tree's age, volume, diameter and height to make sound management decisions,

Trees grow in two different ways. At the tip of every twig there is a group of specialized cells that divide and make the twig grow longer. In addition to growing in height, trees add a layer of wood to their circumference each year. This occurs in the cabium, a living, dividing layer of cells just under the bark. Wood formed at the begining of the growing season, known as earlywood or springwood, is porous and light in color. Wood formed at the end of the growing season is known as latewood or summerwood and is darker in color. The two together represent one year's growth or an annual ring.

A tree's pattern of annual rings is extremely informative. Foresters can determine the age of a tree by counting its rings. A ring count made on the cross section at ground level provides the total age of the tree, and a count taken at any point higher up on the stem gives the number of years' growth that the tree has undergone since attaining that height. The width of the rings gives an idea of the rate of growth. Wide rings represent periods of rapid growth, while narrow rings represent periods of slow growth. The ring pattern may also reveal health-related events in the tree's life such as fire, drought, insect damage, disease, overcrowding, suppression or release.

In addition to measuring a tree's age, foresters often need to know the volume of a tree to determine its value and how the tree can be used. The standard unit of measure for tree volume is a board foot, which is equivalent to the volume of a board that is 1 inch thick, 12 inches wide and 12 inches long. The volume of an individual tree can be determined by measuring its diameter and height using special tools and standard units of measure.

The diameter of a tree is measured at a height of 4-1/2 feet above the ground, on the uphill side of the stem. This is known as diameter at breast height (dbh). Diameter is measured in inches using a tree caliper, a diameter tape or a Biltmore stick.

A tree caliper has an arm and two prongs, one of which is free to slide along a graduated scale on the arm. The prongs are placed against opposite sides of the tree, and the diameter is read from a scale on the caliper. Calipers are ideal for trees to about 18 inches in diameter.

A diameter tape is a steel pocket tape with a scale on each surface and a bark hook at the zero end. The outside surface is graduated in inches and tenths of inches. Although the tape is placed around the tree, this scale is calibrated to give the tree's diameter. If a steel diameter tape is level and pulled taut, it is the most consistent method of measuring dbh.

A third instrument for measuring dbh is a Biltmore stick, which looks much like a yard stick. The Biltmore stick is held horizontally against the trunk of a tree at 4-1/2 feet above ground and 25 inches from the eyes. The measurer then eyeballs the diameter by lining up the edges of the tree with the Biltmore stick.

Foresters may measure either the total height or the merchantable height of a tree. *Total height* is the linear distance from ground level to the upper tip of the tree crown. *Merchantable height* refers to the length of usable tree and is measured from stump height (1 foot above ground) to the cutoff point in the top, which may vary depending on location, product and excessive limbs.

Instruments used for measuring tree height include a clinometer and Merritt hypsometer, a linear scale often imprinted on one face of a standard Biltmore stick.

Measurements taken with a clinometer are based on basic trigonometry. The observer stands at a fixed horizontal distance from the base of the tree and determines the angle from the fixed point to the top of the tree and from the fixed point to the base of the tree. As with the Biltmore stick, the hypsometer must be positioned at a fixed distance from the eye, and the observer must stand a specified distance from the tree to measure height. The Merritt hypsometer scale normally is used to determine merchantable height rather than total height.

There are many accepted ways to estimate the total volume of a standing forest. If the area is only 10 to 15 acres or contains no more than 1,500 trees, a forester will probably measure each tree and tally them separately. This is referred to as total tree tally or 100 percent cruise. This is the best way to measure volume, but it is not practical for large areas.

On larger acreage, a forester will take a sample of each acre by measuring the merchantable trees on a 1/10 acre area and sampling each acre following a set course on a grid line pattern. A common grid pattern is 5 chains (330 feet) by 2 chains (132 feet). This means that a sample plot is taken every 2 chains along a determined sample line, and the sample lines are 5 chains apart.

Another method used when accuracy is not essential is to walk over the woodland and estimate the volume per acre and then multiply the estimated volume by the number of acres. This method takes years of experience.

Volume estimates are made on harvested logs by weighing. A loaded truck is driven onto scales and weighed as it enters the mill yard and is weighed again after it is unloaded. The difference in the two measurements is the weight of the load. In general, 1,000 board feet of hardwood weighs 16,000 lbs., and 1,000 board feet of southern pine weighs 12,000 lbs. One cord of hardwood weighs 5,500 lbs., and one cord of southern pine weighs 5,200 lbs.

Grading logs: The butt log is the first 14 to 16 feet of a tree larger than 10 inches at the small end. Usually, this log represents the highest value in the tree. If the butt log has been damaged by fires, insects or past logging, or has too much crook or sweep, or too many limbs, the log may be downgraded to pulpwood. Depending on the dbh, the standing tree could have other 14- to 16-foot logs further up the tree. The logs must have at least a 10-inch diameter at their smallest end and be free of knots, sweep or crook, interior rot and exterior scars.

Pulpwood is measured in cords (128 cubic feet) and consists of the top wood and larger limbs in sawlog trees, and smaller merchantable trees that are larger than 5 inches dbh. A straight pine tree, not large enough for sawlog but roughly 6 to 9 inches dbh, and free of limbs and knots, is called chip-n-saw and is more valuable than pulpwood even though it is measured in cords. If there is a chip-n-saw mill in the area, it may be necessary to measure the chip-n-saw separately from the pulpwood.

Vocabulary

- *Biltmore Stick*: A stick similar to a yardstick in appearance, but usually about 25 inches long. One side is scaled to read a tree's diameter by holding the stick at arm's length and horizontally against the tree at breast height. A Merritt hypsometer runs along one edge of the stick and is scaled to read a tree's height from 66 feet away from the tree's base. These two measurements are then used to find the tree's volume according to the volume table printed on one face of the stick.
- *Board foot*: A unit of volume measure that is 1 inch thick, 12 inches long and 12 inches wide, or 144 cubic inches.
- *Cambium*: A thin layer of specialized cells that divide to produce new inner bark cells to the outside and new sapwood cells to the inside. The narrow band of cells that is responsible for the tree's growth in circumference.
- *Clinometer*: An instrument that is held at eye level to read stump height and merchantable or total height when standing 50 and 66 feet from the base of the tree. The difference between the two readings yields the height.
- *Diameter at Breast Height (dbh)*: Tree diameter measured at 4-1/2 feet above ground level.
- *Diameter Tape*: A steel measuring tape that has a scale calibrated to read a tree's diameter when wrapped around the tree's circumference.
- *Earlywood*: Wood cells produced at the beginning of the growing season that are generally light in color. Also called *springwood*.
- *Hypsometer*: Any device used for measuring tree height.
- *Increment borer*: A hollow auger-like tool with a screw bit used to remove core samples from trees.
- *Latewood*: Wood cells produced at the end of the growing season that make up the darker section of an annual ring. Also called *summerwood*.
- *Merritt Hypsometer*: A scale that, when held at arm's length so that the zero end is in line with a tree's stump level while standing 66 feet from the base of a tree, measures the number of 16-foot logs in that tree. Usually found on one side of a Biltmore stick.
- *Release*: To free a tree from competition with its immediate neighbors by removing those neighboring trees. This occurs naturally and artificially.
- *Suppression*: When a tree loses its vigor due to inadequate light, water and nutrients.
- *Springwood*: See *earlywood*.
- *Summerwood*: See *latewood*.
- *Tree Calipers*: A metal or wooden device, consisting of an arm and two prongs, one of which is free to slide along a graduated scale on the arm. The prongs are placed against opposite sides of the tree, and the diameter is read on the scale.

Doing the Activity

Begin with a review of the basic parts of a tree. Ask the class to name the parts of a tree that can be measured and to think of reasons for measuring trees. Briefly review the importance of tree measurement to determining inventory and health of a forest.

Use this discussion to impress upon the students the importance of forest statistics and accurate measurements to produce these numbers. In order to provide all the things we want from the forest, resource managers start by measuring what we have (inventory), how fast it's growing and what we take from the forest annually. From this data, we can form management plans that provide a sustainable resource that can, in turn, be available for multiple uses.

Activity 1:

Explain or review the formula for calculating the volume of a cylinder, which is essentially the shape of a tree's trunk. Discuss that the two measurements that are necessary are diameter and height.

Activity 2:

Use a 1-chain course for students to determine their number of paces per chain. (Standing at the starting point and beginning with the left foot, count the number of times the right foot touches the ground until you reach the end marker.)

Activity 3:

1. Explain to the students that people in early times used their own bodies to measure things. Pick a nearby tree and have several students measure its circumference in arm or hand spans. Discuss the importance of having a standard unit of measure.

2. Next, discuss standard equipment used to make common forestry measurements. Demonstrate how to measure dbh using whatever instruments you have available. Demonstrate how to use a Biltmore stick and let the students practice. Then demonstrate how to measure tree height using the available hypsometers and the Merritt hypsometer on the Biltmore stick. Let students practice measuring height with a Biltmore stick.

3. Show the class how to read the volume table on the Biltmore stick. Give the class height and diameter readings and see who comes up with the volume first. Let the students practice measuring heights and diameters.

Activity 4:

Walk the students through the basics of cruising timber and how it uses the skills they've just learned. Explain that this is how many of the statistics you cited in the introduction were derived.

Helpful Hints

The activity sections of this class are lengthy. Don't spend too much time on the introduction (10 minutes maximum) or you will not be able to get through the activities in 1 hour. Tell the students that the conclave will test their tree measurement skills and knowledge.