

Optional Laboratory:

Calculating Board Footage In A Tree

Introduction

Trees are valued not only for their beauty, but also for their renewability and use as a construction material. Foresters that manage areas for lumber production often conduct volume cruises through a forest. At each sample point of a volume cruise, the forester makes only two measurements per tree. The forester measures the tree diameter and the tree height. From these two measurements a forester can determine how much lumber is in a tree, and thereby predict how much wood is in a particular timber area. The unit of wood that a forester wants to know is called a 'board foot'. A board foot is one foot by one foot by one inch thick. In 1988, 12.6 billion board feet of lumber were harvested from U.S. Forest Service lands.

Questions

1. How much lumber comes from one tree?
2. How many trees did it take to build the house or apartment you live in?

Hypothesis

Students should make their own before continuing.

Materials

Clinometer
Diameter tape / tree caliper
Pencil and paper
100 foot tape measure

Procedure

1. Measure the height of the tree you are studying.
2. Measure the diameter of the tree you are studying. Make sure you write these two measurements down very carefully on the data sheet.
3. Remember the formula to find the area of a circle is ($A=r^2 \times \pi$). Area = radius squared times 3.14). Since a tree is almost circular, use this formula to find the area of your tree at DBH (diameter at breast height). Since the formula requires the radius of the tree and you just measured the diameter, divide the diameter by 2. Dividing the radius by 12 converts inches to feet.
4. Now use this number to calculate the area of your tree.
5. Don't relax now! We are only beginning! Use the formula in step 5 of the data sheet to find out how many cubic feet of lumber are in your tree.

Cubic Feet = Area (ft) X Height (ft) / 4
(note: 4 is used to account for the taper of the tree)

6. There are 12 board feet of lumber for every one cubic foot, so multiply cubic feet by 12. You have calculated how many board feet of lumber your tree has.
7. Practice on several other trees to get comfortable with this series of calculations.
8. Your teacher may have already measured and calculated board footage for the trees. Compare your own measurements with your teachers.

Board Footage Data Sheet

Tree # _____

Tree species: _____

1. Height _____ feet
2. Diameter _____ inches
3. Diameter in feet / 2 = _____ radius in inches / 12 = _____ feet
4. Area of tree cross-section = above number squared x 3.14 = _____ sq.ft.
5. Volume of tree in cubic feet = above number x tree height / 4 = _____
6. Volume of tree in board feet = above number x 12 = _____

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Tree # _____

Tree species: _____

1. Height _____ feet
2. Diameter _____ inches
3. Diameter in feet / 2 = _____ radius in inches / 12 = _____ feet
4. Area of tree cross-section = above number squared x 3.14 = _____ sq.ft.
5. Volume of tree in cubic feet = above number x tree height / 4 = _____
6. Volume of tree in board feet = above number x 12 = _____

Background Information

As a renewable resource, trees are managed professionally for a variety of reasons. Forests are managed for recreation, watershed protection, animal habitats, and for products such as paper and lumber. Foresters have used silvicultural techniques to optimize lumber production for many decades, which would place trees in the category of a long term crop. When it is time to harvest a stand of trees, the U.S.D.A. Forest Service has traditionally offered the stand up for bidding between logging companies. In order for the loggers to accurately bid on the stand, they need to know how much wood is on the stump, or 'stumpage'. It is the job of the forester to conduct a pre-bid volume cruise in the stand of timber. Foresters express 'stumpage' as board feet. A 'board foot' of lumber is a board one foot by one foot by one inch. In a volume cruise, a forester will randomly select trees to measure. The forester will measure the height and diameter of a tree. A forester does not, however, calculate the board footage for each single tree that is measured because of the numbers of trees involved in a volume cruise. A forester has various formulas to determine board footage on large tracts of forests. This exercise, however, is designed to calculate the board footage of a single tree to give the student an idea of the process that a forester uses.

Target Group

Sixth through eighth grade.

Timeline

This activity can be completed within one hour in the field. Thirty minutes of classroom preparation time is needed to review tree height measurements and tree diameter measurements. It might be beneficial to go over the board footage formula in class also.

Student Learning Objectives

Students will be able to:

1. Gain experience at measuring tree heights and tree diameters.
2. Understand the standard unit of measurement for lumber.
3. Calculate the board footage of a given tree using a formula.
4. Relate the number of trees needed to build a small house.

Procedure

Make sure students correctly measure the tree height by avoiding the upslope and downslope position for the clinometer reading. If the students are not proficient at pacing 100 feet, then provide a 100 ft tape

measure.

When a tree diameter is taken, make sure it is a true DBH. DBH (Diameter at breast height) is measured at 4.5 feet from the ground on the tree trunk. When a tree is on a slope, the 4.5 feet is measured on the up slope side of the trunk.

When students have made both tree measurements and are ready to plug numbers into the formula, make sure they use the radius measurement in feet. The measurement they took was in inches, so it must be converted into feet. For example, if a student measured a tree's diameter to be 14 inches, the radius would be 7 inches and the number to used in the formula would be 0.58 feet. ($7 / 12 = 0.58$)

A fairly straight pine tree is an ideal tree for this exercise.

Blowouts

1. A small ranch style house with 3 bedrooms (approximately 1000 square feet) would require about 3000 board feet of lumber to build. Have students arrive at the number of trees that would be needed to build the house they presently live in. Have the students make this calculation from their data (originally measured trees).
2. Conifers are the trees of choice for construction lumber. Have students research the products that are made from oaks, hickories and ashes.

Glossary

volume cruise: a set of randomly selected plots through a forest tract where trees are measured in height and diameter.

watershed: an area of land outlined by high ground where all the water that falls on the land leaves by one major waterway.

silviculture: the cultivation of forest trees.

stumpage: standing timber with reference to its value or the right to cut such timber on the land of another.

board foot: a piece of wood one foot by one foot by one inch.

DBH: diameter at breast height. Breast height is considered to be 4.5 feet from the ground.

References

1. *Earth's Trees: Environmental Learning Series*. WP Press, Tucson, Arizona. 1992.
2. *Illinois Council on Forestry Development*. A Long Range Plan for Illinois Forest Resources. 1990.
3. *Elements Of Forestry: With Special Reference to Illinois*. Department of Conservation, Division of

example data

Board Footage Data Sheet

Tree # 3

Tree species: Red Oak

Height 60 feet

Diameter 14 inches

Diameter in feet / 2 = 7 radius in inches = 0.58 feet

Area of tree cross-section = above number squared x 3.14 = 1.05 sq.ft.

Volume of tree in cubic feet = above number x tree height / 4 = 15.75

Volume of tree in board feet = above number x 12 = 189

An Example of How Midwest Lumber Is Used

Production of Primary Wood-Using Firms, Illinois, 1984					
Products	Firms producing (percent)	Average volume	Largest volume	Total	Percent of total volume
		(thousand board feet)			
Industrial lumber	64	180	3,000	29,200	20
Pallet lumber, cants	34	490	5,000	42,700	30
Grade lumber	23	395	2,400	23,600	16
Railroad ties	17	210	1,200	9,100	6
Mine timbers	11	530	3,000	15,200	11
Blocking	9	400	2,500	9,600	7
Other	--	--	--	14,600	10
Total		565	7,500	144,000	100

From: *A Long Range Plan for Illinois Forest Resources*. The Illinois Council on Forestry Development. 1990.