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SECTIONAL ALUMINUM POLES IMPROVE LENGTH MEASUREMENTS IN STANDING TREES

Abstract.--The use of sectional aluminum poles to measure lengths in standing trees can reduce bias and improve measurement precision. The method has been tested extensively under a variety of field conditions by Forest Survey crews in the Southeast. Over 16,000 trees with lengths up to 120 feet have been measured over the past 5 years.

The determination of standing-tree volume is essentially a matter of measuring stem diameter at one or more points on the bole of a tree, converting diameters into cross-sectional area, multiplying by length to obtain a volume estimate, and then discounting for bark and cull volumes. If volume tables or volume prediction equations are used, a single diameter measurement is usually taken at d.b.h. and length is measured to a specified upper limit of merchantability. More complicated prediction equations generally require additional diameters, lengths, or some measurement of tree form to refine further the estimation of individual tree volume. A more precise estimate of standing-tree volume can be obtained by measuring the tree bole as a series of short sections, computing section volumes by mathematical formulae, and summing section volumes to determine tree volume. Estimates of tree volume based on form class require a measurement of diameter inside bark at a point 16.3 feet above the stump. Therefore, regardless of which standing-tree volume procedure is used, accurate volume determination is highly dependent upon accurate length measurement.

A wide variety of instruments are now being used to determine the height of trees by triangulation. Such instruments are broadly classed as hypsometers and require the measurement of a horizontal base distance and an included angle. Accurate length measurements can be taken with these instruments if the stem is straight, if the tree is vertical, and if the base distance is sufficiently long to keep angles above and below the horizontal from exceeding 90 to 100 percent. In most cases, where tree lean is not excessive, a reasonably accurate length measurement can be obtained by simply measuring the tree perpendicular to the direction of lean. In the final analysis, much of the bias associated with hypsometer measurements is attributable to the fact that these instruments

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do not measure lengths, only heights above and below the horizontal. A hypsometer cannot be used to measure lengths in forks or limbs which are oriented at angles approaching the horizontal, and is limited in precision when large angles are involved.

Various types of sectional and telescoping poles of different materials have been used in studies where maximum lengths did not exceed 30 to 40 feet, but the weight, strength, or design features became limiting factors to the measurement of tall trees. The sectional aluminum poles described in this Note were developed for use by special study crews on Forest Survey. Several sizes of round and square aluminum tubing were field tested. Round 3/4-inch tubing was difficult to control above 40 feet. Square 3/4-inch tubing could be controlled but lacked stiffness. Square tubing over 1 inch was too heavy, but square 1-inch tubing proved to have all of the required features. It was stiff enough to reach into the lower limbs of most trees, easily controlled because of its square shape, and light enough to carry into remote sample locations.

The construction and use of these poles is quite simple (fig. 1). Individual 5-foot poles are constructed of 1-inch square, extruded, tempered, anodized aluminum tubing which has a wall thickness of .062 inch and a weight of .279 pound per linear foot. A hickory peg 7/8 by 7/8 by 8 inches is treated with a wax base preservative, half of its length is inserted into the top of the pole, and a single sheet-metal screw is used to hold the peg in position. The bottom 12 inches of the pole is wrapped solidly with black plastic tape, a strip of red plastic tape is placed immediately above the 2-, 3-, and 4-foot marks, and a strip of yellow plastic tape is placed immediately above the $1\frac{1}{2}$-, $2\frac{1}{2}$-, $3\frac{1}{2}$-, and $4\frac{1}{2}$-foot marks. The wooden peg of one pole can be more easily inserted into the bottom of another pole if the top of the peg is beveled.

The sectional poles are extended up alongside the tree bole by holding the bottom of one pole at head height and inserting the peg of another pole into the bottom of the first. Total pole length is increased by 5-foot increments as additional sections are added in a similar manner, and the top pole is directed between limbs by manipulating the bottom pole as it is raised to head height. Experienced crews can control the path of the poles with considerable precision by twisting and bowing the poles as they are extended into the upper stem. The poles are usually placed on one side of the tree so that the measurer can relate a point on the tree to pole length by an imaginary horizontal line.

Total tree length is usually measured by counting the number of poles used to reach above the crown and then subtracting the overextension back to the tree's tip. The length up to any point on the bole is easily measured by counting the number of black marks below the point, multiplying by 5, and adding additional footage by counting red and yellow marks. The bottom of each black mark will be at 5-foot intervals, the top of a black mark will be 1 additional foot, the bottom of each red mark will be 1 additional foot, and the bottom of each yellow mark will be an additional $\frac{1}{2}$ foot of length. Interpolation between $\frac{1}{2}$-foot marks can be

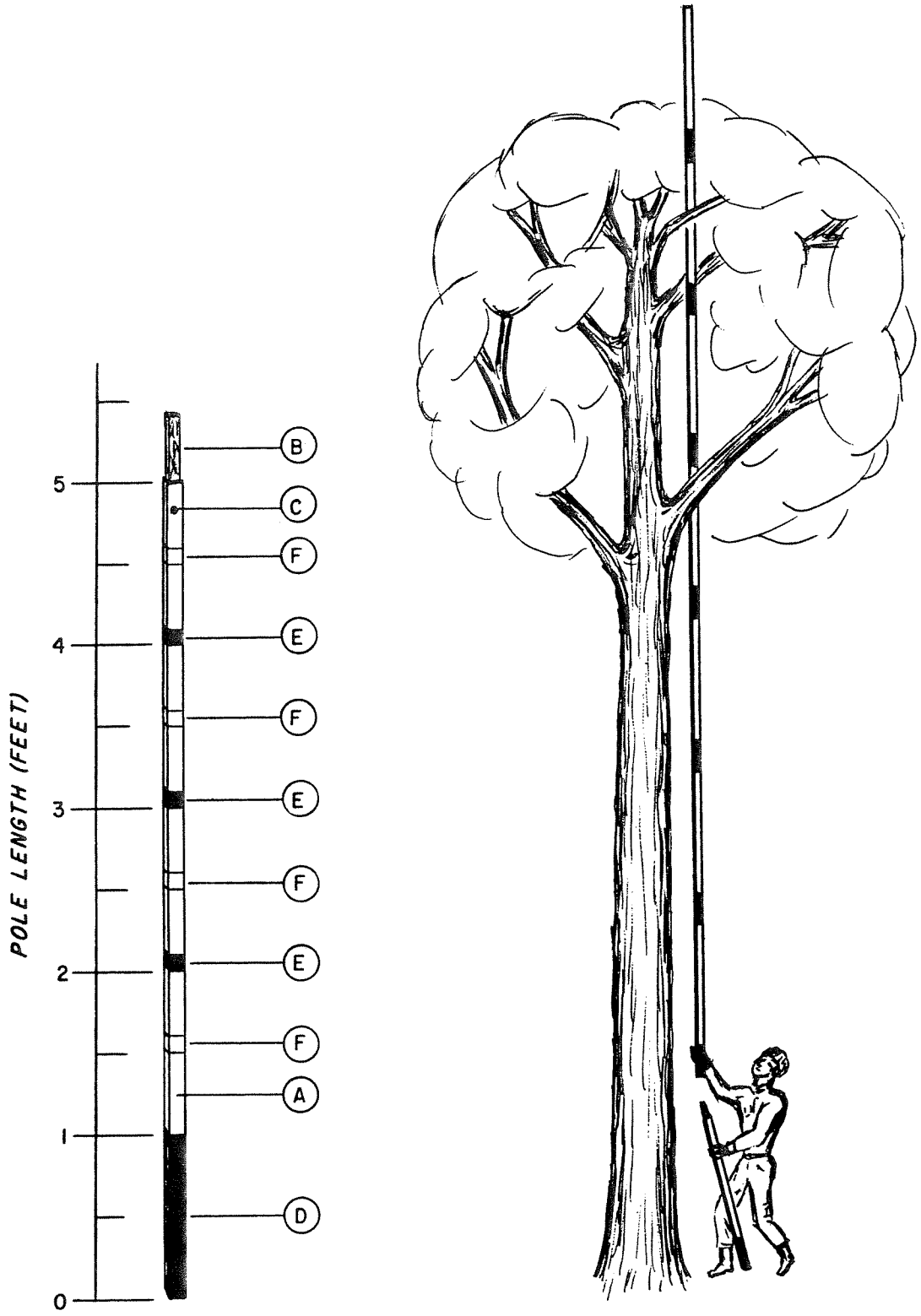

Figure 1.--Construction features of sectional aluminum poles: A, 1- by 1-inch square aluminum tubing, 5 feet long; B, 7/8- by 7/8- by 8-inch treated hickory peg; C, sheet-metal screw; D, black plastic tape; E, red plastic tape; F, yellow plastic tape.

estimated when lengths are recorded to the nearest 1/10 foot. An alternate method of measuring length to a point requires two men, one to extend the poles and the other to observe the pole position from a vantage point away from the tree. The pole handler extends the poles until the top is even with the point. Holding the poles in this position, he then measures the odd footage from the ground up to the bottom of the poles.

Leaning trees are measured by extending the poles along the upper side of the bole and directing the top pole between limbs and branches that will help hold it in position. When forks or limbs are measured for length, the poles are extended slightly above the intersection and then the bottom of the pole series is pulled away from the tree, allowing the further extension of the poles to follow the direction of the fork or limb.

Since these poles were first used in 1963, Forest Survey crews have used them to measure over 16,000 trees under a wide range of field conditions, and under ideal conditions they have been extended up to 120 feet above the ground.

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