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Nacogdoches, Texas

COMPUTER REDUCES CRUISE-DATA COMPILATION ERROR

by

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Mensurationists have long known that midpoint volumes applied to numbers of trees by one-inch or broader diameter classes generally underestimate stand volumes. The errors stem primarily from two causes:

1. The distributions within diameter classes may be biased in either direction.

2. Tree stem volume is proportional to the square of diameter rather than to diameter.

The first cause may operate at random; the second tends always toward underestimation in random distributions.

Because manual compilations are slow and costly, foresters have customarily economized by estimating and computing volumes by diameter classes, ignoring the resulting inaccuracy. Computer compilation now makes it feasible to avoid these errors.

Development of a computerized plantation inventory program at SFA (Texas Forestry Paper No. 2, 1970) afforded an opportunity to evaluate the size of the errors resulting from using one-inch dbh classes. Stand volume for ten inventories of two stands near Nacogdoches were computed by both tenth-inch and one-inch diameter classes. Volume per acre computed through summarization by diameter to nearest tenth-inch was always larger than volume per acre computed through addition of the stock table arranged by one-inch dbh classes. The differences averaged 2.4 percent. (Table 1)

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Both computations employ the same relationships between volume and dbh. The first compiled the volume for each sample tree, based on its dbh measured to the nearest tenth-inch. The second, or stock table method, computed the number of sample trees within each one-inch diameter class, and applied to them a volume computed for the nominal midpoint of the class, as in the usual manual computation.

As indicated above, tree volumes do not bear a straight-line relation to diameters, but are approximately proportional to diameter squared. In any group of trees the average of the squared diameters is always larger than the average diameter. In a diameter class within which trees are evenly distributed by sizes, their average diameter will be close to the midpoint of the class, but diameter of the tree of average basal area, or average squared diameter will be higher than the midpoint. The consistent bias revealed in Table 1 results from this mathematical relationship. The *percent* difference, however, probably would be smaller for stands of larger diameter. Consider two theoretical diameter distributions, (1) a single tree in each tenth-inch class, and (2) ten trees at the midpoint of each inch class. The sum of squares of diameters of (1) will exceed that of (2) by 2.3 percent for the five-inch class, but by only 0.66 percent for the sixteen-inch class. Expansion of the squared diameters to volumes might somewhat magnify these differences because larger trees are also frequently taller even within a one-inch dbh class.

In conclusion, for young even-aged stands, one could expect volumes calculated by tenth-inch dbh classes to exceed those calculated by one-inch dbh classes by 1 to 4 percent. The error may be avoided at nominal cost by recording dbh measurements to the nearest tenth-inch and programming the computer to compile volumes on this basis. The printout from the SFA Plantation Inventory Program includes a summary, by one-inch classes, of numbers of trees and volumes computed in this way.

Table 1. *Average volume per acre from ten cruises computed in two different ways. Nacogdoches City Plantation, established 1942.*

Date of Inventory and Species	Computed from tenth-inch dbh classes	Computed from one-inch dbh classes	Difference
	——— Cubic Feet	———	*Percent*
1965B Slash pine[1]	3204	3153	1.62
1965A Slash pine[1]	2047	2015	1.59
1966 Slash pine	2186	2137	2.29
1967 Slash pine[2]	2940	2906	1.17
1968 Slash pine	3038	2993	1.50
1965B Loblolly pine[1]	2620	2512	4.30
1965A Loblolly pine[1]	1727	1666	3.66
1966 Loblolly pine[2]	1950	1873	4.11
1967 Loblolly pine	2154	2112	1.99
1968 Loblolly pine	2287	2247	1.78

[1] "B" was before thinning, "A" was after thinning was complete.

[2] In this and subsequent years, a new volume table equation was used for this species.