USDA FOREST SERVICE RESEARCH NOTE NE-221
1976

Northeastern Forest Experiment Station

FOREST SERVICE, U.S. DEPT. OF AGRICULTURE, 6816 MARKET STREET, UPPER DARBY, PA. 19082

ACCURACY OF BAND DENDROMETERS

by L. R. AUCHMOODY

Research Forester
USDA Forest Service
Northeastern Forest Experiment Station
Warren, Pa.

Abstract.—A study to determine the reliability of first-year growth measurements obtained from aluminum band dendrometers showed that growth was underestimated for black cherry trees growing less than 0.5 inch in diameter or accumulating less than 0.080 square foot of basal area. Prediction equations to correct for these errors are given.

Band dendrometers are often used to monitor changes in diameter growth of trees where accurate measurements of increment are desired. The bands provide an economical, convenient, and accurate method for measuring growth response to cultural treatments over short periods, as well as for making precise measurements over longer periods of one or more growing seasons. Since their introduction by Liming *(1957)*, their use has become common in much forestry research.

Although band dendrometers are perhaps the most accurate of the common devices for measuring diameter growth rates, newly installed bands tend to underestimate growth during their first season of operation because of slack that cannot be completely eliminated from the band during installation. Correction is needed to provide valid comparisons between growth accumulation in the first year and that of following years.

Because band dendrometers are used extensively in our research, a study was done with black cherry (*Prunus serotina* Ehrh.) to determine the amount of first-year radial growth that was being underestimated, and to see if true growth rates could be predicted by using easily measured variables such as tree size or indicated growth rate. With this information, adjustments to first-year growth data could then be made, allowing more accurate comparisons of growth obtained in the first year with that obtained in future years.

Methods

The study area was located in a fully stocked unthinned stand on the Allegheny Plateau in northwestern Pennsylvania. Thirty-three 60-year-old dominant or codominant black cherry trees were fitted with dendrometer bands at breast height in the spring of

Figure 1.—Paired dendrometers were installed at 4.5 feet above ground on 33 black cherry trees.

1972. The trees were first scraped to remove loose bark, then the bands were fitted over the smoothed bark as tightly as possible. After the fitting, initial diameters were measured with a diameter tape to the closest 0.01 inch. Diameters of the sample trees ranged from 9 to 15 inches; and annual diameter increments at breast height (determined later) ranged between 0.03 and 0.41 inch (basal-area equivalent of 0.003 to 0.080 square foot).

In the spring of 1973, before start of the growing season, each sample tree was equipped with a second dendrometer band. All new bands were installed in exactly the same way as the originals (except that the bark was not re-scraped), by the same person, 1-inch below the existing bands (fig. 1). Diameter-growth readings were obtained from both the original and the new bands following the 1973 and 1974 growing seasons. Readings from the original bands were considered to represent true diameter growth rates for 1973 and 1974. Diameter and basal-area growth adjustment equations were developed, using data from the 1973 growing season. The 1974 growth data were used to verify that band readings obtained after one season of operation were similar for each pair of dendrometers.

Results and Discussion

The degree to which dendrometers underestimated true first-year diameter and basal-area growth varied directly with the growth registered by the dendrometers and with tree size (table 1). Predictions of true growth

Table 1.—*Relationship of true growth rate with initial tree size and first-year growth indicated by band dendrometers*

Dependent variable	Independent variable	r^2	Correlation between independent variables (r^2)
1. True basal-area growth	Initial basal area	0.79	0.76
2. True basal-area growth	Indicated basal-area growth	.99	
3. True diameter growth	Initial diameter	.63	.61
4. True diameter growth	Indicated diameter growth	.99	

rates can be made from either the growth reading indicated by the band or from the initial size of the tree. However, indicated growth provides superior estimates for both diameter and basal-area growth.

Multiple regressions, using indicated growth and initial tree size to predict true diameter and basal-area growth rates, did not improve the amount of explained variation nor the standard error of estimate from equations using only indicated dendrometer growth. For this reason, and also because of the strong correlation between these independent variables (table 1), prediction equations for estimating true growth rates were developed by using only the indicated dendrometer growth.

Figures 2 and 3 show that, to adjust indicated to true growth, larger corrections are necessary for slow-growing trees than for fast-growing trees. Growth on trees indicating accumulation of only 0.001 square foot of basal area was underestimated by 69 percent. Underestimates at the indicated mean growth rate (0.022 square foot) of the sample trees amounted to 11 percent, and no correction was necessary for the faster growers that accumulated 0.080 square foot.

Diameter-growth discrepancies were similar in size to those for basal area. Underestimates amounted to 52 percent for trees indicating only 0.01 inch of diameter, 11 percent at the sample mean (0.15 inches); and no correction was necessary for trees growing 0.50 inch per year. Growth registered by each pair of dendrometers in the second season was identical, indicating that discrepancies are limited to the first season as long as enough growth accumulates to take up the slack in the dendrometer band.

These equations (fig. 2 and 3) may be used to correct first-season growth discrepancies associated with band dendrometers. They can also be used to correct readings from bands that may require replacement throughout the course of a study. However, caution should be used in making adjustments for trees having growth rates and diameters not within the range of our data (0.02 to 0.41 inch and 9 to 15 inches, respectively). Care must also be taken to insure that bands are initially

Figure 2.—Relationship between true diameter growth and first-year growth as indicated by band dendrometers.

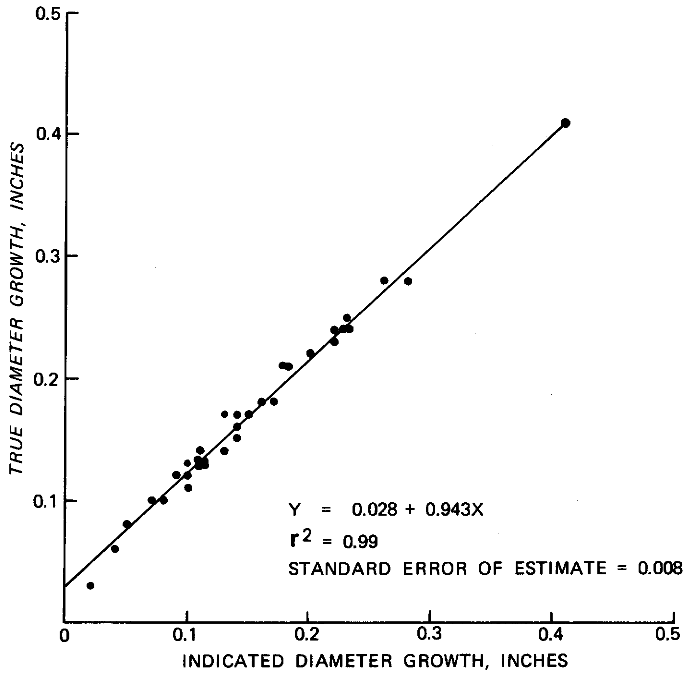
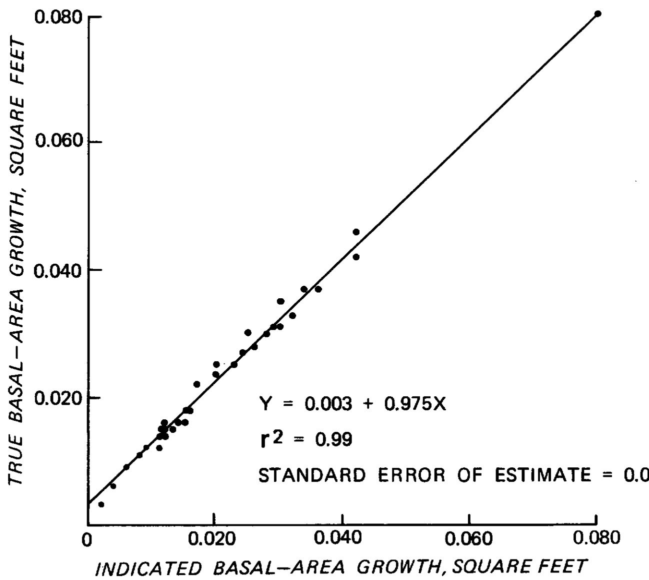


Figure 3.—Relationship between true basal-area growth and first year growth as indicated by band dendrometers.



installed as tightly as possible, or these equations may underestimate the corrections needed.

The equations show that adjustments for trees that have growth rates exceeding 0.5 inch in diameter and 0.080 square foot of basal area are unnecessary. As these growth rates are approached, the amount of band slack becomes negligible relative to the length of band taken up by circumference growth. Also, for very slow-growing trees, adjustment should be made only for those individuals that register a measurable amount of increment. This is essential to avoid overcorrection and the possibility of obtaining negative growth in following seasons.

In an effort to simplify the models, both equations were tested to determine if their slopes were significantly different from one. The regression slope was different from one for the diameter-growth equation, but not for the basal-area equation. This means that the equation (fig. 2) should be used to compute true diameter growth; but in lieu of using the basal-area equation, a constant correction factor of 0.003 square foot may be applied to basal-area computations without introduction of serious errors.

Although black cherry was the only species used in this test, it seems likely that results could be applied to certain other species as well. However, in this we assume that bark characteristics different from those of black cherry would not greatly affect the amount of slack remaining in the band after its installation. Because the bark on all trees in this test was scraped smooth, the equations should be applicable to those species having smooth bark to begin with and also to those that can be scraped to produce a uniform smooth surface.

Literature Cited

Liming, Franklin G.
1957. HOMEMADE DENDROMETERS. J. For. 55:575-577.