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EXPERIENCE WITH BASAL AREA ESTIMATION BY PRISMS IN LODGEPOLE PINE

by

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Estimation of basal area[1/] by prisms offers intriguing possibilities for reducing time and effort in making stand inventories. Increased inventory efficiency is a particular need in stands that are relatively low in value due to small stems, predominance of low value species or heavy defect. In the Pacific Northwest, lodgepole pine characteristically forms dense low-volume stands with many small stems. Accordingly, during the course of a 1956 survey of lodgepole pine stands in the Blue Mountains of northeast Oregon, data were collected to compare prism estimation of basal area with a conventional plot tally by diameters. The study was made by the Blue Mountain Research Center in cooperation with the Pilot Rock Lumber Company.

Measurements were made on 8 plots in each of 50 lodgepole stands randomly selected in the Blue Mountain area. Plots were rectangular, 1/2 by 1 chain in dimension, and 1/20-acre in area. Each stand had at least 80 percent lodgepole by volume and was relatively uniform in terms of age, aspect, tree size, and density of stocking. Stands varied from 5 to 40 acres in total extent. Although average diameters for the sample stands varied from a low of 1 inch

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1/ Bruce, David. A new way to look at trees. Jour. Forestry 53(3):163-167. 1955.

to a high of 10 inches, three-fourths of the stands had average diameters in the 4 to 8 inch range.

On each plot, all lodgepole stems over 1/2-inch d.b.h. were measured with a diameter tape. Using a 4-diopter prism, a tree count was also made at the center of each plot. The two measurements were then compared on both a plot and stand basis.

Prism Counts vs. Measured Plots

Average basal area per acre was found to be significantly higher when estimated from prism counts than from diameter measurements on the plots. The difference was assumed due to errors in making the prism count, since the plots for diameter measurements were very carefully laid out and measured. A regression analysis further showed that this bias increased significantly with increasing basal area stocking. Accordingly, individual prism counts were adjusted to provide a satisfactory comparison between prism and measurement data. Adjustment was made by subtracting the error indicated by the regression analysis from each prism count. This adjustment assumes that, on the average, prism counts sampled the same population as measurement plots. Possible reasons for the bias in original prism counts will be discussed later. Unless otherwise specified, prism count data refer to adjusted values.

Variation within stands was significantly greater by prism count than by diameter tally. This variation within stands, expressed as coefficient of variation, is illustrated in figure 1. Average coefficient of variation for prism basal area estimation is half again higher than the average for measured basal areas. The difference is not surprising since the 1/20-acre measured plots were compared to prism counts that covered a variable area of only 1/30 to 1/50 acre. This difference decreases with an increase of basal area.

As basal area decreases, lodgepole stands become patchy, with small openings and clumps of trees. The smaller the plot, the more likely it will include only one of these clumps or openings. The large 1/20-acre plot would naturally tend to even out such extreme variations more than the smaller area included in a prism count. In lodgepole stands with larger basal areas, tree distribution is more uniform and the prism count variation approaches that of the 1/20-acre measurements.

Relationship between coefficient of variation and number of plots required to estimate mean stand basal area with an error of 5 percent is shown in figure 2. Number of plots increases with the square of the coefficient of variation.

Based on figures 1 and 2, the number of plots necessary for an estimation of the mean stand basal area within ± 5 percent is illustrated for both prism count and tree measurement in figure 3. In stands of less than 150-square-feet basal area, more than twice as many prism points using a 4-diopter prism than measured 1/20-acre plots will apparently be required.

While prism counts may not be advantageous from the standpoint of number, in the long run they may be more efficient in terms of time. Usually no more than a minute or two was required for a prism count in lodgepole. Using a 4-diopter prism, the count averaged 8-1/2 trees. Additional data would, of course, have to be taken to construct a volume table or provide an estimate of stand volume. To determine the most efficient sampling method, time studies covering the following items should be conducted: (a) time per plot for all measurements; (b) travel time between plots; (c) travel time to and from the stand. Office compilation time should also be included since individual tree diameters do not need to be totaled or averaged in the prism count method.

Technique Errors in Using the Prism

The bias for which the original prism counts were adjusted probably resulted from a combination of factors. When the study was made, there was little published information on the use of prisms in the field. While a very comprehensive bulletin on field application of prisms is now available,[2/] some of the common errors in using a prism should be noted.

The prism count must be made from a single point to obtain an accurate count. The error from not sighting over a single point becomes larger as the basal area of the sample increases. If the plot center is between the prism and the eye, the count will be too large. If the prism is between the plot center and the eye, the count will be

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2/ Bell, John F., and Alexander, Lucien B. Application of the variable plot method of sampling forest stands. Oregon State Board of Forestry Research Note No. 30. 22 pp., illus. 1957.

too small. In lodgepole pine stands with a large number of stems of small average diameter, even a slight deviation from the plot center may be important. In such stands the prism should always be oriented over a staff to insure the count is made over a single point. When an offset sight must be made to see behind large or close trees, care is needed to keep the distance between the sighted tree and the offset sighting point equal to the distance between the sighted tree and the plot center.

Difficulty can also be encountered in holding the prism vertically and in a plane perpendicular to the line of sight. To minimize errors from this source, the prism can be rotated around its axes and the minimum image displacement used to determine whether a tree is in or out.

The lower the prism count, the less likelihood there is for error in making the count. For this reason, it is desirable to use a prism that gives a count from 3 to 5. However, it should be remembered that a lower prism count entails a smaller plot, and in lodgepole stands of low basal area this may greatly increase the number of plots necessary for a given accuracy of estimation.

Finally, bias may result from calibration of the prism. Prism factor calibrations may vary considerably from one individual to another. It is difficult even for some individuals to get consistent calibration readings. If extremely accurate work is desired, it may be desirable to obtain specially manufactured prisms ground to exact factors. If precision-ground prisms are not used, the calibration should be repeated often enough to achieve a factor that is sufficiently accurate to meet the desired allowable error.

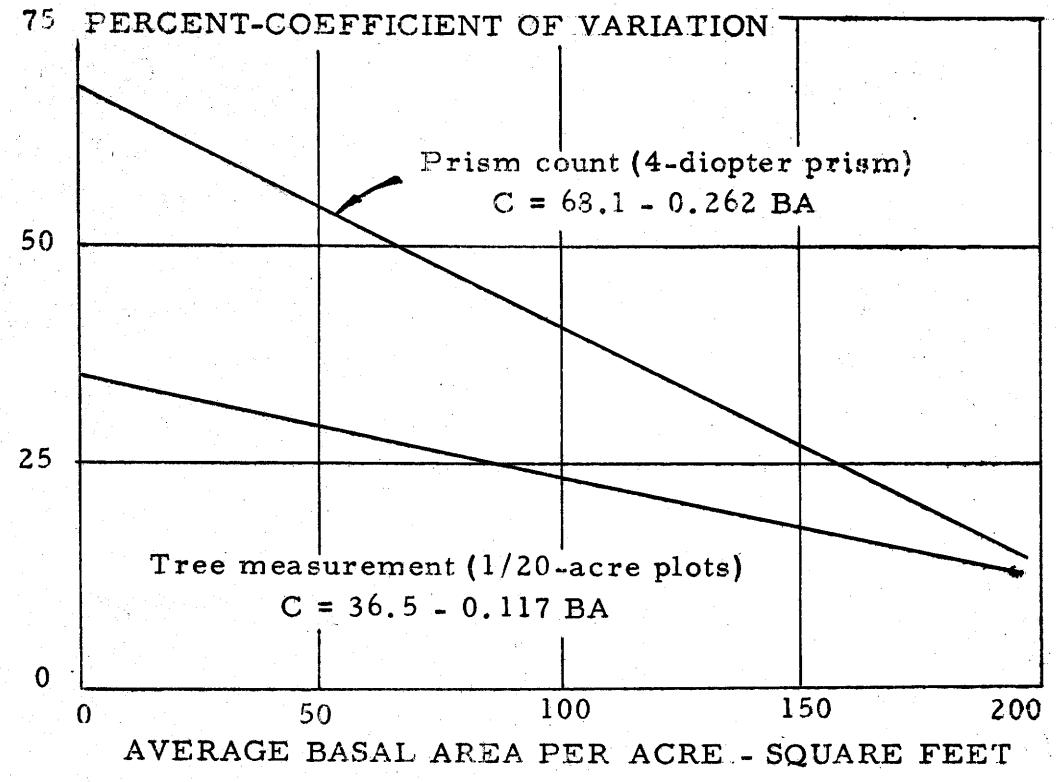

Figure 1.--Relationship of coefficient of variation to basal area in lodgepole stands, using two methods of estimation.

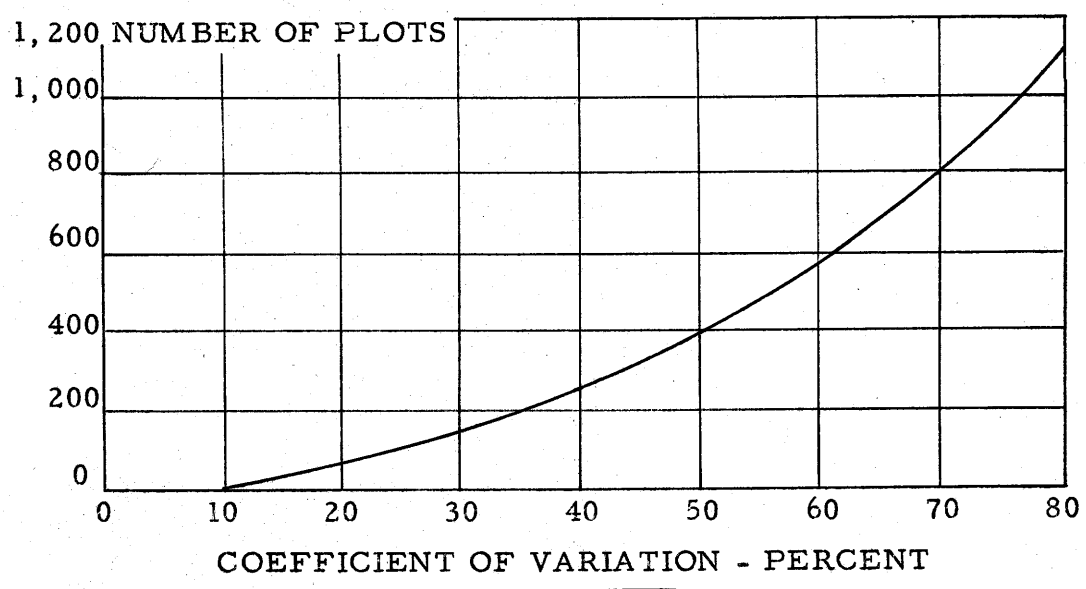

Figure 2.--Number of plots required to estimate basal area with ± 5 percent of the true mean (19 in 20 chance)

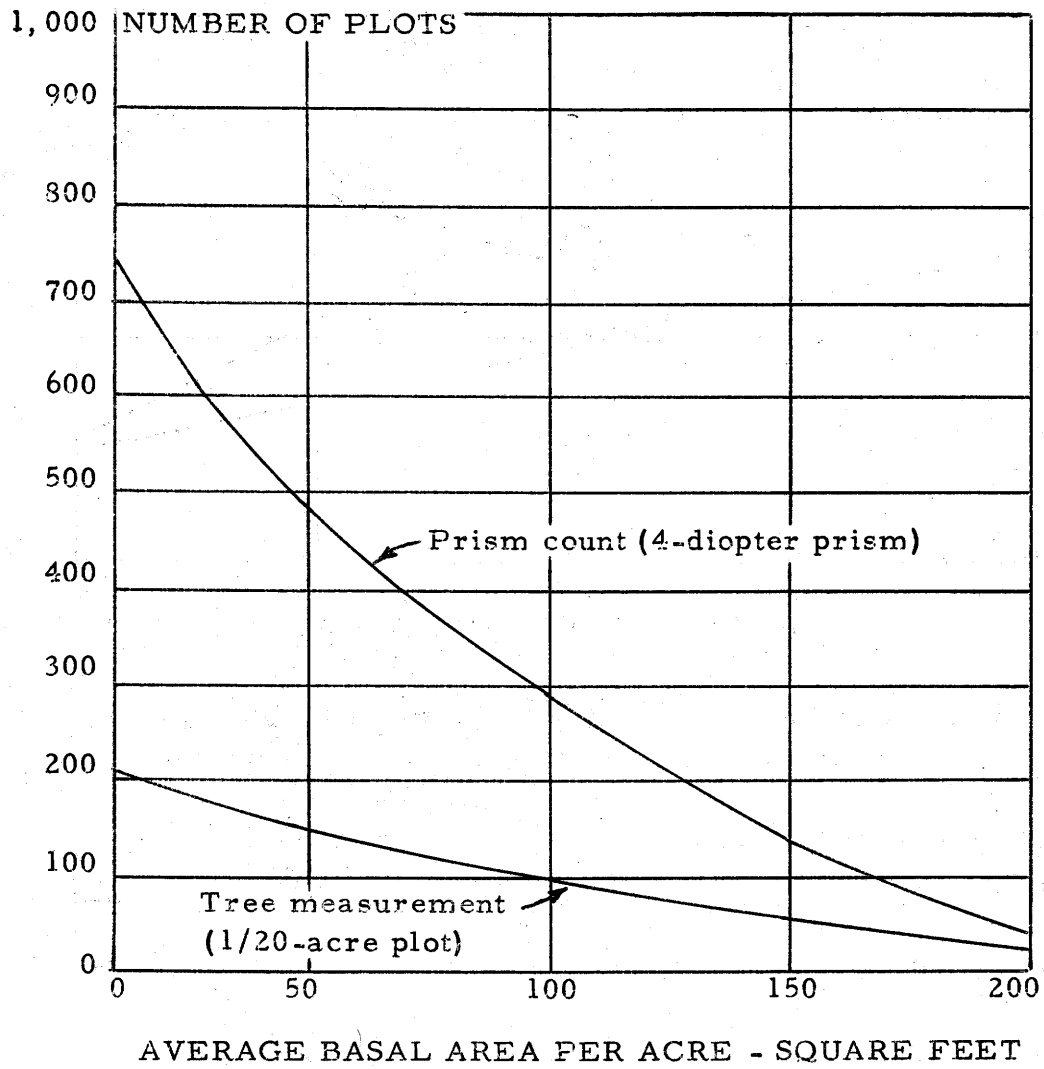

Figure 3.--Number of plots required to estimate basal area within ± 5 percent of the stand mean (19 in 20 chance) for lodgepole pine stands of varying densities.