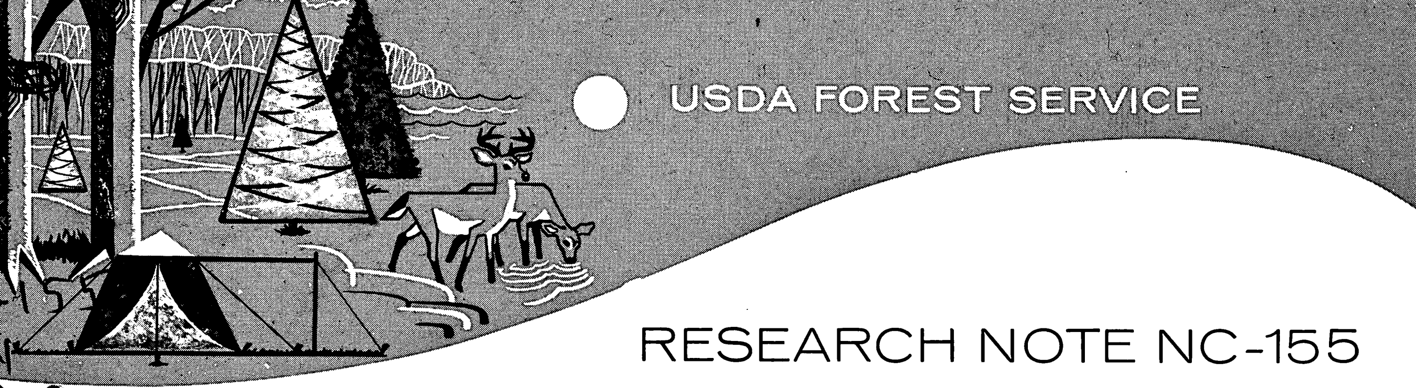

RESEARCH NOTE NC-155

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE
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A TEST OF A PHOTOGRAPHIC METHOD FOR DETERMINING CUBIC-FOOT VOLUME OF PULPWOOD

ABSTRACT.--Describes a method for measuring pulpwood that involves photographing loads on trucks.

OXFORD: 527:526--015.5:U77. KEY WORDS: pulpwood, measurement, photographs.

Determining cubic-foot volumes of pulpwood usually requires measuring stick lengths and end diameters. Such measurements are often made in the woods or pulpmill yard. The cost can be high if loaded trucks are delayed or if the pulpwood is piled separately for measurement. Also, weather conditions may prohibit outdoor measurement.

In order to maintain a consistent schedule during a study of converting the weight of pulpwood to cubic-foot volume, we tested a simple, relatively inexpensive method of measuring pulpwood end diameters from photographic slides. Although this method was used primarily as a research tool, we think it can also be readily applied to other situations where pulpwood diameters are measured.

Measuring pulpwood from photographs is not new (Miller 1941, Keepers 1945, Mountain 1949, Prebble 1959, Miller and Tardif 1970). Computer digital processing for determining the areas of the ends of pulpwood sticks from photographs also shows much promise, but more work is needed to develop the necessary refinements for our use. And for our immediate purpose we needed a method that was quick, simple, and economical.

In addition to convenience and cost savings, there is another advantage of using photographic methods. Photographs provide a permanent record of the pulpwood being studied. Accuracy of measurements can be checked. It is also possible to observe any unusual characteristics of the pulpwood on photographs that may explain deviations in weight-volume relationships.

COLLECTION OF DATA

We collected our data at a pulpwood-storage yard operated by Boise Cascade, Inc., in International Falls, Minnesota. Five truckloads of aspen pulpwood were selected at random as a basis for comparing measurements made in the field with those made on projected slides in the laboratory.

The pulpwood loads were photographed by 8-foot sections. An 8-foot scale rule was placed vertically at one end of each section; another identical scale rule was placed horizontally at the bottom edge of each section. To minimize distortion, the camera was positioned on a line perpendicular to the center of the load being photographed (fig. 1). Each photograph overlapped the adjacent ones by 1 foot.

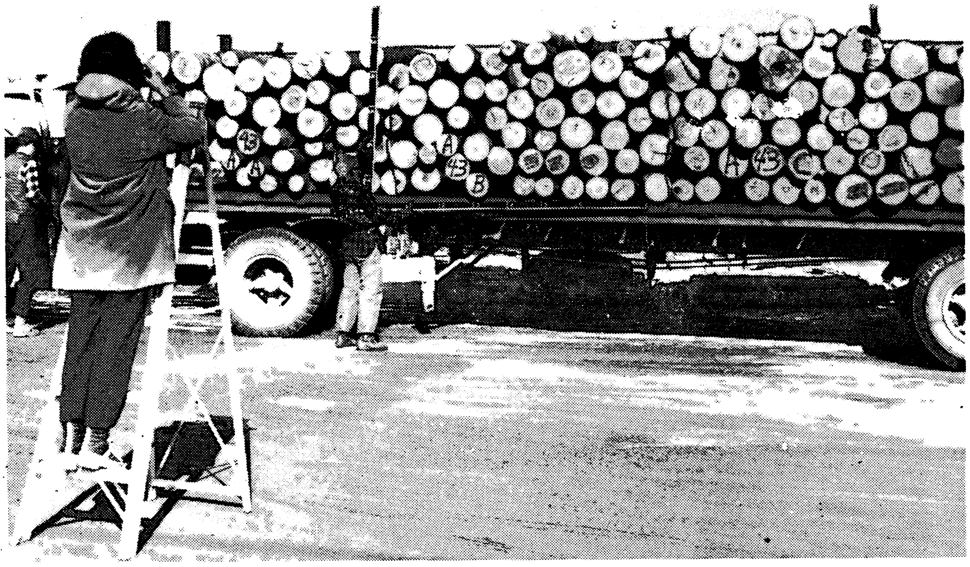

Figure 1.--*Photographing pulpwood loads.*

After the photographs were taken, the logs were spread on the ground and end diameters (inside and outside bark) and length of each stick were measured to the nearest 0.1 inch.

The 35-mm. colored-photographic slides of the pulpwood were projected on a rear projection screen at half the actual size. Average end diameter outside bark (d.o.b.) of each pulpwood log was measured directly on the screen and recorded to the nearest 0.1 inch (fig. 2). It was not possible to accurately measure pulpwood end diameters inside the bark (d.i.b.) on the projected photographic slides because the line between the inner bark and the wood was not always discernible, even on photographs taken under the best conditions. Therefore, results were compared for outside bark diameters only. The percent of solid wood can readily be obtained from measuring d.o.b.'s and d.i.b.'s of sample pulpwood sticks while in the field.

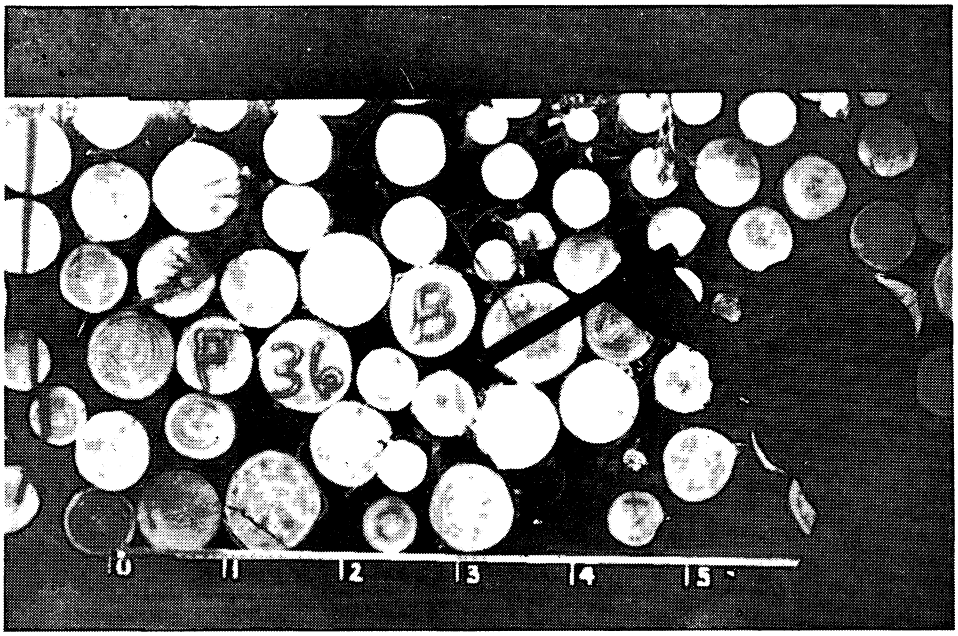

Figure 2.--*Rear projection screen measurements.*

COMPARISON OF RESULTS

Field measurements showed that the average end diameter of all pulpwood on one side of the load was not significantly different from that on the other side; i.e., the large and small ends were equally distributed on each side. Furthermore, the average length of the pulpwood sticks did not vary significantly from the specified 100 inches required by the pulpmill. Therefore, cubic foot volume for each stick was calculated from both photographic slides and field measurements using the following formula:

$$V = \frac{\left(\frac{D}{2}\right)^2 \pi \, 100}{144(12)} = \left(\frac{D}{2}\right)^2 \; 0.1818$$

where V = volume in cubic feet, and
D = diameter outside bark to the nearest tenth inch.

Differences in cubic-foot volumes between field and slide measurements for individual loads ranged from 0.12 percent to 1.32 percent and the average difference for the five loads was 0.17 percent of the total volume (table 1).

Table 1.--*Comparison of cubic foot volume (wood and bark) of five aspen loads*

Load number	Field measurement	Slide measurement	Difference
	Cubic feet	*Cubic feet*	*Percent*
1	655.07	656.88	0.27
2	891.61	896.31	.53
3	869.46	859.73	1.12
4	474.24	474.83	.12
5	669.36	678.20	1.32
Total	3,559.74	3,565.95	.17

The t-test for paired samples (Snedecor and Cochran 1969) showed that there was no real difference between cubic-foot volumes determined from photographic and field measurements. From the data in table 1, the calculated t equals 0.4021. A similar test on 225 individual pulpwood sticks again showed that the difference between the screen and field measurements was not significant.

DISCUSSION

The photographic method described in this report can be used to accurately determine the cubic-foot volume of wood and bark contained in pulpwood loads provided the length of pulpwood sticks is known. In addition, when the percent wood is obtained from a randomly selected subsampling of pulpwood d.o.b. and d.i.b. measurements, the cubic-foot volume of solid wood (without bark) can be determined.1/

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1/ *Estimated proportion of wood* = $\frac{\Sigma \, d.i.b.^2}{\Sigma \, d.o.b.^2}$.

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