United States
Department of
Agriculture

Forest Service

Southern Forest
Experiment Station

Research Note

SO-334
March 1987

Ocular and Densimeter Estimates of Understory Foliar Cover in Forests of Alabama

Thomas W. Popham and Roger L. Baker

SUMMARY

Foliar cover estimates of woody and herbaceous understory vegetation were done on twenty 1-m^2 plots for a variety of forest types in Alabama. The methods of estimation were ocular, loop-densimeter assisted ocular, and point frame. The point frame was used as the standard and the other two methods were compared using chi-square. Some ocular estimates were accurate, but the number and amount of inaccurate estimates were sufficient to result in a statistically significant difference at $\alpha=0.05$. A difference existed in the ability of estimators to accurately estimate foliar cover of different vegetation groups. Therefore, ocular and loop-densimeter assisted ocular estimates did not provide consistently accurate estimates of the proportion of foliar cover of understory vegetation for forests in Alabama.

INTRODUCTION

The Forest Inventory and Analysis (FIA) unit of the Southern Forest Experiment Station has the responsibility for surveying and estimating the forest resources of seven Midsouth States. The Resources Planning Act of 1974 required evaluation of other nontimber resources such as understory vegetation that might be utilized as food or cover by wildlife or domestic livestock. One of the characteristics identified as potentially important in evaluating the understory vegetation was foliar cover. Foliar cover, as defined by Daubenmire (1968), was considered to be the total amount of ground surface shaded by all plant parts when plants are standing in their natural growing condition. Proportion of foliar cover for plant groups is used in this study rather than percentage.

Pilot studies in Tennessee in 1979 and 1980 had shown that to attempt species identification was not only time consuming but also nearly impossible in a broad area survey. The greatest difficulty came from trying to identify the immense variety of vegetation that was not flowering or fruiting. Three plant groups were selected to measure the growth types present. Although this excluded information as to forage value, the purpose of the study was to evaluate the methods used, not to provide forage values. The plant groups selected for sampling were woody (tree and shrub), grass and grasslike, and other herbaceous.

The study objective was to evaluate the use of a loop-densimeter to improve the accuracy and precision of ocular estimates of foliar cover of the three plant groups. An ocular estimate of foliar cover (subjective) was to be used rather than an objective measurement technique such as the point frame because less time was required to measure each sample plot. The point frame was used to evaluate the accuracy of the estimates. The loop-densimeter method uses a measuring device, and thus is not purely a subjective estimate, and it could be easily transported (Cully 1938, Brown 1954).

METHODS

The FIA unit maintains permanently marked sample points that systematically grid the entire state of Alabama. Of a possible 850 plots, 20 were selected at random for use in comparing methods of estimating foliar cover. Plots selected were sampled between July 14 and September 15, 1982, and were located in 12 counties throughout the State. Plots were 0.5 m by 2 m and were laid out along randomly selected azimuths at randomly determined distances from the permanent point markers.

Numbers of selected plots in each FIA forest type were: 4 loblolly pine, 2 loblolly pine-oak, 12 white oak-red oak-hickory, and 2 mixed hardwoods.[1] After marking the plot boundaries, two technicians made foliar cover

[1]Forest type classification is from the Southern Forest Experiment Station Renewable Resources Inventory Work Plan, Alabama 1980–1981.

Southern Forest Experiment Station/T-10210 U.S. Postal Services Bldg., 701 Loyola Avenue, New Orleans, La. 70113
Forest Service, U.S. Department of Agriculture.
Serving Alabama, Arkansas, Louisiana, Mississippi, E. Oklahoma, Tennessee, E. Texas, Puerto Rico, U.S. Virgin Islands

estimates. All vegetation up to 1.52 m in height was included in the estimates. One technician made ocular estimates while the other made loop-densimeter estimates. The observations of each technician were recorded independently to avoid influencing either estimate and to avoid influencing the point frame estimate. Next, the two technicians jointly made an estimate of foliar coverage with the point frame. One of the two technicians was present for the entire study. Observations of the second technician were divided between two people; the first 12 plots were done by one person and the next 8 plots by another.

The ocular estimates were done without the aid of any mechanical device. Previous experience had established that the size of a human fist is approximately 0.01 m^2, and a fist was often held directly above or below the vegetation to assist with the ocular estimate. The technician could mentally tally the number of 0.01-m^2 areas covered by each understory vegetation plant group.

The loop-densimeter consisted of a steel tape with one end attached to a slotted wood block (fig. 1). The other end of the tape was inserted into the slot so that pushing or pulling the tape through the block formed a loop of varying area. The tape was scribed to give areas of 0.01, 0.02, 0.03, 0.04, and 0.05 m^2. Using the wood block as a handle, the estimator held the loop above or below the vegetation and adjusted the tape to obtain a direct measure of the area covered. The areas were totaled to get the proportion of foliar cover.

The point frame is shown in figure 2. Horizontal crossmembers are located at the top and at 38 and 76 cm from the top (fig. 2). Five holes were drilled at 10-cm intervals in each crossmember beginning 10 cm from the legs. Pins 76 cm in length were lowered to the ground or pushed upward to a 152-cm height to check for pin contact with one of the three vegetation groups as described in Baker and Thomas (1983).

The point frame was set across the plot at 20 equidistant points along the 2-m plot sides beginning 5 cm from one end, which resulted in 100 pin readings per plot. The placement of the point frame introduced some randomness since the legs could seldom be placed at the exact location of the 20 points along the plot boundary. As previously stated, the point frame was used as a standard for estimate comparisons (Hutchings and Pase 1963, Baker and Thomas 1983).

Following completion of the data collection for each plot, results of ocular and loop-densimeter methods of estimating foliar cover were compared with results from the point frame method. The unassisted ocular method was also compared to the loop-densimeter method. A statistical test based on the chi-square test of a hypothesized variance described by Freese (1960) was used to make the comparisons. The test allows the user to set an acceptable level of accuracy for a trial method compared to a standard method of measurement. The test is to determine if the accuracy of the trial method falls within the set limit with some preselected level of probability. In this study the probability level used was 0.05.

RESULTS

The range in proportion of foliar cover for woody vegetation was from 0.03 to 0.66 (table 1). For grass and grasslike vegetation the range was much smaller, and for coverage by herbaceous vegetation the range was

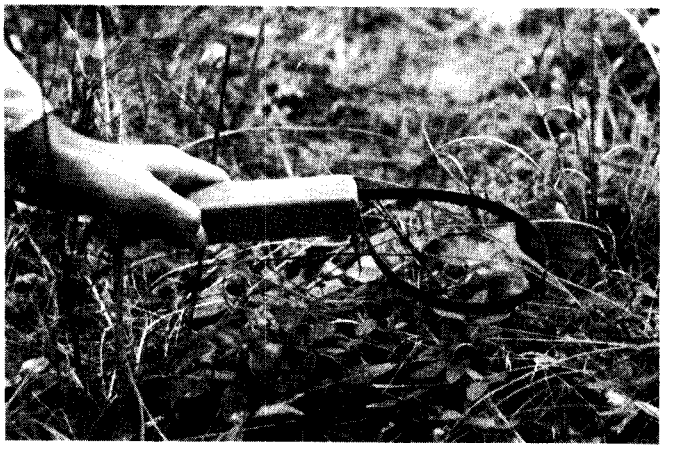

Figure 1.—*Loop-densimeter used in estimating foliar cover.*

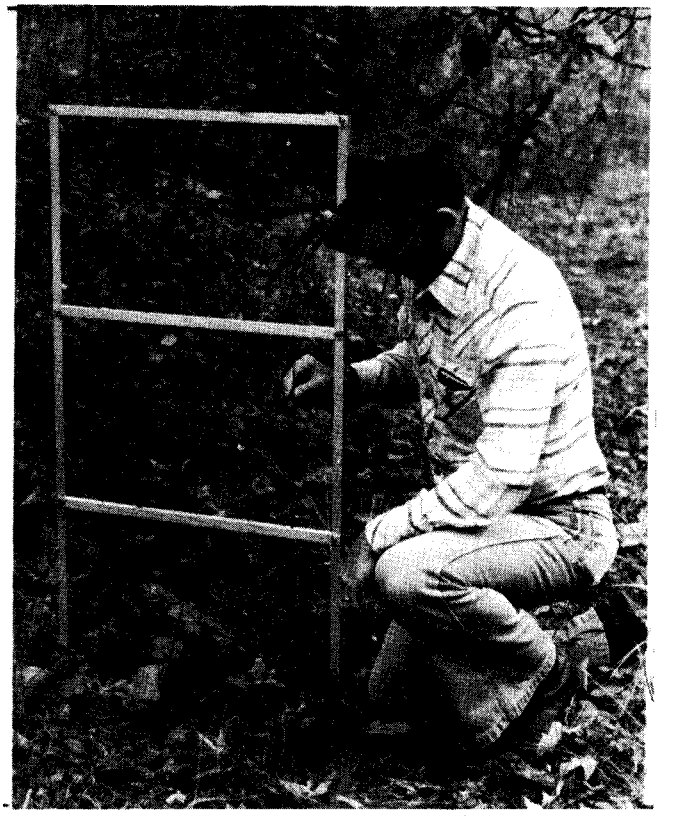

Figure 2.—*Point frame used in determining foliar cover.*

Thomas W. Popham is mathematical statistician, Southern Plains Area, Agricultural Research Service—USDA, Stillwater, OK; Roger L. Baker is research soil scientist, Wildlife Habitat and Silviculture Laboratory, Southern Forest Experiment Station, Forest Service—USDA, Nacogdoches, TX.

intermediate. These ranges were expected in the tree-dominated communities observed because FIA plot estimates from Tennessee and southern Alabama had shown similar values (R. L. Baker unpublished data).

The range of differences and the average difference between methods of estimation provided information pertinent to the objective of the study (table 2). The woody vegetation group, with the higher proportion of cover values (up to 0.66), had a larger range of differences; however, the average differences were encouragingly low. The average difference was less between the ocular and loop-densimeter methods than between either one and the point frame method. The results were similar for grass and grasslike vegetation except the range of differences and the average differences were smaller for these groups than for the woody vegetation.

The largest estimation errors were inconclusive concerning any improvement by using the loop-densimeter, but large errors were possible with either ocular method (table 3).

Mean proportion of foliar cover for estimation methods as compared to the point frame in each vegetation group were within 1 percent (table 3). For individual plots the largest estimation error for ocular or loop-densimeter estimates compared to the point frame occurred for the first 2 estimates in 7 of 12 comparisons. There was no evidence that estimates improved with time after the initial two estimates. Instead, results indicate that variation increased with the amount of foliar cover on plots.

The statistical tests indicate that accuracy within 0.05 was not achieved with either the ocular or loop-densimeter methods for the woody vegetation using the point frame as the standard (table 4). Accuracy within 0.05 percent probability was obtained with the loop-densimeter and ocular methods for the grass and grasslike vegetation. However, considering the range of 0.06, this was no real achievement. It also became evident that the point frame was often less accurate than the other methods when foliar cover was 2 percent or less. For herbaceous vegetation only, the estimates from the loop-densimeter method were closer to point frame readings than were ocular estimates. Again, the range of values observed makes this no real achievement. For the grass and grasslike vegetation, there was no evidence of a difference in accuracy when the ocular was compared with the loop-densimeter method. Too few samples were available to test differences between forest types. Tests between plant groups would not be valid because of the large differences in variances (Freese 1960).

Differences between technician estimators were tested. Ocular estimates from the technician who was present for the entire study (estimator A) were the same

Table 1.—*Range of foliar cover values* for each method of estimating cover and each vegetation group*

Vegetation group	Estimation method	Foliar cover values	
		Minimum	Maximum
Woody	Ocular	0.03	0.65
	Loop-densimeter	0.03	0.65
	Point frame	0.03	0.66
Grass and grasslike	Ocular	0.00	0.06
	Loop-densimeter	0.00	0.06
	Point frame	0.00	0.07
Herbaceous	Ocular	0.00	0.25
	Loop-densimeter	0.00	0.18
	Point frame	0.00	0.23

*As a proportion of total cover for that group.

Table 2.—*Range of difference and average difference in foliar cover* from a comparison of estimation methods in each vegetation group*

Vegetation	Estimation methods compared	Differences in foliar cover		
		Minimum	Maximum	Average
Woody	Ocular vs. densimeter	−0.08	0.21	0.0055
	Ocular vs. point frame	−0.08	0.11	−0.0120
	Densimeter vs. point frame	−0.17	0.05	−0.0175
Grass and grasslike	Ocular vs. densimeter	−0.02	0.01	−0.0005
	Ocular vs. point frame	−0.04	0.01	−0.0055
	Densimeter vs. point frame	−0.05	0.01	−0.0050
Herbaceous	Ocular vs. densimeter	−0.05	0.07	0.0005
	Ocular vs. point frame	−0.15	0.03	−0.0080
	Densimeter vs. point frame	−0.10	0.01	−0.0085

*As a proportion of total cover for that group.

Table 3.—*Percentage error for each vegetation group and estimation method as compared to the point frame method of measuring foliar cover*

Vegetation group	Estimation method	Proportion cover*	Largest error of estimation	
			Positive	Negative
			------ *Percent*	-------
Woody	Ocular	0.19	100	73
	Densimeter	0.19	45	64
Grass and grasslike	Ocular	0.01	50	75
	Densimeter	0.01	50	71
Herbaceous	Ocular	0.03	50	65
	Densimeter	0.03	50	67

*Mean of 20 plots.

Table 4.—*Chi-square test of accuracy indicating the probability of obtaining a difference between estimation methods in each vegetation group*

Vegetation group	Estimation methods compared	Chi-square probability[2]			
		0.01	0.02	0.05	0.10
Woody	Ocular vs. densimeter	*[1]	*	*	
	Ocular vs. point frame	*	*	*	
	Densimeter vs. point frame	*	*	*	
Grass and grasslike	Ocular vs. densimeter				
	Ocular vs. point frame	*	*		
	Densimeter vs. point frame	*	*		
Herbaceous	Ocular vs. densimeter	*	*		
	Ocular vs. point frame	*	*	*	
	Densimeter vs. point frame	*	*		

[1]Asterisk indicates that methods for obtaining cover were not equal.

[2]Probability is less than or equal to 0.05 of getting a chi-square value greater than observed for difference in proportion of 0.01, 0.02, 0.05, 0.10.

as point frame readings for all three vegetation types. Estimator A had considerable field experience. However, when the densimeter was used to assist in ocular estimates made by estimator A, estimates were comparable only for grass and grasslike and herbaceous vegetation, not for woody vegetation. Estimator B (the technician estimating values for the first 12 plots) had considerably less field experience, but by using the densimeter, estimates of foliar cover were comparable to point frame readings for all three vegetation types. Ocular estimates were comparable to point frame readings only for grass and grasslike vegetation.

CONCLUSION

We concluded from this evidence that the use of a loop-densimeter in these forest types did not improve foliar cover estimates over the ocular method already in use and may hinder an experienced estimator. The loop-densimeter may be useful in training field personnel to estimate foliar cover, but an experienced, trained technician can produce usable ocular estimates. The results did indicate the ocular estimates of understory vegetation should not be expected to be within 0.05 percent probability of the point frame estimate in similar communities. It is recommended that regular checks be made with a point frame to provide field personnel a reference standard for ocular estimates.

LITERATURE CITED

Baker, R. L.; Thomas, C. E. A point frame for circular plots in southern forest-ranges. Journal of Range Management. 36:(1):121–123. 1983.

Brown, D. Methods of surveying and measuring vegetation. Commonwealth Bureau of Pastures and Field Crops Bulletin 42. Reading, England; Bradley & Son, Ltd., The Crown Press; 1954. 223 p.

Culley, M. Densimeter, an instrument for measuring the density of ground cover. Ecology. 19(4):588–590. 1938.

Daubenmire, R. Plant communities, a textbook of synecology. New York; Harper & Row; 1968. 300 p.

Fresse, F. Testing accuracy. Forest Science. 6(2):139–145. 1960.

Hutchings, S. S.; Pase, C. P. Measurement of plant cover—basal, crown, leaf area. p. 22–30 In: Range Research Methods. U.S. Department of Agriculture, Forest Service Misc. Publ. No. 940. 1963: 22–30.