Efficiencies of the Point-Centered Quarter and Quadrat Methods in Forest Sampling

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Using a complete tree census as a standard for comparison, the total efficiencies of the point-centered quarter and quadrat methods were determined. Consideration was given the time required in the field and the time spent in office computations of the desired attributes. Using a new, rapid method for delineation of quadrats, it was found that the quadrat method was more efficient than the quarter method in this forest. Both methods were found suitable for obtaining accurate, reliable data for frequency, density, and basal area.

INTRODUCTION

In recent years much consideration has been given to the efficiencies of various forest sampling techniques (Cottam and Curtis, 1956; Lindsey, et al., 1958; Rice and Penfound, 1955; Penfound and Rice, 1957; and others).

Various authors have suggested criteria for selecting sampling methods. Rice and Penfound (1955) stated that: "(1) the method must be rapid, (2) it should require little equipment, and (3) it must include data for frequency, density, and basal area." Shanks (1954) added, "operable by one person at a reasonable level, and susceptible to statistical measurement of variability so that confidence limits can be established." Cottam and Curtis (1956), wrote, "Probably the most important factor is the time required to obtain an adequate sample." From these statements it would appear that the sampling method used should be determined by: (1) the time and equipment required in the field; (2) the time required

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to compute the desired attributes; and (3) its reliability and validity.

The purpose of this paper is to compare the efficiencies and results of data derived by the point-centered quarter and quadrat methods with the data obtained from the census of a bottomland forest.

Location of Stand

The area under consideration is located about one mile southeast of Norman in Cleveland County, Oklahoma. This forest occurs within the lower floodplain on the north bank of the South Canadian River (Fig. 1). It is bordered on the north side by a fenced pasture and on the south side by the sloping sandy embankment of the river. The forest ranges in width from 200 to 300 ft and is approximately 1,000 ft long. The area sampled was a rectangle 165 ft wide and 525 ft long and included an area of two acres. A total of eight woody species was sampled. Nomenclature used herein is according to Waterfall (1962). Previous surveys had indicated the homogeneity of this forest, thus making it desirable for a study of this kind.

Methods

In the census of a total of 80 square plots of 1/40 acre each was delineated by 4-ft steel rods at the corners. Each rod was marked, using a system of coded aluminum tags. A complete list of species and the diameters of all individuals were taken in each quadrat.

In the point-centered quarter method, points were established at equal intervals along parallel lines. At each sampling point a metal rod about 3 ft long with four perpendicular arms arranged at 90° angles near the top of the rod was used to define each of the four quarters. At paced intervals the rod was placed in the ground in such a fashion that two of the arms are superimposed on the compass line. Hence, each sampling point was considered the center of four quarters with orientation along

Fig. 1. Bottomland forest showing cottonwood predominance with an understory of elm.

the line of traverse. At each point the tree closest to the center in each of the four quarters was chosen as a sample tree. The distances to each of the four trees were determined, the tree diameters measured, and these data, by species, were entered on an analysis form. In this sample, tapes were used to measure point-to-tree distances.

To decrease the time of establishing quadrats in the field, the following method of delineation was devised. A metal rod with four perpendicular arms arranged at 90° angles near the top, of sufficient length to be firmly placed in the ground and to allow approximately 3 ft to remain exposed, was used to establish quadrats. A self-winding fly reel of the type used in fishing was attached by a swivel to the top of the rod. A length of line equal to one half of the diagonal (23.3 ft) of the desired quadrat size was then allowed to run off the reel. After the rod was placed in the ground, the investigator proceeded to the end of the line while keeping it superimposed on one of the four arms. At the end of the line the worker then placed a brightly flagged stake to serve as one corner of the quadrat. Often it was not necessary to return all the way to the center, if no obstructions occurred. As the worker returned to the center, the line was rewound automatically. As this was repeated for the other three corners, the reel swiveled about to keep the line of constant length. By this method no tapes, range finders or transits were required, and a square plot was laid out by one person in less than 60 sec. After the count was made, the corner stakes were removed, and the next quadrat was established.

In the point-centered quarter method, a total of 60 points were sampled at 33-ft intervals along four transects 33 ft apart. The survey was done in such a manner that the data from 30 points or from 60 points each could be compared. In like manner, the quadrats were arranged in such a fashion that the data from 10 quadrats (0.25 acre) or 30 quadrats (0.75 acre) could be collated. The same data were taken in each method: number and diameter breast height of all woody plants over 3 inches dbh. Computations were made for frequency, density, basal area and importance percentage and computation times were calculated. However, only the data on basal area and importance percentage are presented in this paper.

RESULTS

The total basal area, according to the census, was found to be 103.5 sq ft/acre. Of the basal area for the entire stand, cottonwood and American elm were the only important contributors (Table I). On the basis of importance percentage (I. P.) cottonwood and American elm were the only dominants (Table II).

The data on the parameters from the sets of 30 points and 60 points were very similar (Tables I and II). The greatest difference was in basal area (sq ft/acre) where the 30-point set yielded a value of 100.1 as against 112.5 in the 60-point group. Furthermore, the importance percentages of both cottonwood and american elm were almost identical (Table II). Since 30 trees or more of each dominant were sampled by 30 points, the sample of 30 points proved adequate. The data obtained by use of 10 or 30 quadrats were very similar and quite close to the census data (Tables I and II). A review of Tables I and II suggests that ten quadrats constitute an adequate sample. These data also suggest that there was little difference between the accuracy of the point-centered quarter and the quadrat methods.

COMPARISON OF EFFICIENCY OF QUARTER AND QUADRAT METHODS

In comparing the two methods, consideration was given (1) to the time per tree in the field, and (2) to the total time spent in calculating a sample that was of sufficient size to yield data that closely approximated

TABLE I. BASAL AREA, IN SQ FT/ACRE, AS BASED ON DATA FROM QUARTER, QUADRAT AND CENSUS METHODS.

	Quarter method		Quadrat method		Census
Species	30 pts.	60 pts.	10(¼a)	30(¾a)	2 acres
Ulmus americana	25.2	29.4	28.8	29.3	28.2
Populus deltoides	64.5	68.3	70.4	67.9	63.7
Morus alba	4.2	6.9	4.0	5.6	4.8
Fraxinus pennsylvanica	4.4	4.6	1.2	2.1	3.6
Others	1.8	3.3	3.6	2.5	3.2
Totals	100.1	112.5	108.0	107.4	103.5

TABLE II. IMPORTANCE PERCENTAGES IN BOTTOMLAND FOREST, BASED ON DATA DERIVED BY QUARTER, QUADRAT AND CENSUS METHODS.

	Quarter method		Quadrat method		Census
Species	30 pts.	60 pts.	10(¼a)	30(¾a)	2 acres
Ulmus americana	36.1	35.2	37.1	35.8	34.3
Populus deltoides	37.6	38.2	40.0	39.6	38.8
Morus alba	12.9	11.9	9.5	13.0	10.7
Fraxinus pennsylvanica	7.6	8.5	5.8	5.0	7.7
Others	5.9	6.3	7.6	6.7	8.4
Totals	100.1	100.1	100.0	100.1	99.9

values derived from the census. Field time did not include travel between points. In the quadrat method, field time included the time required to delineate the quadrats. In comparing field and computation times, 30 units (points or quadrats) were used to determine the average time per tree.

When two persons used 30 points (120 trees) in the quarter method, an average field time of 51 sec per tree was obtained. In computations, 38.5 sec per tree were required. Lindsey et al. (1958), using a range finder in determining point-to-tree distances, reported a field time of 22.8 sec per tree. When 30 quadrats of 1/40 acre each with an average of seven trees per plot were used in this study, 29.6 sec per tree were required in computations. Thus, the total times required per tree for the quarter and quadrat methods were 89.5 sec and 55.3 sec respectively. The quarter method, therefore, requires more time per tree, especially in the time required for computation.

In comparing field efficiencies, Lindsey et al. (1958) believed the 1/40 acre quadrat to be the least efficient of all methods tested since it required 77 sec per tree in the field. But by the use of the rapid method for delineation of quadrats devised in this investigation, the field time per tree in the 1/40 acre quadrat was only 29.6 sec per tree. With this improvement the quadrat method was considerably more rapid than the quarter method.

SUMMARY

1. A comparison of the results and efficiencies of the point-centered quarter and quadrat sampling methods is presented.

2. The standard for comparison was a complete tree census of a two-acre bottomland forest, with cottonwood *(Populus deltoides)* and American elm *(Ulmus americana)* as the dominant trees.

3. A new rapid method for delineation of 1/40 acre quadrats is presented.

4. Both methods were found suitable for obtaining accurate, reliable data on frequency, density and basal area.

5. When tapes were used to measure point-to-tree distances, the quarter method required 51 sec per tree in the field and 38.5 sec per tree in computation.

6. The quadrat method required 29.6 sec per tree in the field and 25.7 sec per tree in computation.

7. It is concluded that the quadrat method is the more efficient method in a forest of this type.

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