7.63 The Point-Centered Quarter Method. In the point-centered quarter method four distances instead of one are measured at each sampling point. Four quarters are established at the sampling point through a cross formed by two lines. One line is the compass direction and the second a line running perpendicular to the compass direction through the sampling point. The line-cross can also be randomly established by spinning a cross over each sampling point. The distance to the midpoint of the nearest tree from the sampling point is measured in each quarter (FIG. 7.4).

The four distances of a number of sampling points are averaged and when squared are found to be equal to the mean area occupied by each tree. COTTAM and CURTIS (1956) tested the reliability of this method on several random populations by checking the result with the plot method. They ranked the four quarter (Q) distances of each sampling point by computing the mean of the shortest (Q1), the second shortest (Q2), the third (Q3) and the longest (Q4) distances. The following estimates of the correct mean area per tree (MA) were found to apply to each of the different sets of mean distance.

Q1 shortest	$= 0.5\ \sqrt{MA}$
Q2	$= 0.8\ \sqrt{MA}$
Q3	$= 1.12\sqrt{MA}$
Q4 longest	$= 1.57\sqrt{MA}$
$\bar{Q}$ mean of 4	$= 1.0\ \sqrt{MA}$

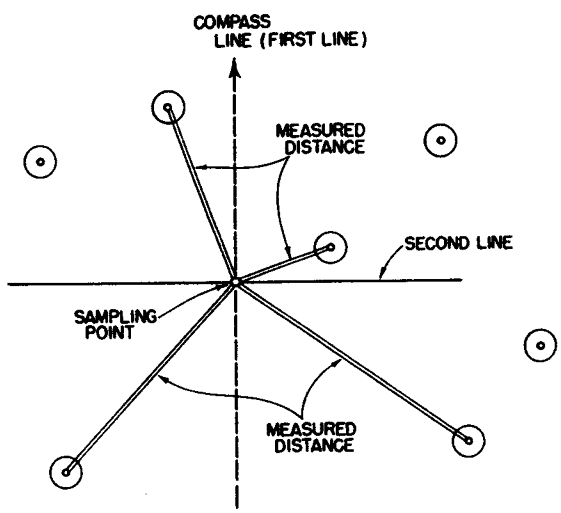

FIGURE 7.4. Point-centered quarter method.

Therefore, no correction factor is needed when the four quarter distances are averaged; and $MA = D^2$, where D = the mean distance of four point-to-nearest-tree distances taken in each of four quarters. Mathematical proof of the workability of this method has been given by MORISITA (1954).

Of course, the accuracy increases with the number of sampling points, and a minimum of 20 points is recommended (COTTAM and CURTIS 1956).

The method has two limitations (NEWSOME and DIX 1968) for field applications. An individual must be located within each quarter, and an individual must not be measured twice. Therefore, stands with wide spacing of individuals present a problem in using this method. The second limitation applies also to the random pairs method.

The parameters obtained in the distance methods are:

1. Species.
2. Density (from mean distance).
3. Diameter (and therefore basal area and dominance).
4. Frequency (as the occurrence of a species at a sampling point).

The same parameters are also obtained from plots. However, the distance methods have an advantage in that they do not require laying out of plot boundaries. This saves considerable time. It also eliminates to a certain extent the personal error from judging whether boundary individuals are inside or outside the quadrat.

7.64 Example of a Point-Centered Quarter Analysis. The following example relates to the same tropical rain forest stand that served for the relevé example (SECTION 5.3) and for the quantitative plot example (SECTION 7.3). The point-centered quarter example is shown only for five sampling points to save space (TABLE 7.4). It is recommended to sample at least 20 points per stand. The adequacy of sampling points can, of course, also be determined by plotting the running mean as described in SECTION 6.42.

In the example analysis in TABLE 7.4, trees with basal diameters less than 3 cm were omitted. These included all woody plants under 2 m height. The small trees could, however, be sampled as a second size category from the same sampling points with each four distances. The objective was to determine (from individuals taller than 2 m):

1. the density for each tree species,
2. the dominance of each tree species, and
3. the frequency of each tree species.

A second objective was to convert these absolute values into relative values as an example for deriving the importance value, which will be discussed in SECTION 7.67.

TABLE 7.4 shows the raw data for five sampling points that were arranged in a transect, one point every 5 m. TABLE 7.5 shows the derivation of the mean basal area by species. This value is needed to determine the dominance of the species, which is a combination of number and basal area.

TABLE 7.4. *Quantitative Analysis by Point-Centered Quarter Method. Five Sampling Points, One at Every 5 m Along 110°, Starting at End of Convex, Gently Sloping Ridge Below Pauoa Flats Trail Going Upslope Toward the Trail. Raw Data, March 4, 1972.*

SAMPLING POINT	QUARTER NUMBER	DISTANCE (M)	SPECIES	DIAMETER AT BASE (CM)
1	1	0.7	*Psidium guajava*	5.5
	2	1.6	*Acacia koa*	42.5
	3	3.5	*Metrosideros collina*	17.0
	4	2.0	*Metrosideros tremuloides*	25.0
2	1	1.1	*Psidium guajava*	4.0
	2	0.8	*Psidium guajava*	5.0
	3	1.9	*Psidium guajava*	5.0
	4	1.8	*Psidium guajava*	4.0
3	1	1.3	*Acacia koa*	75.0
	2	0.7	*Psidium guajava*	3.0
	3	1.5	*Metrosideros collina*	9.0
	4	2.0	*Metrosideros collina*	23.0
4	1	3.1	*Acacia koa*	14.0
	2	1.7	*Psidium guajava*	6.0
	3	1.1	*Psidium guajava*	5.0
	4	1.9	*Acacia koa*	12.0
5	1	2.5	*Acacia koa*	23.0
	2	2.2	*Acacia koa*	18.0
	3	1.4	*Psidium guajava*	5.0
	4	2.8	*Metrosideros collina*	25.0
		Total 35.6		

Results:

Mean distance (D) = 35.6/20 = 1.78 m

Absolute density = Area/D^2

Where *D* = mean distance

Number of trees per 100 m^2 = $100/(1.78)^2$ = 100/3.17 = 31.5

Absolute dominance = mean *ba* per tree × number of trees in species

Where *ba* = basal area

Number of trees in species

SPECIES	NUMBER IN QUARTERS	NUMBER OF TREES IN 100 M^2
Acacia koa	6/20=0.3	0.3 ×31.5= 9.4
Metrosideros collina	4/20=0.2	0.2 ×31.5= 6.3
Metrosideros tremuloides	1/20=0.05	0.05×31.5= 1.6
Psidium guajava	9/20=0.45	0.45×31.5=14.2
		Total 31.5

TABLE 7.5. *Mean Basal Area by Species for the 20 Trees Shown in TABLE 7.4.*

ACACIA KOA		*METROSIDEROS COLLINA*		*METROSIDEROS TREMULOIDES*		*PSIDIUM GUAJAVA*	
DIAMETER (CM)	BA (CM^2)	DIAMETER (CM)	BA (CM^2)	DIAMETER (CM)	BA (CM^2)	DIAMETER (CM)	BA (CM^2)
42.5	1418	17.0	227	25.0	491	5.5	24
75.0	4418	9.0	64	..	..	4.0	13
14.0	154	23.0	415	..	..	5.0	20
12.0	113	25.0	491	..	..	5.0	20
23.0	415	..	..	..	..	4.0	13
18.0	254	..	..	..	..	3.0	7
..	..	..	..	..	..	6.0	28
..	..	..	..	..	..	5.0	20
..	..	..	..	..	..	5.0	20
Total *ba*	6772		1197		491		165
Mean *ba*	1129		299		491		18

Therefore, dominance of

		Dominance rank
Acacia koa	1129 × 9.4 = 10613 cm^2	1
Metrosideros collina	299 × 6.3 = 1884 cm^2	2
Metrosideros tremuloides	491 × 1.6 = 786 cm^2	3
Psidium guajava	18 × 14.2 = 256 cm^2	4
	13539 cm^2/100m^2	

$$\text{Absolute frequency} = \frac{\text{number of points with species}}{\text{total points}} \times 100$$

Acacia koa	= 4/5 × 100 = 80 percent
Metrosideros collina	= 3/5 × 100 = 60 percent
Metrosideros tremuloides	= 1/5 × 100 = 20 percent
Psidium guajava	= 5/5 × 100 = 100 percent
	260 percent

7.67 The Importance Value. The distance methods yield three quantitative parameters—density, basal area, and frequency. These are, of course, also obtained in the quantitative plot methods.

Any one of the three parameters may be interpreted as an "importance value" (WHITTAKER 1970). This depends on which of the values the investigator considers most important for a particular species, group of species or community. For example, tree seedlings may occur with a high frequency in an undergrowth layer, while in terms of cover, they may be insignificant. However, their high frequency may be of great importance as indicating a new stage of uniformly distributed reproduction. In this case their high frequency may be interpreted as of high "importance."

Yet, it has become common practice, in quantitative descriptive studies that employ the distance measuring techniques, to use the so-called importance value of CURTIS (1959) for the presentation of results. This importance value (*I.V.*) is defined as the sum of relative density, relative frequency, and relative dominance.

The absolute values for density, dominance, and frequency were defined already in the point-centered quarter example (SECTION 7.64).

The corresponding relative values for the example shown in TABLE 7.4 are shown on the following page.

The importance value may be converted into the so-called "importance percentage" by dividing the importance value by three (RISSER and RICE 1971).

The importance value of a species reaches a maximum of 300 in stands consisting of only one tree species. Two monodominant (single tree species) stands with different numbers of trees per acre and different basal areas will have the same importance value for each species.

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*To lay out a circular plot, calculate the radius (R) from the area (A) as $R = \sqrt{(A/\pi)}$. Example for 0.1 acre plot $R = \sqrt{(400\ m^2/3.14)} = 11.3$ m.

1. Relative density = $\frac{\text{number of individuals of species}}{\text{total number of individuals}} \times 100$

Acacia koa	$\frac{9.5}{31.5} \times 100 =$	30 percent*
Metrosideros collina	$\frac{6.3}{31.5} \times 100 =$	20 percent
Metrosideros tremuloides	$\frac{1.6}{31.5} \times 100 =$	5 percent
Psidium guajava	$\frac{14.3}{31.5} \times 100 =$	45 percent
		100 percent

2. Relative dominance = $\frac{\text{dominance of a species}}{\text{dominance of all species}} \times 100$

Acacia koa	$\frac{10,613}{13,539} \times 100 =$	78.4 percent
Metrosideros collina	$\frac{1884}{13,539} \times 100 =$	13.9 percent
Metrosideros tremuloides	$\frac{786}{13,539} \times 100 =$	5.8 percent
Psidium guajava	$\frac{256}{13,539} \times 100 =$	1.9 percent

3. Relative frequency = $\frac{\text{frequency of a species}}{\text{sum frequency of all species}} \times 100$

Acacia koa	$\frac{80}{260} \times 100 =$	30.8 percent
Metrosideros collina	$\frac{60}{260} \times 100 =$	23.1 percent
Metrosideros tremuloides	$\frac{20}{260} \times 100 =$	7.7 percent
Psidium guajava	$\frac{100}{260} \times 100 =$	38.5 percent
		100.1 percent

4. Importance value (I.V.) = Relative density + relative dominance + relative frequency

	RELATIVE DENSITY	RELATIVE DOMINANCE	RELATIVE FREQUENCY	I.V.	I.V. Rank
Acacia koa	30.0	78.4	30.8	139.2	1
Metrosideros collina	20.0	13.9	23.1	57.0	3
Metrosideros tremuloides	5.0	5.8	7.7	18.5	4
Psidium guajava	45.0	1.9	38.5	85.4	2

* Note, same as number of species occurrences in quarters.