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RESEARCH ARTICLE

An Evaluation of the Efficiency of Four Plotless Sampling Techniques in the Study of a Savanna Woodland Community at Agu-Awka, Anambra State, Nigeria

Ukpaka Chukwujekwu G[1] and EI Mbaekwe[2]

[1]Biological Science Department, Anambra State University, Uli, Anambra, Nigeria
[2]Department of Botany, Nnamdi Azikiwe University, Awka, Anambra, Nigeria

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***Corresponding Address:**
Ukpaka Chukwujekwu G
ukpakachukwu@yahoo.com

ABSTRACT

The efficiency of four plotless sampling techniques-point-centred quarter, closest individual, nearest neighbour and random pairs as a means of determining abundance measures, were studied on a secondary savanna woodland vegetation at Agu-Awka, Awka South Local Government Area of Anambra State, Nigeria. The objective of the study was to establish the techniques that are more efficient than the others. Three analytical methods used in assessing their efficiencies include: Analysis of variance (ANOVA) test, Fischer's least significant difference (F.L.S.D) test, and test for skewness. Absolute and relative values for Density, frequency, Dominance and Importance values were determined and used extensively in the assessment. It was established at the end of the study that none of the techniques showed a statistically significant higher level of efficiency than the other. This surmisation was based on the following empirical results: from the analysis of variance test carried out for the efficiencies of the four techniques using three major abundance measures, the calculated final cases was less than the tabulated f, thereby signifying a non-statistically significant difference in the efficiencies of all four techniques. Again, the result of the Fischer's least significant difference test on the mean of means of the techniques showed in all cases that no two techniques had a difference in mean that was more than the Fischer's least significant difference. This agrees completely with the ANOVA test. Also in agreement with the duo, is the result, from the test for skewness, because the departure from symmetry (-0.32) was negative and therefore very insignificant.

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INTRODUCTION

In ecological studies, one must necessarily sample the vegetation of an area in order to understand the species composition of that area. Most frequently, this is done using the quadrat sampling technique in most communities. However, quadrat sampling has been found to be inadequate for some vegetation types, particularly those dominated by trees and shrubs. This has informed the employment of plotless sampling techniques – where species analysis are carried out in space without practical consideration for two dimensional fixtures or borderline measures. This relatively more recent technique has gained international prominence owing largely to its ease of application and high levels of success. So many different methods of sampling are encountered under plotless sampling. These utilize point-to-plant or plant-to-plant distance measurements.

The basic premise of these distance techniques is that density can be calculated, if the average space occupied by individual plants can be determined. Thus Dix (1961) came out with the following assumptions for these techniques:

(1) Plants occupy circular areas
(2) Plants are randomly distributed
(3) Individual plants can be easily recognized
(4) Space between plants is a measurable amount

The advantages of these techniques include:

(a) They are usually faster
(b) Require less equipment
(c) Do not require selection or adjustment in quadrat size.

Mark and Esler (1970) opined that in most fields of natural science, the density of individuals is usually determined from counts in defined areas of known dimensions. Because of the reciprocal relationship between density and nearness of individuals to one another, it is necessary to know only the distances between regularly spaced individuals to be able to calculate density. Each plant, has available to it an area equal to the square of the between plant distances. If the individuals are distributed not regularly but at random, density may still be determined from the spacing, since between-plant distances will vary at random from the mean distance. In most, if not all natural communities, there is a departure from randomness, i.e individuals tend to be aggregated to some degree (Greig-Smith, 1964). For most forest sampling methods, this non randomness has usually been considered too insufficient to affect the result seriously. Since it was described by Cottam and Curtis (1965), the point centred quarter method has become accepted, along with other methods of plotless sampling, as one of the most efficient for obtaining quantitative data on forest trees. Other methods that will be encountered in this work include the closest individual technique, the nearest neighbor technique and the random pairs technique.

Apart from density, other quantitative parameters that can be estimated with the plotless methods include: frequency, basal area, dominance and importance value.
The specific objective of this study includes:

(1) Evaluation of the four plotless sampling techniques with a view to determining the order of efficiency of the techniques;
(2) Providing information and re-enlightenment about the techniques which will make them an indispensable alternative to the quadrat method in the determination of relative and absolute values for abundance measures.

Diagrammatic Representation of the Techniques for easier appreciation

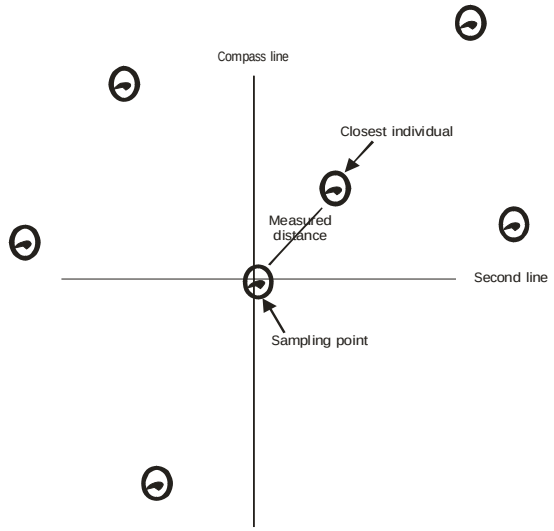

Fig. (1a): Closest Individual method
Source: Meuller-Dombois, D and Heinz Ellenberg(1974).

MATERIALS AND METHODS

Details of Standard Procedure and Equipment Employed

An area 30m square was delineated with a tape and four pegs. Next, ten transects were established at 3m intervals. On each of the ten transects, sampling points were established at 3m intervals also. This produced ten

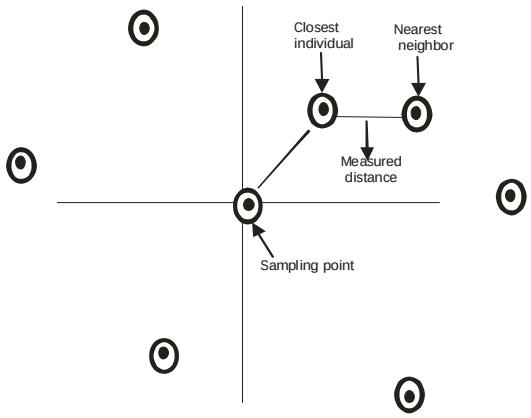

Fig. (1b): Nearest neighbourmethodSource: Meuller-Dombois, D and Heinz Ellenberg (1974).

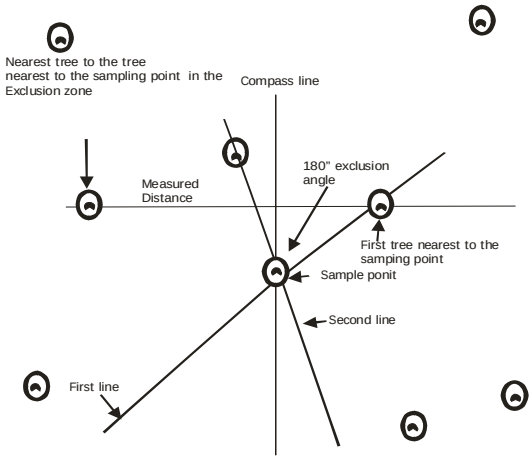

Fig. (2a): Random Pairs Method.
Source: Dieter Mueller-Dombos, and Heinz Ellenberg(1974)

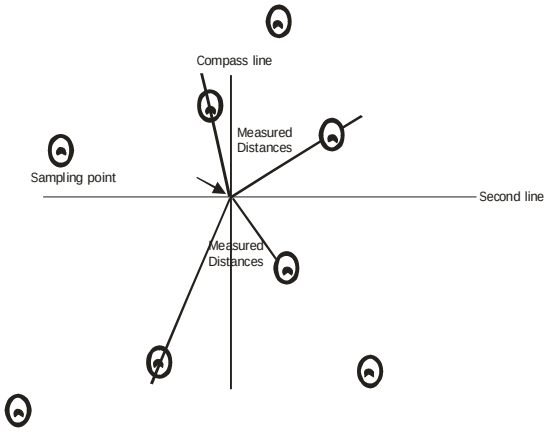

Fig. (2b): Point-centred quarter method.
Source: Dieter Meuller-Dombois, and Heinz Ellenberg (1974).

Abundance measure of importance value highlighted for all species and all techniques

	Closest Individual Technique	Nearest Neighbour Technique	Random Pairs Technique	Point-Centred Quarter Technique
DaniellaOliveri	89.36	54.09	69.61	68.37
Hymenocardiaacida	69.71	52.01	62.61	68.82
Lophiraalata	46.50	34.00	42.22	47.62
Vitexdoniana	42.00	112.54	24.07	33.90
Anonasenegalensis	50.15	20.88	29.85	44.53
	C.I.T	N.N.T	R.P.T	P.C.Q.T.
Total	297.72	273.52	228.36	263.24
Mean (column)	59.54	54.70	45.67	52.65

	D.Oliveri	*H.acida*	*L.alata*	*V.doniana*	*A.senegalensis*
Total	281.43	253.15	170.34	212.51	145.41
Mean (row)	70.36	63.29	42.59	53.13	36.35

			(Control)			
	(Highest mean)		Lowest Mean)		(Highest mean difference)	
Test: eg	(59.54	-	45.67	=	13.87)	<31.84

Skewness Test of Symmetry for Importance Value for all Techniques

Techniques	Importance Values	Mean	Median	Variance	Standard Deviation	Skewness
C.I.T	297.72	265.71	268.38	1024.64	24.93	-0.32
N.N.T	273.52	265.71	268.38	61.0	24.93	-0.32
R.P.T	228.36	265.71	268.38	1024.64	24.93	-0.32
P.C.Q.T	263.24	265.71	268.38	61.0	24.93	-0.32

Fischer's Least Significant Difference Test (F.L.S.D) on the mean of means (Comparison test) for importance value.

A	-	C.I.T	-	59.54
B	-	N.N.T	-	54.70
C	-	R.P.T	-	45.67
D	-	P.C.Q.T	-	52.65
E	-	F.L.S.D	-	31.84

sampling points per transect, giving a total of one hundred sampling points. At each sampling point, five different measurements were taken in the following order:-

Firstly, the closest tree species to each sampling point was identified. Next, the point to tree distance was measured and recorded. Secondly, the distance between the closest individual and its nearest neighbour was measured and recorded. Thirdly, the point to plant distances for the four quarters were measured (i.e the distances between the nearest plant and the sampling point, for each of the four quarters was measured to obtain four values – per random point) for the point-centred quarter technique alone. Fourthly, the nearest plant to a sampling point was located; next, a straight line was formed between that nearest plant and the sampling point. Thereafter, an angle of 1800 was formed at the sampling point facing the nearest plant in such a way that the stick which connects the nearest plant to the sampling point forms an angle of 90^0 each at the two adjacent, sides of this line. This leaves an exclusion angle of 180^0 in the segment containing the nearest plant to the sampling point (i.e the very first plant). The nearest plant to the first plant, in the opposing 180^0 segment was ascertained and the distance between the two taken. This gives the value for the random pairs technique. Finally, any species whose stem was up to 1.3m high had the Girth at Breast Height (GBH) measured immediately at that mark. These measurements were recorded as soon as they were taken. All the plant species were identified and recorded as a first step in all cases before measurements commenced.

The procedure above was carried out for the hundred sampling points.

RESULTS

The table shows the analysis of variance test for importance value for all techniques. F. calculated which is 0.29 was less than the f. tabulated which is 3.24, thus there was no statistically significant difference in the efficiencies of the four techniques. The interpretation is that as far as this critical index of abundance measure estimation is concerned, the four techniques have a relatively uniform measure of efficiency.

Based on the result of Fischer's Least Significant difference test on the mean of means for importance value, the highest limit (mean) was 59.54, the lowest limit (mean) was 45.67 therefore the highest common difference for all means is 13.87. All the other possible combinations (difference) of highest and lowest limits falls below this 13.87, and 13.87 is less than the F.L.S.D value of 31.84. In conclusion therefore, there is no statistically significant difference in the efficiencies of the four techniques as far as importance value is concerned. This is in agreement with the Analysis of Variance result already obtained for the same abundance measure of importance value.

DISCUSSION

In this particular study, the parameters; density, dominance and importance values were all employed to evaluate the efficiency of four plotless sampling techniques. The importance value which is a crucial synthesis of the very significant measures of relative density, relative frequency and relative dominance is a vital determining index. In the analysis of variance (ANOVA) test, the difference between the calculated fs and the tabulated fs, did not show statistical significance,

therefore the null hypothesis was accepted in all cases. To this effect, the four plotless techniques (C.I.T, N.N.T, R.P.T and P.C.Q.T) under study were of a relatively uniform efficiency. This was also the case in Fischer's Least Significant Difference Test (F.L.S.D) and in the test for skewness for importance value. This leads to the overriding conclusion that, as far as statistically analysis was concerned, no technique was more efficient than the other, in the determination of the three abundance measures under consideration.

Conclusion

The value of skewness, which stands for departure from symmetry of the four techniques, is negative and also very insignificant. This agrees with both the earlier results of ANOVA and F.L.S.D for importance value of the techniques.

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