VELD BURNING.

(C). CALIBRATION OF THE BELT TRANSECT METHOD IN COMBRETUM WOODLAND IN THE KRUGER NATIONAL PARK

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The comprehensive veld burning experiment set out in the Kruger National Park by van der Schyff on behalf of the National Parks Board in 1954 consists of four blocks of treatments in each of the four main vegetation types, and each block contains twelve eight-morgen plots. The frequency of the woody species was determined prior to the commencement of burning treatments by a belt transect five feet wide and 2,000 feet long taken roughly along the two diagonals of each plot. Each tree species was recorded in size classes (bole diameters of 0-1", 1-3", 3-5", 5-7" and greater than 7 inches), and the shrubs were recorded separately according to the diameter of the coppice (arranged in classes 0-1', 1-3' and greater than 3 feet in diameter). Grass cover was measured by recording ten points at twenty foot intervals along the transects, giving 1000 points per plot, using a modification of the Bruce Levy point quadrat technique. These two methods have given a satisfactory measure of the experimental sites, since there are four replicates in each vegetation type.

In order to assess the effect of the treatments, the following decisions require careful consideration :-

(a) How often should the plots be analysed botanically?

(b) In the statistical analysis of the data, should the frequency of species be related to the original count in each plot, or should the treatments be compared with one another on the basis of a randomized block analysis?

The amount of field work involved in the botanical analysis is considerable, and the answer to both questions depends upon the size of sample necessary to give a reliable estimate of the population in each plot. It should be noted that for statistical treatment of data it is necessary to obtain a good estimate of the species in each plot, not only a good mean of the four replicates. The use of fixed quadrats or fixed transects may give reproducible results, but these may not be representative of the plot as a whole. Furthermore the difficulties of maintaining fixed points in the Park, because of the destructive habits of elephant, virtually rule out fixed quadrats.

PROCEDURE FOR CALIBRATION.

In March/April 1960 the belt transect method was examined in the Combretum woodland in the Skukuza Block. In each of Plots 5, 6 and 7 transects totalling 8000 feet were recorded in separate samples of 1000 feet with the usual width of 5 feet. Four of these were on the diagonals and four were at random in the plots. The results for each plot were arranged as 8 x 1000 ft.

samples, 4 x 2000 ft. samples and 4 x 4000 ft. samples (the latter obtained by grouping samples 1 to 4, 5 to 8, samples 2 + 4 + 6 + 8 and samples 1 + 3 + 5 + 7). The correlation of two of the 4000 ft. samples with the other two reduces the standard error of this mean, which should be borne in mind throughout the discussion. For each plot these samples were then used to calculate the Standard Error of the Mean of total species and of each species separately. In each case the S.E. of trees alone and shrubs alone was also calculated. This was done for eleven of the commoner species, viz. *Albizzia harveyi, Acacia exuvialis, A. nigrescens, A. gerrardii, Combretum apiculatum, C. zeyheri, C. hereroensis* (*C. imberbe* included), *Dichrostachys nyassana, Ormocarpum trichocarpum, Terminalia sericea* and *Dalbergia melanoxylon.*

The frequency of these species varied from a mean frequency per 1000 ft. (i.e. 5000 sq. feet) of about 50 plants and 0.5 plants. These means are calculated from 8000 ft. and the individual counts were frequently much less. There are some twenty other species present, some of which warrant separate treatment, such as *Strychnos innocua* and *Pterocarpus rotundifolia,* but it is presumed that these will give similar results to other species with the same frequency.

In presenting the results in graphical form the Standard Errors have been given as a percentage of the frequency of each species, and in the case of the S.E. of trees, shrubs and totals the percentages were calculated from the mean totals of each. This has enabled a generalisation about the reliability of the transect method with respect to species within frequency classes of 0.1 to 3, 3.1 to 6, 6.1 to 12 and above 12 plants per 1000 ft. belt transect 5 ft. wide.

Apart from the calculation of standard errors, the data have also been used to determine the accuracy of transects totalling 1000, 2000, 4000 and 8000 feet in recording the presence of species.

DISCUSSION OF RESULTS.

The Use of Belt Transects in Floristic Survey.

In the Skukuza *Combretum* woodland, in which there are over thirty woody species, it is apparent from Figs. 1, 3 and 5 that an 8000 ft. transect will record about 31 species, a 4000 ft. transect about 28 species, a 2000 ft. transect about 22, and 1000 ft. about 16.

The increase between 4000 and 8000 ft. is so small that it may be concluded that for floristic survey in this woodland 4000 ft. is adequate. The range of variation about the mean at 4000 ft. is small. The original survey by van der Schyff comprised 8000 ft. in each vegetation type (four plots each with 2000 ft.).

The Frequency of Trees and Shrubs of All Species.

The accuracy of the belt transect method in measuring the density of woody growth irrespective of species is shown in Figs. 2, 4 and 6, referring respectively to the Annual Burn in August, Control and Biennial Burn in April. Taking trees and shrubs together, the S.E. varies from 8 to 33% in a 1000 ft. transect; in a 2000 ft. transect it is still high in the annual burn at 28%, but only 10% and 4% in the other plots; in a 4000 ft. transect it is below 10% in all cases.

For trees or shrubs separately the S.E.'s are higher, of course, and they fall from about 30% to 20% to 10% respectively in 1000, 2000 and 4000 ft. transects.

In the annual burn in August the density of trees and shrubs is lower than in the other two plots (77/1000 ft. against 118/1000 and 158/1000) and this could account for the higher S.E. It is concluded that in woodland with a density above 100 plants per 1000 ft. a reasonable estimate of total density can be obtained from 2000 ft. transects, but in sparser woodland it would be necessary to use 4000 ft. transects, if small differences are to be detected.

The Frequency of Individual Species.

The reliability of a belt transect sample with respect to any one species depends upon the frequency with which it occurs in the community, as well as the uniformity of the vegetation. In the plots examined the frequencies range from less than 1 to 44 plants per 1000 ft.

The S.E.'s of the species in Plot 6 have been grouped according to the frequency of the species, and in Fig. 7 the mean S.E. of species in each frequency class are shown for each transect length. These means are all above 50% in 2000 ft. transects, but with 4000 ft. transects the S.E.'s average out at below 32% for all species, being only 10% in *Ormocarpum* with 15 plants/1000 ft. For trees and shrubs separately the S.E.'s are above 40% except in a few of the commoner species, even in the 4000 ft. transects.

Similar treatments of the data from plot 5 is presented in Fig. 8. The mean of the percentage S.E.'s of species more common than 12 plants/1000 ft. is 12%, at 2000 ft. and 6% at 4000 ft. The others average out between 28% and 42% at 2000 ft., but at 4000 ft. all the species average out between 2% and 16%. For trees and shrubs separately the S.E.'s average out below 20% in all frequency classes.

The percentage S.E.'s of eleven of the individual species in Plot 7 are presented in Fig. 9. In 2000 ft. transects only one species has a S.E. below 10%; the others are all above 20%. In 4000 ft. transects, however, six species have a S.E. below 10%, and two more are below 20%. For trees and shrubs separately the S.E.'s are mostly above 50% with 2000 ft. transects, but with 4000 ft. transects most of the commoner species are below 20%.

Interpretation of Calibration Data.

In the data presented the effect of the size of the sample upon the Standard Error is clearly demonstrated. In deciding upon the S.E. which should be tolerated in these botanical analyses, it should be borne in mind that the experimental layout consists of four replicates of each treatment, and in this calibration the S.E.'s of the 2000 and 4000 ft. transects are calculated from four samples. These S.E.'s may therefore be used to estimate roughly the levels of least significant difference, using the formula Sig. Dif. $= 2 \times$ S.E. $\times \sqrt{2}$, for $P = 0.05$. Where a S.E. is 10%, the least significant difference would be about 32% of the density, and with a 20% S.E. a difference of about 65% between plots would be significant.

In comparing Plots 6 and 7, for example, only the totals would appear to be significantly different using 2000 ft. transect data, whereas using 4000 ft. samples it should be possible to show that not only the totals but also about four of the commoner species exhibit a significant difference in density between the two plots.

CONCLUSIONS.

In making the final decision about the length of transect necessary in this woodland, it is necessary to have some information about the variation between the four blocks in each vegetation type. It is to be expected that the standard error of four samples, one from each block, will be greater than the figures calculated here. The advantages of a block analysis of a randomized block layout, however, tend to reduce the error variance.

In the overall view, a 2000 ft. transect five feet wide appears to provide a satisfactory sample if all trees and shrubs are to be treated together. Where it is desired to compare the density of individual species, it is clearly necessary to double the area of the belt transect. This should not mean twice as much field work, because much of the time in the field is taken up with setting out the chain. It is suggested that a five foot belt on both sides of the chain be recorded, either by one observer or two persons working simultaneously, thus retaining the procedure of measuring 2000 ft. on two diagonals. It can well be argued, however, that this extra work is not justified to record a species which occurs with a frequency less than 15 plants per 5000 square feet.

The difficulties of assessing the frequency of separate species are greatest in woodland with a large number of species, because any one species is usually present in small numbers. This is true of the *Combretum* woodland. In more uniform vegetation types, with one or two dominant species, an adequate measure of the dominant species would be obtained with a 2000 x 5 ft. transect, and in dense woodland with only one dominant such as *Colophospermum mopane* veld a 1000 ft. transect may suffice.

One of the unsatisfactory features of statistical analysis of belt transect data is the inability of such data to reflect the difference between trees and coppices. A coppice three feet in diameter may contain twenty stems, yet it is accorded the same significance as a single-stemmed tree. Where the effect of fire may be the conversion of trees to coppices, some measure of the number of stems or the total area of coppice growth should be incorporated in the statistical analysis.

It is suggested that the original survey carried out before the commencement of treatments be regarded as a uniformity trial. Any plots which are shown to have had an exceptionally high or low total count can be more carefully examined. The results of surveys carried out in future to determine the effect of fire should be analysed statistically on the basis of a randomized block analysis, simply comparing one treatment with another with four replicates in each veld type. Since some of the treatments are triennial burns, it is reasonable to resurvey the plots every six years (after the second triennial burn in the first instance). In the vegetation types with many species, such as the *Combretum* veld, where individual species require examination, the belt transect should be 2000 feet x 10 feet. In types such as the Mopane veld 2000 feet x 5 feet in each plot should suffice. In all the surveys a separate analysis of coppice growth should be carried out.

ACKNOWLEDGEMENTS.

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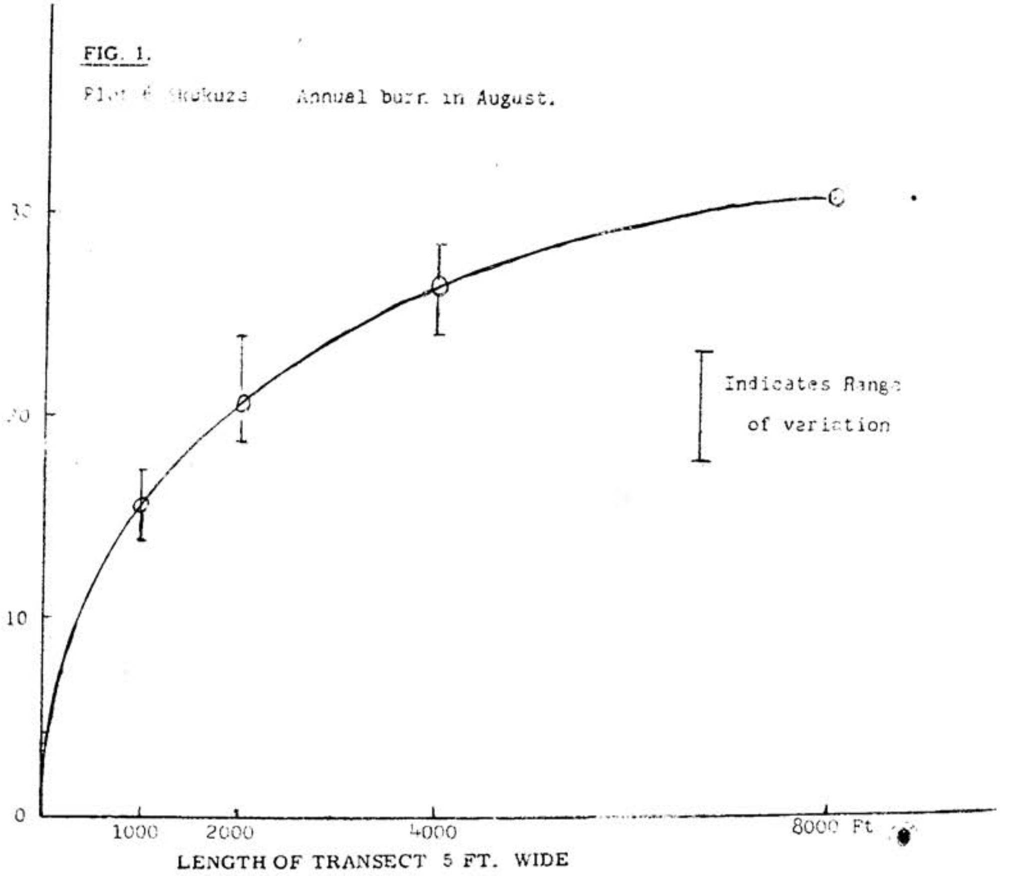


FIG. 1.
Annual burn in August.
30
20
10
0
1000
2000
4000
8000 Ft
LENGTH OF TRANSECT 5 FT. WIDE
Indicates Range of variation

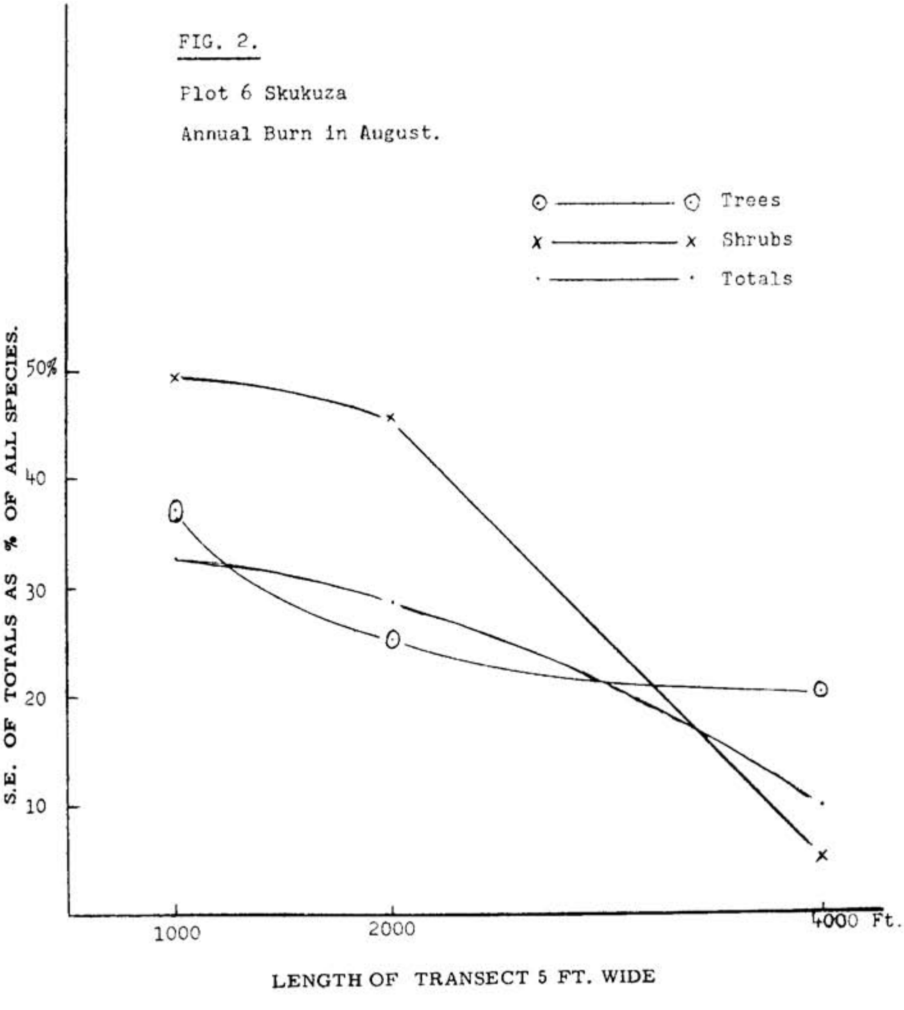


FIG. 2.
Plot 6 Skukuza
Annual Burn in August.
Trees
Shrubs
Totals
S.E. OF TOTALS AS % OF ALL SPECIES.
50%
40
30
20
10
1000
2000
4000 Ft.
LENGTH OF TRANSECT 5 FT. WIDE

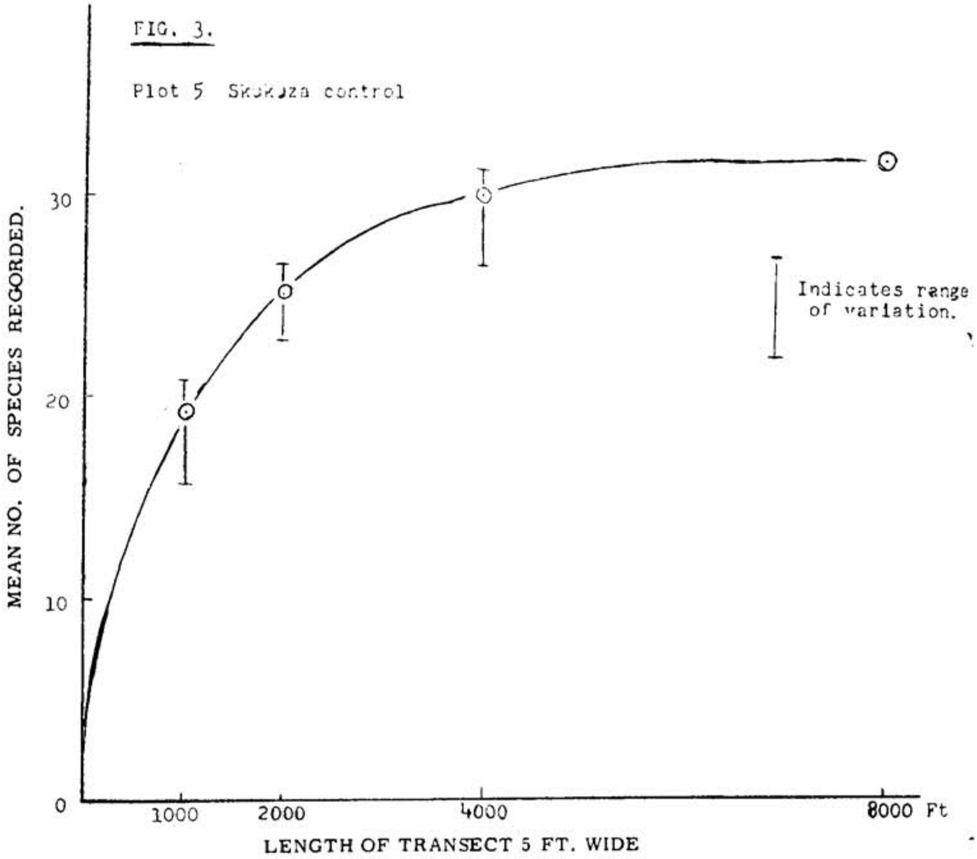
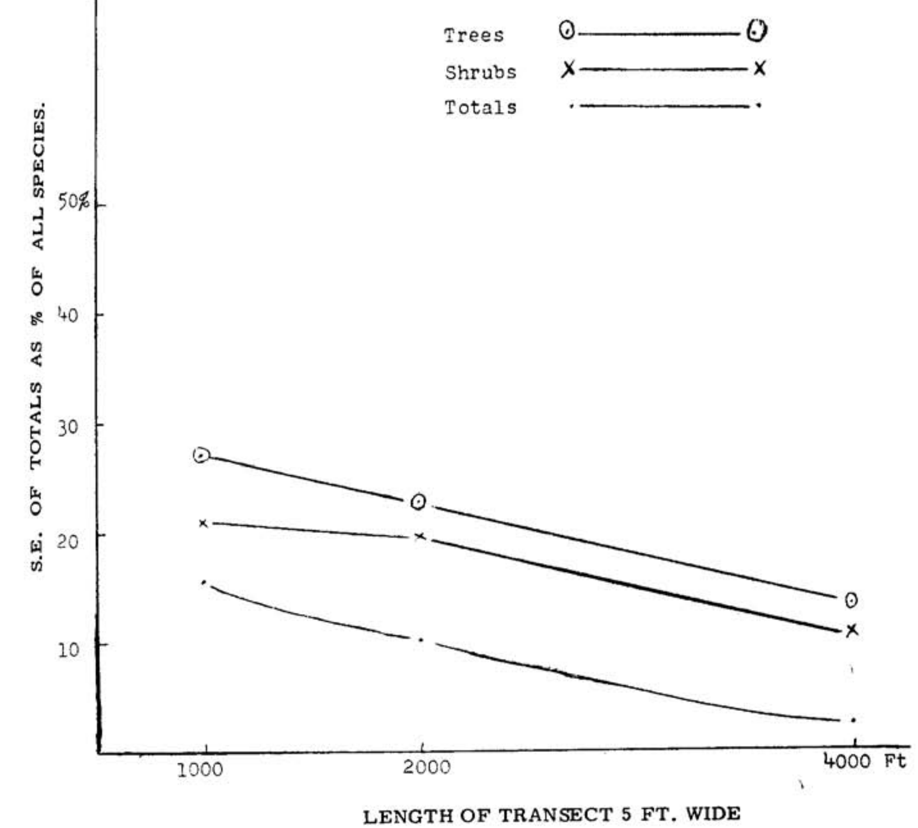


FIG. 3.
Plot 5 Skukuza control
MEAN NO. OF SPECIES RECORDED.
30
20
10
0
1000
2000
4000
8000 Ft
LENGTH OF TRANSECT 5 FT. WIDE
Indicates range of variation.

FIG. 4.

Plot.5 Skukuza control.



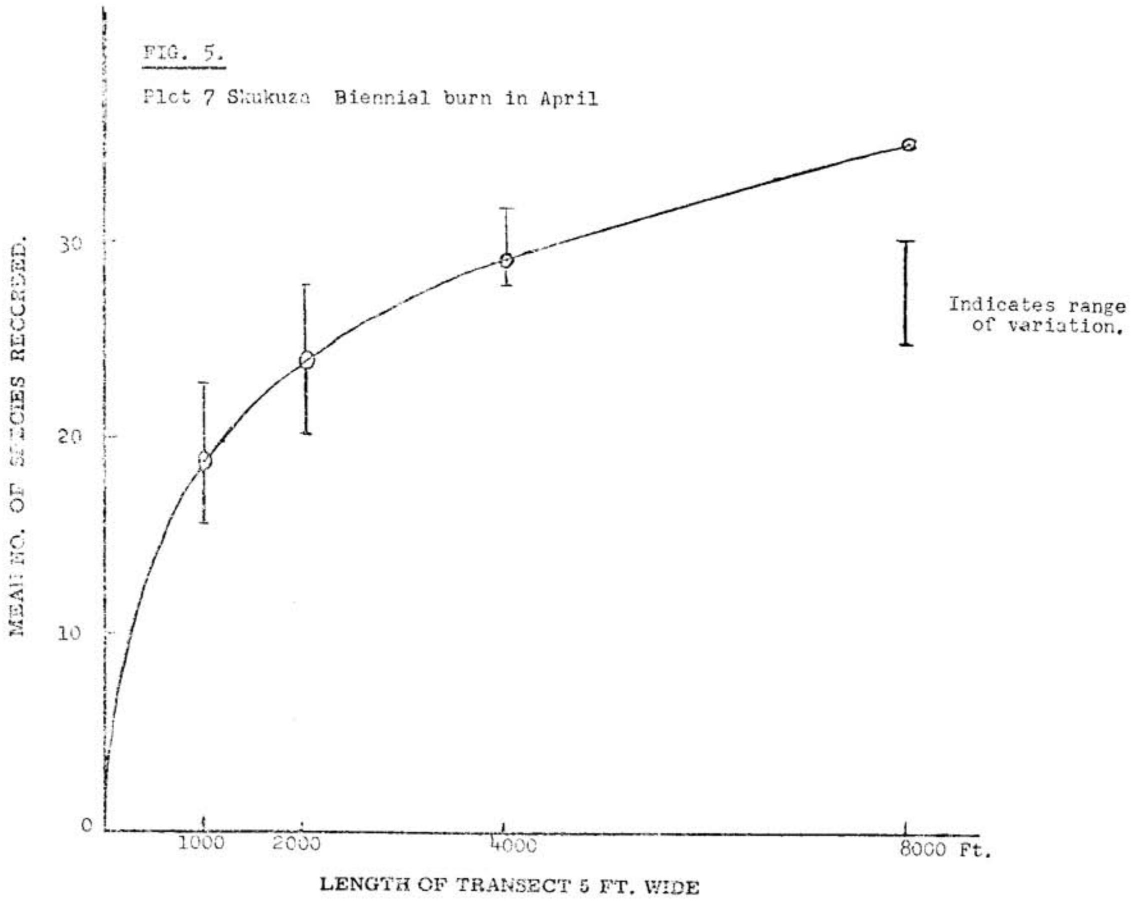
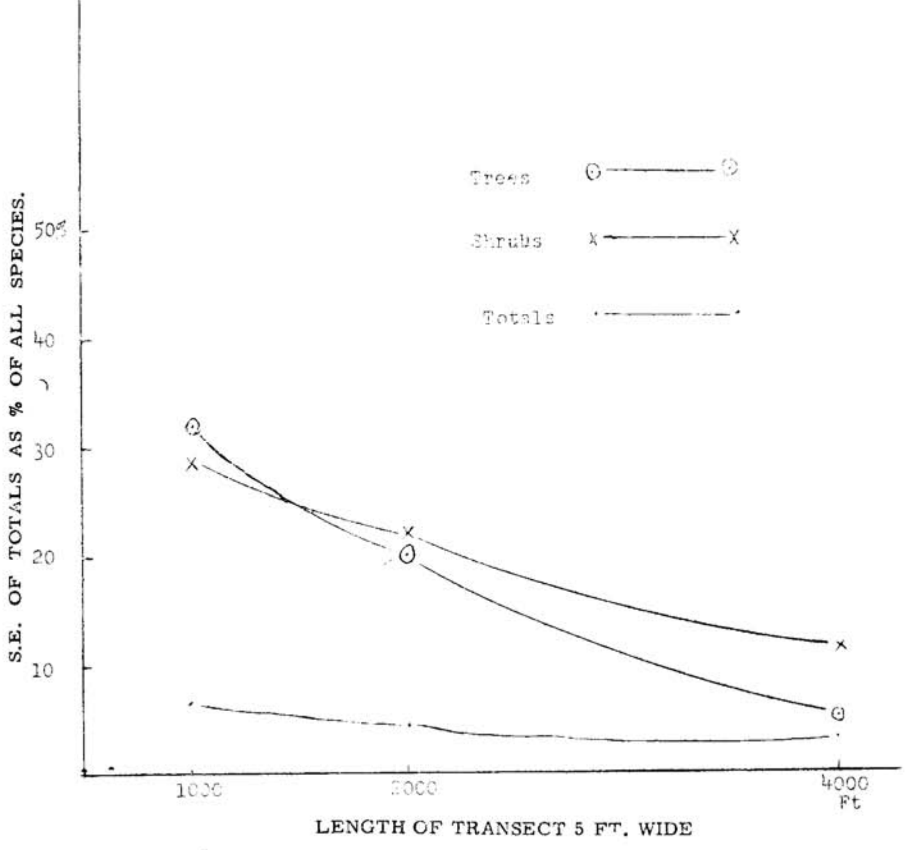


FIG. 5.

Plot 7 Skukuza Biennial burn in April

FIG. 6

Plot 7 Skukuza.
Biennial burn in April.



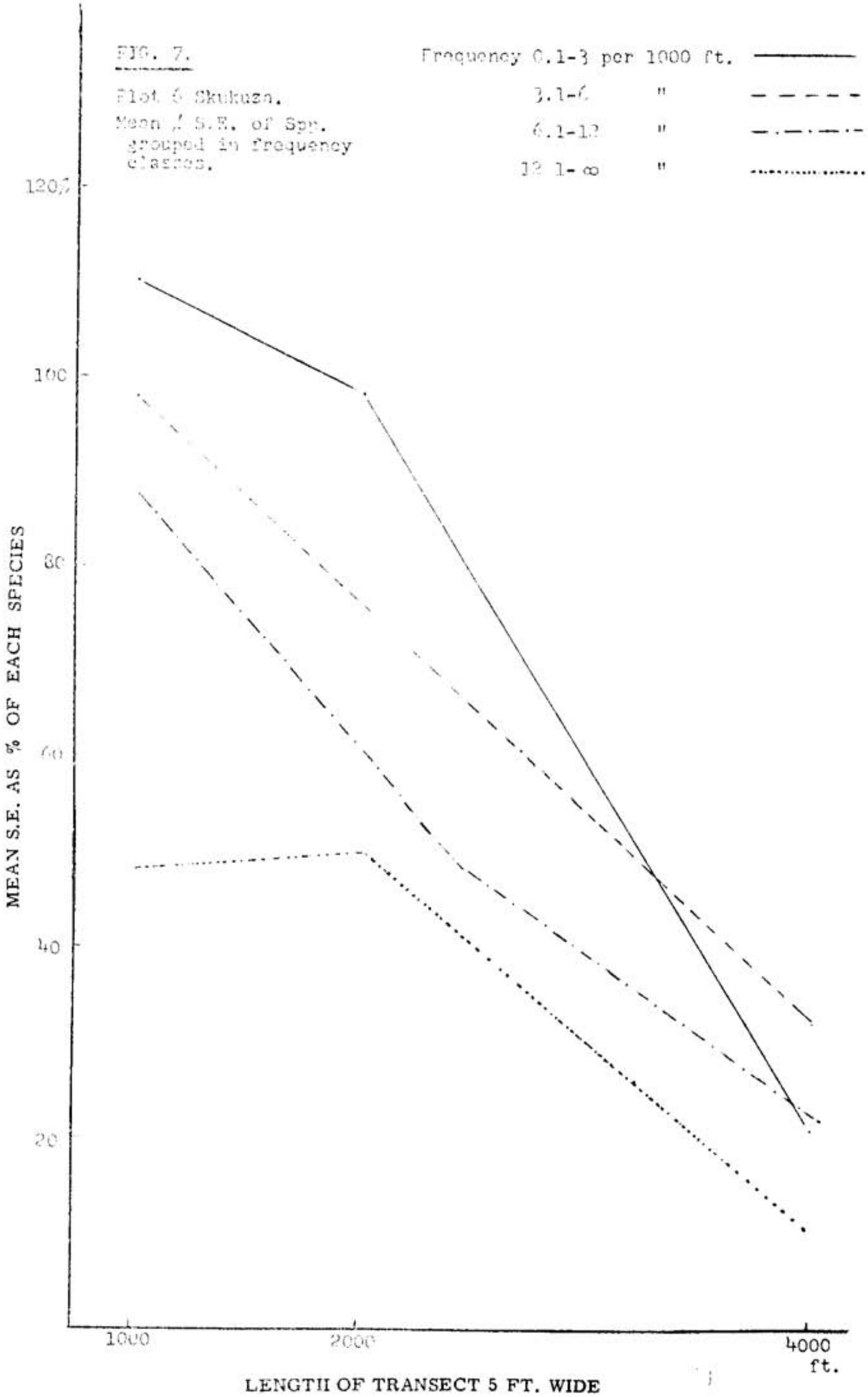


FIG. 7.
Plot 6 Skukuza.
Mean ± S.E. of Spp. grouped in frequency classes.
Frequency 0.1-3 per 1000 ft.
3.1-6 "
6.1-12 "
12.1-∞ "
120%
100
80
60
40
20
MEAN S.E. AS % OF EACH SPECIES
1000
2000
4000 ft.
LENGTH OF TRANSECT 5 FT. WIDE

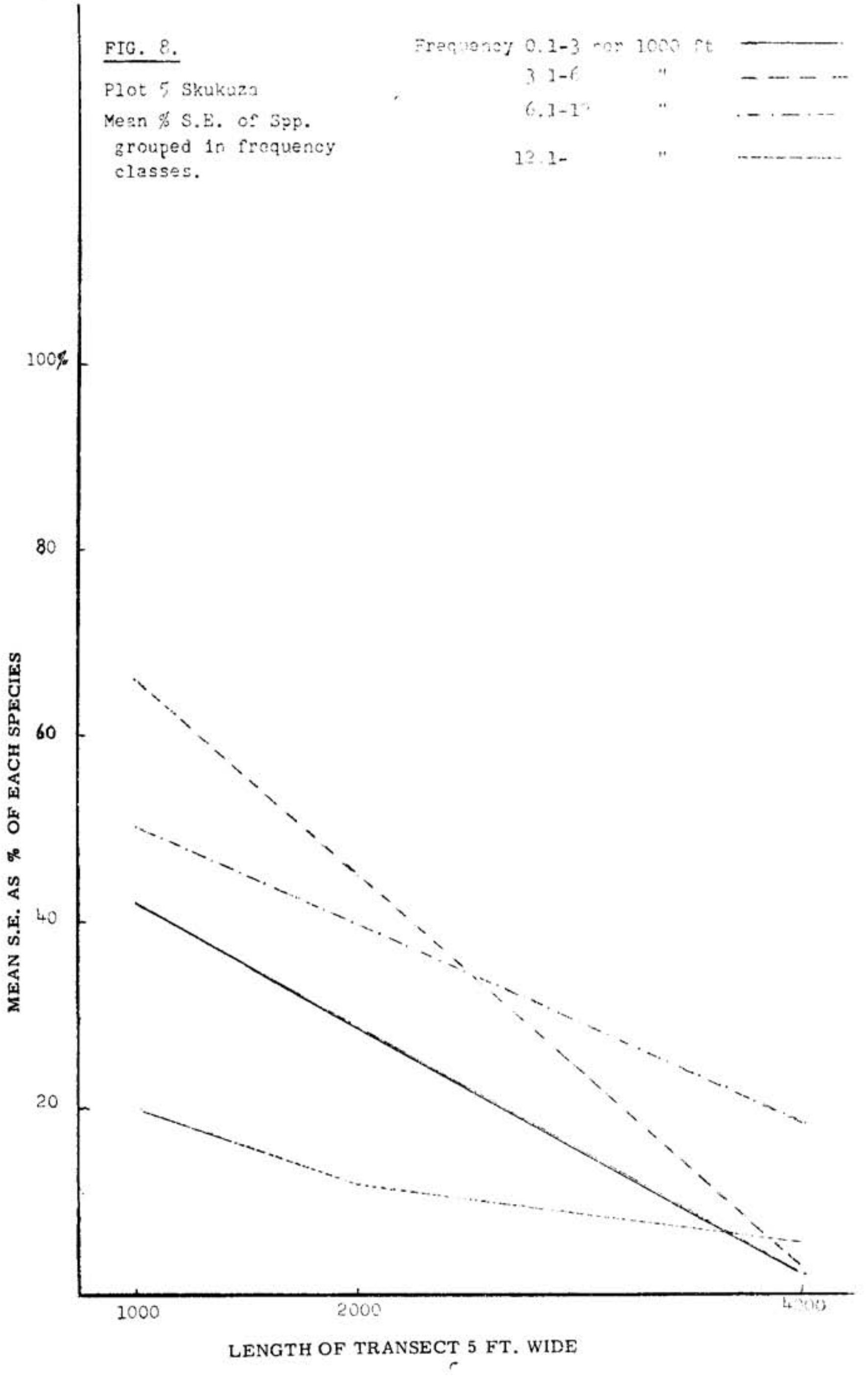
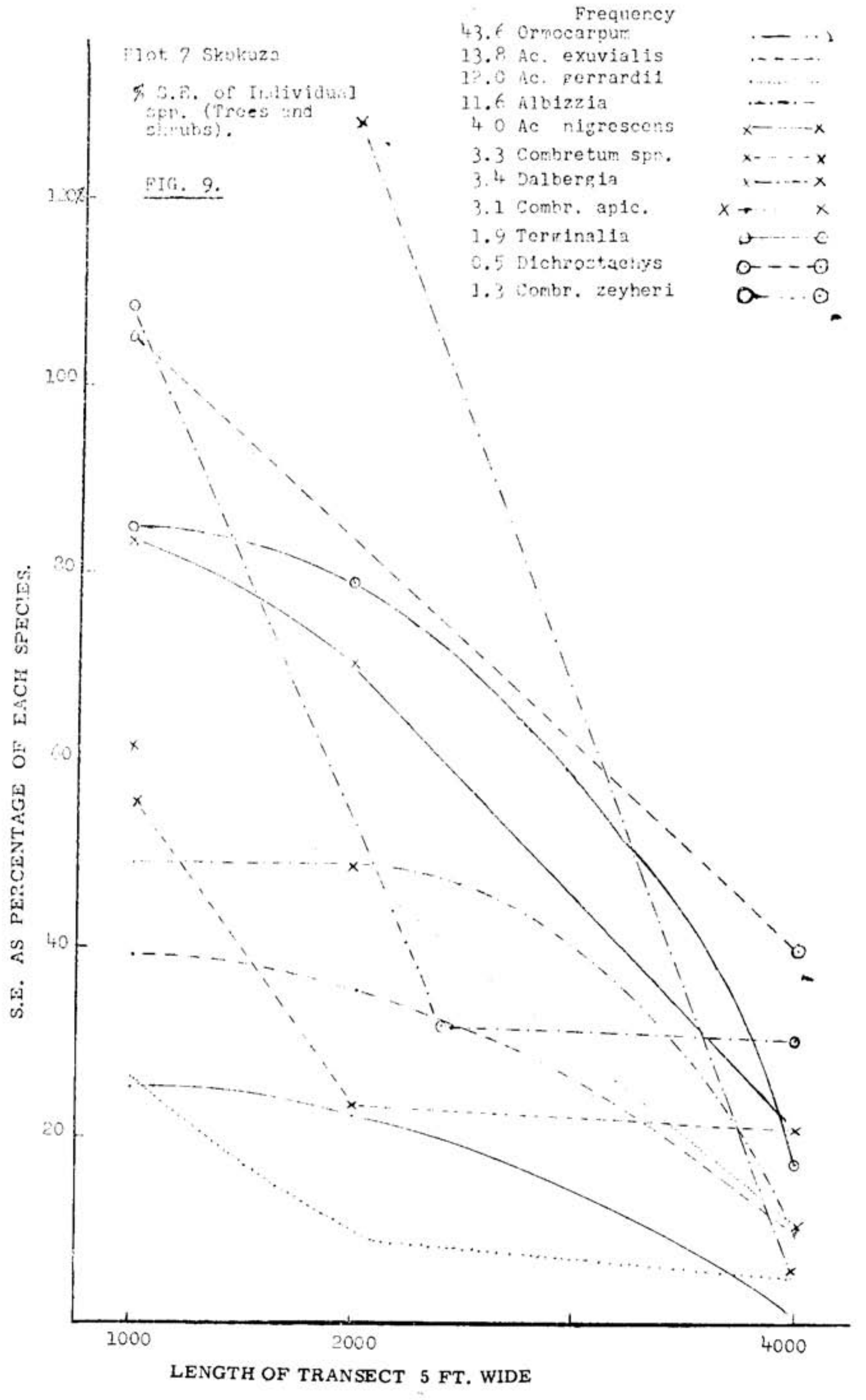


FIG. 8.
Plot 5 Skukuza
Mean % S.E. of Spp. grouped in frequency classes.
Frequency 0.1-3 per 1000 ft
3.1-6 "
6.1-12 "
12.1- "
100%
80
60
40
20
MEAN S.E. AS % OF EACH SPECIES
1000
2000
4000
LENGTH OF TRANSECT 5 FT. WIDE


Plot 7 Skukuza
% S.E. of Individual spp. (Trees and shrubs).
FIG. 9.
Frequency
43.6 Ormocarpum
13.8 Ac. exuvialis
12.0 Ac. gerrardii
11.6 Albizzia
4 0 Ac nigrescens
3.3 Combretum spp.
3.4 Dalbergia
3.1 Combr. apic.
1.9 Terminalia
0.5 Dichrostachys
1.3 Combr. zeyheri
120%
100
80
60
40
20
S.E. AS PERCENTAGE OF EACH SPECIES.
1000
2000
4000
LENGTH OF TRANSECT 5 FT. WIDE