A Comparison of Methods of Estimating Plant Cover in an Arid Grassland Community

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The area of ground covered by the aerial parts of plants has proved a valuable measure of vegetation and its changes. In the study of pastures either the total crown area or the basal area of tussock grasses is used. Generally the area is considered as the projection of the plant onto a horizontal surface or one at 45° to the ground, and is expressed as a percentage of the total area.

Pasture research has led to the development of a large variety of methods for estimating percent cover; these have been collated by Brown (1954). The methods fall into four basic categories, depending on the type of observation made and the dimensions of the sampling unit (termed a quadrat sens. lat.). The categories are charting, ocular estimates, line intercept and point methods.

Some recent attempts have been made by range workers in the U.S.A. to compare methods. Whitman and Siggeirsson (1954) found that the line transect method gave significantly lower estimates of cover than did a point method in mixed grassland. Johnston (1957) found small differences between the line intercept and point methods, though the former gave lower values. Heady, Gibbons and Powell (1959) obtained the same estimate of cover using a charting technique, line intercept and point methods in shrubland, and the variances also appear to be very similar. Cook and Box (1961) compared a point method with an ocular estimate in a small circular plot (diameter 0.75 inches) and the latter gave significantly lower estimates of cover.

In these studies the testing of differences was not always rigorous. However the different results obtained may be real and reflect differences in the type of vegetation being studied.

A comparison of methods in each of the four categories was made in a grassland of central Australia, the field work being carried out in 1957. The vegetation of the study area was dominated by hard spinifex *(Triodia basedowii);* small numbers of feathertop spinifex *(Plectrachne schinzii)* plants were present. Both species are tussock grasses with long, terete, pungent leaves and are very unpalatable to stock. The tussocks are generally compact, 1-2 feet tall, semi-spherical in cross section though often irregular in outline. These plants dominate many thousands of square miles in arid Australia. The possibilities of clearing and replacing them with more palatable species are being studied. It was therefore desirable to determine the most reliable method for a survey of these areas.

Methods

Eight parallel transects, each 50 m. in length, were measured out 5 m. apart. Observations were made at the same locus every 20 cm. along the transects using the following methods:

1. Charting method. A chart or photo is made and used as a reproduction at reduced scale of the plane projection of the plant cover. The areas can then be measured by a planimeter. The process of charting oversimplifies the outlines of plants and loses such details as canopy gaps, leading to overestimation. Photographs may overcome this, and in the present study the whole area was sub-divided into a grid of squares and vertical photographs taken by means of a camera on a tall step-ladder.
2. Ocular estimates. These are methods in which a visual estimate is made of the proportion of the area of a plot which is covered by plant material. With sub-division of the plot by strings or wires considerable accuracy can be achieved by experienced observers. The main errors are due to the use of relatively large quadrats; a reduction of quadrat size should reduce bias. In this study three small quadrat sizes were tested:
   (a) A circular plot with a diameter of 1.9 cm. (0.75 inches) in which presence or absence was scored according to whether cover was greater or less than 50 percent. This plot is the same as the loop used in the 3-step method (Parker and Harris 1959) but in that method presence is recorded if a plant overlaps any part of the loop.
   (b) A rectangular plot measuring 5 cm. x 2 cm. in which cover was scored in 10 percent classes from 0 to 100.
   (c) A rectangular plot measuring 10 cm. x 4 cm. scored as in (b).

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3. Line Intercept. In this method the sample area is reduced to a line along which the length of canopy projection is measured. The major difficulty is that it is not practicable to measure all the minor gaps in cover, or to assess narrow leaves and stems, and various arbitrary systems are adopted to define the minimum linear measurement. In this study intercepts were measured along the full length of the transects. Gaps and intercepts less than 1 cm. were ignored.
4. Point Method. The presence or absence of plant material over the upward projection of a series of points on the ground is recorded in this method. The main errors are associated with the thickness of the pin used to demarcate the point projection (Goodall 1952) and with the grouping of points in clusters (e.g. frames of 10 pins are frequently used). Recent workers have tended to use a sharpened point. In this study a cross-wire sighting tube was used. This is particularly useful where species overlap is slight.

Only 2 observers were available. One made all 3 ocular estimates and the other made the line and point observations. All observations were made as the vertical projection.

Results

The photos gave an excellent projectional representation of the vegetation (Figure 1) subject to parallax errors and spherical aberration in peripheral regions. However, it was impossible to measure areas planimetrically without simplifying the plant outlines quite arbitrarily. This was considered so unsatisfactory that the attempt was abandoned.

The percent cover estimates for the five sampling methods are shown in Table 1. An analysis of the differences of each measure from the point method showed that only the line intercept was significantly lower for hard spinifex, but clearly this has little practical significance. For this and other tests spinifex data were transformed to angles and the percent cover computed for each 10 m. length of transect, giving five such units in each of the eight transects.

FIGURE 1. Vertical view of a 2½ meter square quadrat.

An examination of the variances (Table 2) shows that the line intercept method has the highest and the circular plots the lowest, but comparisons between each of the methods did not reveal significant differences. These tests were made by a method described by Morgan (1939) in which correlations due to the observations being made at the same loci were taken into account.

A multivariate analysis of the hard spinifex data was next made. A test (Wilkes 1946) for homogeneity of variances and co-variances failed. The similarity of the variances suggests that this failure was due to co-variances and so a test was made of the homogeneity of correlation

Table 1. Mean percent cover for eight transects in the spinifex community.

	Method				
Species	Point	Circle	Rectangle 5 cm. x 2 cm.	Rectangle 10 cm. x 4 cm.	Line Intercept
Triodia basedowii	35.4	35.4	34.9	35.0	33.6
Plectrachne schinzii	0.4	0.3	0.4	0.3	0.1
Litter	4.0	4.6	4.2	4.8	5.7
	39.8	40.3	39.5	40.1	39.4

Table 2. Sample variances for estimates of percent cover of *Triodia basedowii* (after angular transformation).

Method	Variance
Point	19.809
Circle	18.654
Rectangle 5 cm. x 2 cm.	22.297
Rectangle 10 cm. x 4 cm.	22.742
Line intercept	25.414

coefficients. This showed highly significant heterogeneity, with very high inter-correlations of all three ocular estimate methods.

Discussion

The simple composition and structure of the community and the uniformity in cover over the study area afforded a very suitable situation for field comparison and statistical treatment of the various methods. Though each observation was taken at the same locus, different areas were included by the differently sized sample units and so different means could be expected. It was found that for all practical purposes the five methods gave similar results and proved equally reliable. The line intercept was the only method subject to doubt on the basis of differences in mean and variance.

The higher intercorrelations of the three ocular estimates compared with those involving the point and line intercept can be attributed to their similarity as techniques and possibly also to their being made by the same observer in succession at each position. This divergence, then, does not allow any further selection of methods.

American workers have shown that line intercepts gave estimates similar to or lower than the point method; this was confirmed in the present trial. It is interesting to note that all ocular methods gave similar results. General experience of estimating cover in 1 square m. quadrats indicates that values less than the point method are obtained. The use of much smaller quadrats may have been responsible for the increased precision, though this was not so for the denser mountain shrubland studied by Cook and Box (1961).

This virtual failure to distinguish the reliability of methods means that the criteria for selection of any one method must be based on practical grounds. No records of the time taken by each method could be kept but the point method and circular plot estimate were obviously the most rapid for both field recording and computation.

Summary

Percent cover was estimated by five sampling methods in an arid tussock grassland in central Australia. A charting method was abandoned owing to the impracticability of planimetric measurement. Two thousand observations were made with each method at the same loci. A comparison of means and variances by appropriate statistical tests showed that, while the line intercept method was in doubt, for all practical purposes the five methods gave similar and equally reliable estimates. Though no records were kept of times taken, the point method and an ocular estimate in a small circular quadrat were obviously more rapid than either ocular estimates in larger quadrats or the line intercept method.

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Medusa Head Meeting

The annual weedy grass, medusa head *(Elymus caput-medusae)* L. of our floras, *(Taeniatherum asperum* (Simk.) Nevski more precisely), has become a very serious range pest in the Pacific Northwest states in recent years. It has taken over on areas at least seasonally arid, in the lower Columbia River, lower Snake River and coastal mediterranean climates. Medusa head thrives on lands which have been occupied by annual grasses such as *Bromus tectorum* L. and *Bromus mollis* L. following destruction of the original plant cover by overgrazing and fire.

A first regional conference on medusa head was organized by MIN HIRONAKA and met in Boise, Idaho on 21-22 July, 1960.

A second regional meeting was held at Davis, California on March 26-27, 1962. The same states and agencies in general were represented, but of the 23 men in attendance 19 were new so as many new personal contacts were made as old ones renewed.

The next medusa head meeting will be in conjunction with the Western Weed Control Conference in Portland.