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The Step-Point Method of Sampling—A Practical Tool in Range Research

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Step-point sampling provides a rapid, accurate, and objective method of determining the botanical composition and total cover of herbaceous vegetation. These determinations enable one to evaluate the forage stand on any specific area. The method has been used to inventory herbaceous cover relative to soil type, woody vegetation cover, aspect and slope, and other environmental factors by the Soil-Vegetation Survey in California. Values have been assessed by this method to seeding and fertilizer trials in irrigated pastures and improved dryland ranges. Changes in botanical composition of improved ranges resulting from grazing manipulation have also been recorded by use of this sampling method.

The step-point method of sampling is based on point quadrat sampling. Point quadrat sampling had its origin in a suggestion made to E. B. Levy by Dr. L. Cockayne in 1925 to the effect that a pin point would prove mathematically sound as the basis of a method for charting vegetation (Levy and Madden, 1933). Cockayne vaguely referred to point quadrat sampling in 1926. From 1927 to 1930 a number of papers by Levy, Smith, and Davies appeared recording results obtained by the use of this method. The first description of the method was that of Du Rietz in 1932; and in 1933 Levy and Madden published a full account of it (Goodall, 1952). The method used by Levy consisted of taking a number of locations at random and recording all vegetation that was hit as the point was projected from above into the sward. He used a frame of 10 pins spaced 2 inches apart (Levy and Madden, 1933). The use of inclined points in a frame was first developed by Tinney, *et al.* (1937). Eden and Bond (1948) first used a single point for analysis of herbaceous vegetation.

Crocker and Tiver (1948) used the point quadrat method for purposes of a grassland survey which they conducted in South Australia. Results of Goodall's study (1952) showed that when individual points are taken, about one-third the number are needed for the same level of precision as when points grouped in a frame are used. Biswell, *et al.* (1953) compared data of initial hits only wth those of all hits of each pin. Their results show that in terms of the more abundant species of the stand there was less than 3 percent difference in composition between methods. Distribution of sampling points used by various operators in point-frame sampling (ten pins in a frame) have been either at random, in transects, or grouped in individual plots or quadrats (Brown, 1954). Eden and Bond (1948) approximated an even spacing of single pins in their sampling. Brown (1954) stated that the general opinion of investigators using the point method of sampling is that it has every prospect of becoming the accepted one for large scale surveys as well as for exact field analyses.

Procedure

In step-point sampling a single pin is used rather than pins grouped in a frame. An individual step-point is established by the sampler lowering the sampling pin to the ground, guided by a definite notch on the toe of his boot (Fig. 1). At each step-point the sampler places his boot at a 30° angle to the ground to avoid disturbing plants in the immediate vicinity,

FIGURE 1. The sampler is establishing a sampling point with the use of a pin and a notch on the toe of his boot—the step-point.

and lowers the pin perpendicularly to the sole of the boot until it either hits an herbaceous plant or the ground. The first herbaceous plant hit by the point or the side of the point of the pin is recorded. If no herbaceous plant is hit the pin is pushed into the ground and the plant nearest to it in a forward direction (180° arc) is recorded.

The position of the step-points are determined by specific designs. For investigation of the effects of a particular treatment, *e.g.*, grazing manipulation, fertilizer or seeding treatment, transects are run across the field or plot. The transects are equally spaced and the sampling points within transects are also equally spaced. Usually, 300 to 500 points are sufficient to encompass the variability found in a field or local area in which the vegetation is essentially of one type. Where variation of aspect, slope or woody vegetation is encountered in a specific field or sampling area, separate samples of smaller size (100 to 200 points) are usually taken. Information concerning variation resulting from the diverse sections of the field as well as mean values is obtained in this manner. In small sub-plots of fertilizer or seeding trials, the number of points per treatment varies from 100 to 300 depending upon the variation within the area to be sampled.

For purposes of the Soil-Vegetation Survey the sampling design covers an acre area and consists of 100 step-points. In the design there are 5 equally-spaced transects of 20 equally-spaced points (Fig. 2). The location of the design is determined by a randomly placed initial point. The specific area to be sampled is determined by criteria of soil, topography, and cover of vegetation. By this procedure the sampling results are correlated with a specific set of environmental factors. An experienced operator can sample an acre area using the step-point method in about one-half hour.

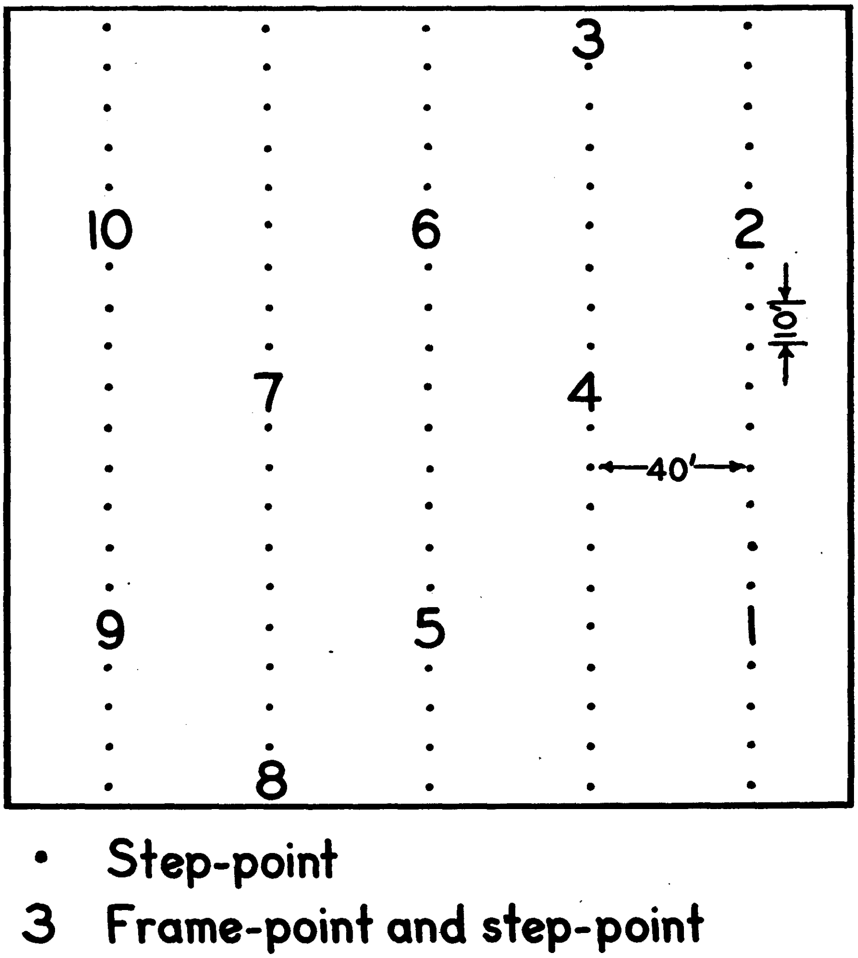

FIGURE 2. Sampling design for grassland survey plots.

Since readings of the sampling points are taken in terms of herbaceous plants and not of bare ground, an estimation method for determining total ground cover is incorporated in the technique. It is felt that to measure botanical composition and total cover by the point method alone would require a larger number of points for a valid sample. This is particularly true when sampling an area of low percentage cover of herbaceous vegetation. However, by combining the point method with an estimation method for determining total ground cover the number of sampling points can be reduced. Further, the intensity of sampling for botanical composition will remain constant regardless of the percentage cover. A sample of one hundred points will determine botanical composition with one hundred hits on herbaceous plants even when the areas sampled are of low percentage cover. Otherwise, for example, a sample of 1,000 points would be required to afford 100 hits on herbaceous vegetation in an area of 10 percent cover.

Table 1. Classes of total herbaceous cover.

Cover class	percent
0	0 — 5
1	6 — 15
2	16 — 25
3	26 — 35
4	36 — 45
5	46 — 55
6	56 — 65
7	66 — 75
8	76 — 85
9	86 — 95
10	96 —100

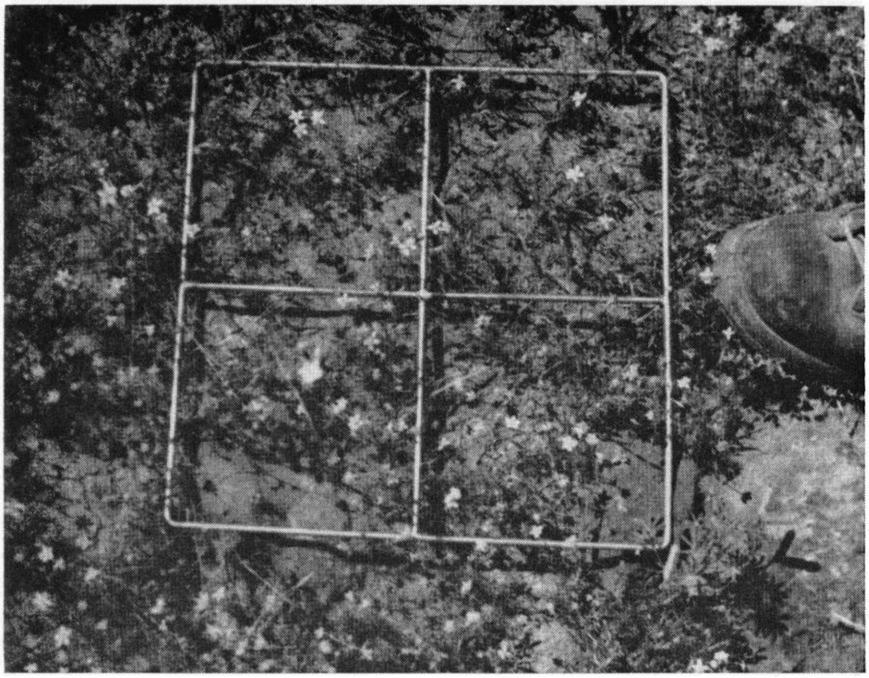

FIGURE 3. The frame is placed by aligning a cross bar with the notch on the toe of the boot. An estimate is made of the total cover of the herbaceous vegetation with the use of the square-foot frame—establishment of a frame point.

Estimates of total ground covered by herbaceous plants are made with the use of a square-foot frame subdivided into four 6-inch squares (Fig. 3). The estimates are made in terms of 10 percent classes (Table 1). Concepts of estimation are standardized among different operators if more than one is sampling and are checked with total cover values using the point-frame. The locations of the square-foot frame readings are incorporated within the sampling designs. Ten frame-points are used with 100 step-points for survey work (Fig. 2). Twenty frame readings are incorporated in the 300 step-point design. Sixteen to twenty frame readings are ordinarily used to sample one treatment in seeding or fertilizer plot work. Exact location of the square-foot frame is determined by aligning one of the subdivision crossbars of the frame with the notch on the toe of the sampler's boot (Fig. 3). This is done at specified step-points according to the sampling design.

For evaluation of a forage stand with respect to a range manipulation practice the sampling is done in terms of the pertinent species. If one is interested in recording data on one or a few key species, only these need be identified, and all others can be put into a general category. This saves much time in species identification, especially in seasons when inflorescences are not present. For the California grassland survey work herbaceous plants are grouped into six categories. They are: desirable and undesirable annual grasses; desirable and undesirable perennial grasses; and desirable and undesirable forbs. Individual species, or in some cases genera, are recorded within each of the categories of grasses and the more important forbs are recorded by species or genera.

Results

Variability resulting from different operators sampling the same area was examined by field trials conducted at three different locations in annual grassland. In Table 2 are presented sampling data of nine different two-man teams sampling an acre area (Location 1). The two-man teams consisted of a sampler and a recorder. Ordinarily, for greatest expediency of time one man samples and records. Mean values and standard deviations for total cover percentages and species composition percentages are given in the table. The results show that the estimates of total ground cover were in close accord with a standard deviation of about 5 percent. The variability among species groups was of such magnitude that it did not change the relative positions of these groups except in cases where the mean values were similar. These data were collected by men who had no previous experience in this

Table 2. Comparison of data of nine different two-man teams sampling the same area. (location 1).

Sampling team	Percent total cover %	Botanical Composition—Percent *Bromus mollis* %	Other annual grasses %	Resident legumes %	*Erodium botrys* %	Other forbs %	Perennial grasses %
1	43	42	9	18	15	15	1
2	31	58	8	13	12	9	—
3	41	37	9	24	16	12	2
4	33	52	4	19	9	15	1
5	43	45	14	19	11	10	1
6	34	41	14	15	8	21	1
7	31	61	8	13	10	7	1
8	43	47	4	17	14	18	—
9	39	39	6	21	13	19	2
x̄	37.5	46.9	8.4	17.7	12.0	14.0	1.0
s	5.3	8.4	3.7	3.7	2.7	4.7	—

Table 3. Comparison of data of three different two-man teams sampling the same area (location 2).

	Botanical Composition—Percent							
Sampling team	Percent total cover %	*Bromus mollis* %	*Festuca* spp. %	Other annual grasses %	Resident legumes %	*Erodium botrys* %	Other forbs %	Perennial grasses %
1	67	24	58	15	—	—	3	—
2	57	22	57	10	2	2	5	2
3	59	17	63	12	—	1	5	2
x̄	61.0	21.0	59.3	12.3	0.7	1.0	4.3	1.3
s	5.3	3.6	3.3	2.6	—	—	1.2	—

type of sampling. In fact, most of the men had not estimated herbaceous cover before that day.

In Table 3 a comparison is made of data of three two-man teams sampling an acre area (Location 2). The standard deviation of estimates of total ground cover was about 5 percent. The standard deviations of composition percentages among the major plant groups ranged from 2.6 to 3.6. Again, in this test the samplers had no previous experience. Table 4 compares the results of three different operators sampling an acre area of annual grassland (Location 3). The sampling was done early in the year so identification of species was impracticable. For this reason the data are grouped into general categories. Again, the standard deviation of the total ground cover estimates was about 5 percent. The magnitude of variation among plant group percentages ranged from 2.6 to 5.5. The relation among plant groups in all of these comparisons was not altered because of different operators sampling the same area of annual range.

In Table 5 a comparison is made between results of sampling an acre area of annual range with 500 points with pins grouped in sets of ten (point-frame method) and three step-point analyses using 100 individual points and 10 estimates of total cover. Both in measurements of total cover and botanical composition the step-point analyses compare favorably with the 500 point sample of the point frame. The only appreciable difference resulting from this comparison of methods is in percent of resident legumes in the stand. Results of the point frame sampling indicate about three percent resident legumes while step-point sampling indicates about seven percent. The magnitude of this difference is negligible compared with differences among forage classes. Only because of the low total percentage of this group in the stand is this discrepancy noteworthy. The average time required to sample the area using the step-point method was 30 minutes. Between three and four hours were required to run the point-frame analysis.

When a more precise determination of botanical composition of the minor elements of the stand is desired, a large number of points is recommended. For instance, in Table 5, a larger number of points would be required to differentiate with precision between three and seven percent composition of resident legumes. However, the relation between resident legumes and other plant groups is established at the lowest sampling level (100 step-points and 10 frame-points).

Most of the authors' experience with step-point sampling has been on annual ranges. Some sampling has been done in the perennial ranges on the north coast of California. In tall, heavy vegetation the method has limitations. It is difficult not to disturb the vegetation to be sampled in these cases and also to determine exactly what plant has been hit by the pin. In chaparral or other areas of dense woody vegetation a sampling design consisting of straight transects is not feasible. In these instances the sampling points are

Table 4. Comparison of data of three different operators sampling the same area (location 3).

	Botanical Composition—Percent				
Sampler	Percent total cover %	Annual grasses %	Forbs %	*Erodium* spp. %	Resident legumes %
1	57	65	28	—	7
2	59	55	26	2	17
3	50	59	31	2	8
x̄	55.3	59.7	28.3	1.3	10.7
s	4.7	5.0	2.6	—	5.5

Table 5. Comparison between the point-frame and step-point methods of sampling.

	Botanical Composition—Percent				
Sampling method	Percent total cover	Annual grasses	*Erodium* spp.	Resident legumes	Other forbs
Point frame	%	%	%	%	%
(500 points)	54.1	63.6	0.7	2.9	32.8
Step-point					
(Means values and standard deviations of three samples of 100 points and 10 density estimates)					
x̄	57.7	62.0	1.3	6.7	30.0
s	0.6	3.0	—	1.6	2.0

usually placed at random among the woody plants.

Summary

The step-point method of sampling consists of procedures for determining total ground cover and percentage cover of the herbaceous species in the stand. Involved in the procedure is the point method using individual points and an estimate method utilizing a square-foot frame. Predetermined sampling designs are used in the sampling procedures.

In comparisons among data of different operators sampling the same acre area standard deviations of total ground cover and botanical composition measurements are of low magnitude. Also data of total ground cover and botanical composition from the step-point method were comparable to that of the point-frame method. The time required to sample an area with the step-point method was about one-sixth to one-eighth as much as required by the point-frame method.

From comparisons presented in this paper and from three years of field experience with the method, it is felt that the degree of accuracy and objectivity are suitable for valid analyses of field plots and are comparable to other methods. Of prime importance is the short time in which areas can be sampled using this method. The latter point in many cases is the factor which will mean success or failure of range experimentation, particularly in respect to long-term continuity of the collection of data.

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