A NEW INSTRUMENT FOR MEASURING GROUND COVER BASED ON THE POINT-HIT TECHNIQUE - THE OPTICAL POINT BAR

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Abstract.--The advantages of the point-hit technique are many, however, the disadvantages of pin based point frames limit the utility of the technique to relatively short vegetation. A new optically based point frame or "bar" was developed to allow use of the technique for measurement of ground cover for any stratum of vegetation. Additional benefits of this new instrument include: faster collection of data, more accurate data (technical deviation and bias have virtually been eliminated), and the ability to collect data from a true vertical position. Results from field trials comparing the two kinds of instrumentation show the advantages of the optical point bar as well as the advantages of the point-hit technique over other methods for measuring ground cover.

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BACKGROUND

The point-hit procedure for measuring ground cover has been used in studies of range vegetation since its 1925 origination in New Zealand. Since that time several papers have been presented evaluating the technique and comparing it to other methodologies used for measuring ground cover (Brun and Box 1963, Cook and Box 1961, Crocker and Tiver 1948, Fisser and Van Dyne 1966, Goodall 1952, Johnston 1957, Warren-Wilson 1959, and Winkworth 1955 among others). The overall finding of these studies indicates that the point-hit procedure is generally superior to other methods, and exhibits several advantages including: 1) relatively precise quantitative determination of cover can be objectively obtained; 2) observations are repeatable among observers; 3) many replicates can be obtained since the method is more rapid than other methods; 4) close examination of most species is possible; 5) a completely random distribution of species is not necessary; and 6) vegetation damage from sampling is minimal.

Despite the superiority of the technique, the instrument (pin frame) used to implement the procedure exhibits several disadvantages. Primary among these is the limitation on height of vegetation which can be measured. Most standard pin frames can only accommodate the lower portions of the herbaceous and shrub strata. Taller vegetation (generally over one meter tall) cannot be measured using a pin frame. Another disadvantage of pin frames involves pin size and concomitant increases in cover estimations due to "side touches" being recorded when only point intercept should be recorded. Warren-Wilson (1963) observed that a contact would be recorded when the center of the needle fell within the area of the leaf plus a border area which was equal in width to the radius of the needle. This error caused by pin thickness became relatively larger as leaf size decreased and was affected by leaf shape. Narrower pins reduced this bias to some degree, however, Winkworth (1955) found that pins less than 1.83-mm diameter were considered impractical for field use because they bend and swayed and were easily damaged. Although use of a pin frame to obtain point samples is relatively rapid (Brun and Box 1963, Johnston 1957) when compared to other methods, proper implementation of the technique still requires considerable time and effort on the part of the observer. In addition, constant kneeling or stooping to properly view the passage of pins through vegetation can quickly become a disadvantage.

INTRODUCTION

An optical solution to the disadvantages of pin frames was first proposed by Goodall (1952) where he indicated that "...pins used in point quadrat work should be as fine as is practicable and that where data for percentage cover only are required an optical apparatus is preferable to a rigid pin,.... An optical method would of course, be essential for use with the tree layer." The only indication in the literature of such an apparatus is the "crosswire sighting tube" developed by Winkworth and Goodall (1962) which requires the alignment of two sets of crosshairs to define the contact point. Despite admitted problems of parallax and eye strain, this crosswire sighting tube is commonly used in Australia, especially for forest canopy measurement (Majer 1985).

Because of the advantages of the point-hit technique and the disadvantages of the point frame, Goodall's crosswire sighting tube idea was taken a step farther and the optical point bar was developed. As exhibited in Figure 1, the instrument replaces the standard pins with ten low power short focus scopes situated 10-cm apart. Very fine (0.001") crosshair wire is situated at a precise location between two lenses within each scope resulting in a parallax free image similar to that seen through a rifle scope, but with a short infinite focus point. The bar on which the ten scopes are mounted can be attached to either a tripod or monopod and used in the same fashion as a regular pin frame.

This new instrument exhibits several advantages over conventional pin frames. These include: 1) the ability to use the instrument in vegetation of any height (the instrument can be set up at a multitude of heights and, if necessary, readings can be facilitated with the aid of a handheld mirror - this includes "shooting" upward to detect "hits" on overstory vegetation); 2) additional precision when sampling canopy cover as the area covered by the crosshairs (approximately 0.2-mm) is significantly smaller than the diameter of a pin; 3) more rapid collection of data (a quick glance identifies a "hit or miss" as compared to careful observation of a pin point passing through vegetation such as a shrub); and 4) the instrument can be easily leveled with the aid of a bubble to provide true vertical orientation over the sampled vegetation regardless of slope.

METHODOLOGY

The theoretical advantages of the optical point bar required confirmation. This confirmation was provided in two ways, one in actual field use and the other in a controlled experiment. A controlled experiment to test the new optical point bar against the old conventional pin frame in various heights and strata of vegetation was not possible as conventional pin frames will not operate in vegetation much above knee height. However, actual field use over two years in a variety of vegetation types revealed that the instrument could indeed function well for

Figure 1.--The optical point bar in use on tall sagebrush.

recording ground cover of vegetation existing within all three strata. For example, point contacts could be obtained for oakbrush communities which in the past have always presented major difficulties for ground cover measurement.

The optical point bar's advantages of increased precision and rapidity of use could, however, be tested with a controlled field trial. This field trial involved use of both the optical point bar and a conventional pin frame used coincidentally along ten transects of ten meters length. Transects were chosen from a vegetation community exhibiting low growth form to facilitate use of the conventional pin frame. Starting at the same initial point, contacts were determined with each instrument at each 10-cm interval along each transect for a total of 100 contacts per transect. Only first hits were recorded (by species, litter, standing dead, bare ground, or rock) and each hit represented one percent cover for the transect. In addition, for comparative purposes, Daubenmire size quadrats were also read at each meter interval along the transect for a total of ten quadrats. Time requirements to complete each transect with each kind of instrument were also recorded.

RESULTS

Results of the field trial are summarized on Table 1. As can be seen from the data the mean live plant ground cover as measured by the optical point bar (22.4%) is slightly lower than that measured by the pin frame (23.3%). This follows Warren-Wilson's (1963) finding that pin diameter tends to increase cover estimates due to the increased size of pins. In addition, the coefficient of variation is significantly lower for the optical point bar (35.85% as opposed to 44.47% for the pin frame) indicating a more narrowly defined estimate of the population mean. This increased precision might be due to a variety of reasons including random sampling error. However, when one looks at the correlation coefficient (0.9478) between recorded contacts of the optical point bar and the conventional pin frame, a significant relationship existed indicating that the same population was being sampled by the two instruments. If the same population was, in fact, being sampled, then differences between sample estimates must be due, at least in part, to differences in sampling precision of the two instruments. Both instruments provided more narrowly defined estimates of the population than did the Daubenmire quadrats which exhibited a coefficient of variation of 67.47%.

The optical point bar's advantage of more rapid collection of data is very apparent from Table 1. An average of 7.2 minutes was required to run each transect (set of 100 points) with the optical point bar as opposed to an average of 12.6 minutes for each transect (set of 100 points) for the conventional pin frame. One could expect that the time required to get to each sample point and set up a transect would be identical for either instrument, however, once ready to sample, the optical point bar can "read" 100 points in a little over one-half the time of the conventional pin frame. By comparison, an experienced biologist can "read" ten Daubenmire quadrats in about the same time (average of 7.1 minutes) as it takes to use the optical point bar (with, however, much less precision and repeatability).

CONCLUSION

Use of the point-hit technique may still exhibit certain difficulties in application, however, general conclusions that emerge are not adverse to the method. "On the contrary," as stated by Goodall (1952), "it remains one of the most trustworthy methods available to the ecologist and one of the most nearly objective." Use of the optical point bar improves the method significantly and mitigates the major deficiency of the conventional pin frame - measurement of tall vegetation.

The point-hit technique and optical point bar exhibit substantial utility to the reclamation society. Precise data facilitating decisions regarding reclamation success and bond release can be gathered more quickly, economically, and accurately.

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Table 1.--Comparative data of different instrumentation for ground cover measurements run on coincidental transects - optical point bar, conventional pin frame, Daubenmire quadrat.

Transect	Instrument	Time for Measurement (mins)	Percent Cover				
			Bare Ground	Litter	Rock	Standing Dead	Total Live Plant Cover
1	Optical	8	79	3	0	3	15
	Pins	13	80	0	0	5	15
	Quadrat	8	77.7	2.95	0	N/A	19.35
2	Optical	6	69	2	0	4	25
	Pins	13	64	14	0	4	18
	Quadrat	8	77.9	6.9	0	N/A	15.2
3	Optical	9	37	22	0	11	30
	Pins	14	26	36	1	1	36
	Quadrat	8	16.8	35.8	0	N/A	47.4
4	Optical	9	38	16	0	11	35
	Pins	13	26	30	0	6	38
	Quadrat	7	36.6	21.3	0	N/A	42.1
5	Optical	6	72	6	0	4	18
	Pins	12	69	10	0	0	21
	Quadrat	6	89.45	5.5	0	N/A	5.05
6	Optical	7	77	3	0	1	19
	Pins	13	69	6	0	0	25
	Quadrat	6	77.25	8.8	0	N/A	13.95
7	Optical	9	61	3	0	9	27
	Pins	13	52	16	0	0	32
	Quadrat	8	61.65	13.7	0	N/A	24.65
8	Optical	6	68	5	0	8	19
	Pins	11	69	16	0	1	14
	Quadrat	7	66.6	21.6	0	N/A	11.8
9	Optical	6	60	1	30	1	8
	Pins	12	65	3	25	1	6
	Quadrat	7	60.3	1.4	26.4	N/A	11.9
10	Optical	6	55	8	6	3	28
	Pins	12	44	12	16	0	28
	Quadrat	6	58.7	14.7	13.2	N/A	13.4
Averages	Optical	7.2	--	--	--	--	22.4*
	Pins	12.6	--	--	--	--	23.3*
	Quadrat	7.1	--	--	--	--	20.48*

*respective standard deviations are: Optical s = 8.030
Pins s = 10.361
Quadrat s = 13.818

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