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## CHARTING QUADRATS WITH A PANTOGRAPH

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The quadrat method of recording changes in the composition of vegetation has been used by the Forest Service in connection with its various grazing investigations for a number of years. The accurate history thus compiled of the changes in plant formations, especially under different conditions of grazing, is invaluable in developing principles of range management. On the Santa Rita Range Reserve, in southern Arizona, eighty chart quadrats are mapped each year and as many more will be established in the near future. It is obvious to those familiar with quadrat charting that the mapping of this number of quadrats involves a great deal of work.

The method of charting heretofore followed is the common one in which straps are used to divide the quadrat into square decimeters, and the vegeta-



FIG. 1. Pantograph used for charting quadrats, folded for carrying.

tion within each decimeter is mapped on a reduced scale by ocular estimate, supplemented by actual measurement. The recognized disadvantages of this method led the writer to experiment with the pantograph as a practical means of avoiding them. Now, the pantograph is commonly considered as adapted for use only when operated upon a drafting table. For mapping vegetation in the field it would seem quite unusable. Nevertheless the experiments showed surprisingly good results. In fact, when mounted upon a suitable frame the pantograph registers the outline of vegetation as accurately as though the work were done on a drafting table. This is not to say that the result of this method of charting is a perfect reproduction of the outlines of vegetation; it is simply an accurate tracing of the outlines which were followed by the operator. The production of accurate charts is largely a matter of acquiring system and skill in guiding a needle around the outlines of plants.

As a result of the experiments with the pantograph the instrument was used in charting most of the established quadrats at the Santa Rita Range Reserve in the fall of 1919. The instrument (fig. 1) used is of wood with arms 40 inches long and set to reduce to  $1/3.75$  which, when applied to a meter quadrat produces a square approximately 10.5 inches on a side. A table 21 inches square, made of three-ply veneer and with demountable legs 10 inches high, was used to support the pantograph, which was mounted on a pivot at one corner. A metal leg 1 inch high with a ball roller, and attached to one arm, supported the instrument and, when the instrument was being used, swung back and forth across the table. The only other modification of the instrument was the substitution of a steel needle 10 inches long for the short needle used in tracing the outline of the figure to be reproduced. The needle not only supported one arm of the pantograph when not in motion but also enabled the outlines of the vegetation to be traced while the instrument remained high enough to be out of contact with the stems of the plants. The form for registering the charts was placed on the table after the instrument was set in position along one edge of the quadrat, and adjusted so as to record properly and then fastened with thumb-tacks.

It requires the services of two persons to chart successfully; one, who should be skilled in charting and familiar with the flora, to trace the outline of the vegetation and call out the proper symbols; the other to record the symbol for each species and to lift the recording pencil from one outline to the next. The equipment can be carried handily by the operators either on foot or on horse. An average day's work as conducted at the Reserve was the charting and describing of fifteen quadrats, although as many as twenty were completed in one day. An average day's work for one man using the hand method is four or five quadrats.

The advantages of charting meter quadrats with the pantograph as compared with the use of straps are:

1. The results are fully as accurate; the pantograph will record as accurately as the skill of the operator in following the outline of plants will permit.

2. The pantograph can be used with entire disregard of the presence of rocks or impenetrable soil—factors very important in using straps.

3. The rank growth of vegetation is even less of an obstacle to accuracy with the pantograph than it is with the strap method, because the foliage can readily be held with one hand while the outline of the plant is traced with the other. Where straps are used the rank foliage is very apt to prevent the straps from lying accurately in position.

4. The work can be done more rapidly with the pantograph and with much less tedium. (Two persons, only *one* of whom need be skilled, can chart fully three times as many quadrats with the pantograph as one skilled person can chart with straps.)

5. The pantograph is especially efficient in locating individual seedlings or one-stemmed plants and in tracing the outline of crowns of low bushes.

The principal disadvantage so far encountered in the use of the pantograph is the fact that the instrument is more cumbersome than the equip-

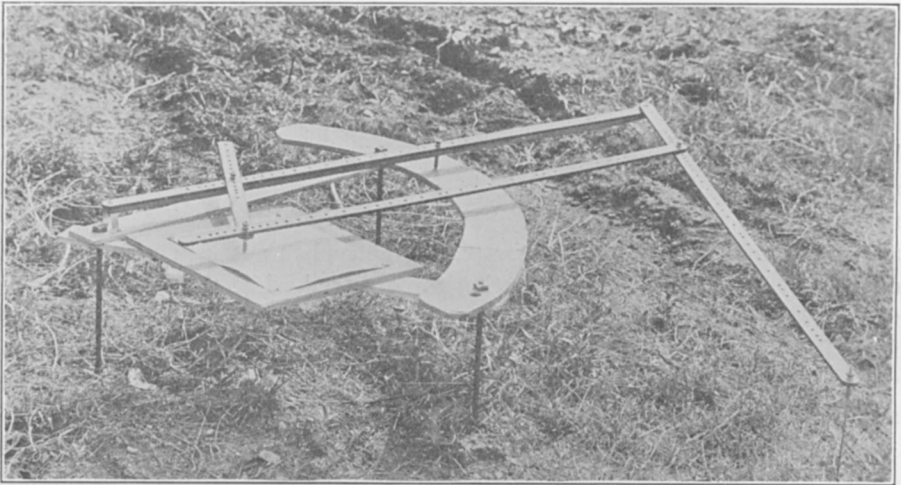


FIG. 2. Pantograph used for charting quadrats, set up ready for use.

ment used with the strap method. This is believed to be offset by the shorter time required to set up the pantograph. Moreover, the perfected instrument should be very easily carried and manipulated. The pantograph can be used on any degree of slope where quadrats are apt to be located; is equally useful whether the vegetation is scattered or dense; or whether it consists of perennials or annuals, and the data can be as readily compiled as the data obtained with the hand method, for in either case standard forms should be used in charting.

Before general use is made of the pantograph in charting, the scale of reduction should be standardized. In future work at the Santa Rita Reserve it is planned to use the scale of 1 to 5. This is a convenient scale for mapping meter quadrats since the reduced base is 2 decimeters square.

The principal improvement which is needed in the instrument is a stand which can be quickly and easily set up; which will be rigid when in use; capable of being folded into compact form and strong enough for field use. The accompanying illustrations (figs. 1 and 2) are of a rough model of a stand designed to embody these qualities. The finished stand will consist of a frame shaped like a sector of a circle, mounted on three legs and supporting a map-holder. The frame will have two arms reaching out from a pivot, on which the pantograph will be mounted, to a curved track where will run the ball-bearing peg used to support the weight of the pantograph and enabling it to be moved smoothly back and forth through an arc of about 90 degrees. The arms will be 25 inches long and two inches wide. The track will be 42 inches long, measured on the outer edge, and 3 inches wide. The map-holder will be 12 inches long and 10 inches wide. The material for these parts will be quarter-inch hardwood reinforced with brass strips. The legs will be of metal; will be bolted onto the frame and made to fold up. The map-holder will be attached to one arm of the frame by means of a bolt which will slide along a slot set diagonally across the under surface of the holder and along a slot of similar length on the arm. This arrangement will allow the holder to be adjusted readily into any position so that the recording pencil will register properly with reference to the position of the quadrat. The record sheets will be held in place by spring clamps. The pantograph will be attached by means of a spring socket on the end of the pivot arm which will fit onto a peg with a ball head. This peg will be an extension of a bolt which will also hold the arms together. By removing this bolt and bringing the arms together toward the track, the stand may be folded quickly and in this position can be carried handily.

It is not presumed that the instrument just described will need no refinements. Continued use of the instrument will doubtless suggest several improvements. The experience already had, however, of charting quadrats with the pantograph has convinced the writer that the method is thoroughly sound and should reduce the burden commonly associated with this phase of ecological work.<sup>1</sup>

<sup>1</sup> It is not known what it will cost to manufacture the charting pantograph but it is believed that the price should not exceed twenty dollars.