TECHNICAL NOTES

Locating Random Points in the Field

F. T. AWBREY

Highlight: A compass and a measuring tape can be used to locate random points in an area of any practical size by employing a pocket calculator to convert rectangular grid coordinates to polar coordinates.

Many ecological techniques depend on random placement of sampling points. Grid coordinates are easily obtained from random number tables but the problem of actually locating the corresponding point in the field has not been satisfactorily solved. Now that rugged pocket calculators with built-in trigonometric functions are widely available, point location has been greatly simplified. Necessary equipment consists of a calculator, preferably with rectangular to polar coordinate conversion function, a measuring tape or other distance measuring device and an angle measuring device such as a transit or sighting compass. A source of uniformly distributed random numbers is also needed.

The method is quite simple to implement. The first step is to lay out a rectangular study area. To do this, choose the location for one corner and designate it as the X-Y intercept. The requirement for this point is that all points within the area must be locatable from it. In very rugged terrain, the size of the study area may have to be limited in order to meet this criterion. Locate the X-axis and measure its length and compass bearing. Then locate the Y-axis by using a compass to find the perpendicular to the X-axis.

Now employ the following algorithm to calculate polar coordinates for each point (Fig. 1). Note that points can fall on the margins, so if the points are used to locate quadrat centers, each side of the actual study area will be longer than its measured length by half the corresponding dimension of a quadrat.

1. Take two independent random numbers (XRN and YRN), each from a uniform distribution between 0 and 1.
2. Establish rectangular position coordinates (XR and YR) of random point P by multiplying each random fraction by respective axis length (X and Y).
3. Convert rectangular coordinates to polar angle (θ) and radial distance (R) from X-Y intercept to P.
4. If necessary, convert polar angle to compass bearing from intercept to P (θ') by subtracting θ from the baseline compass bearing and, if $\theta' < 0°$, adding 360°.
5. If desired, convert θ' to compass bearing from P to intercept (θ_p) by:
   a. If $\theta' \geq 180°$, subtract 180° from θ'.
   b. If $\theta' < 180°$, add 180° to θ'.
6. Repeat 1 through 5 for each point needed.

If the dimensions of the study area are standardized, you can save time and effort in the field by generating all the rectangular coordinate pairs ahead of time. In any case, you should record them for later use in drawing maps and analyzing distribution patterns. Either use the calculator's rectangular to polar conversion feature to convert these rectangular coordinates into the angle (θ) and distance (R) to random point(P)from theX-Y intercept or calculate $\theta = \tan^{-1}$ (YR/XR) and R

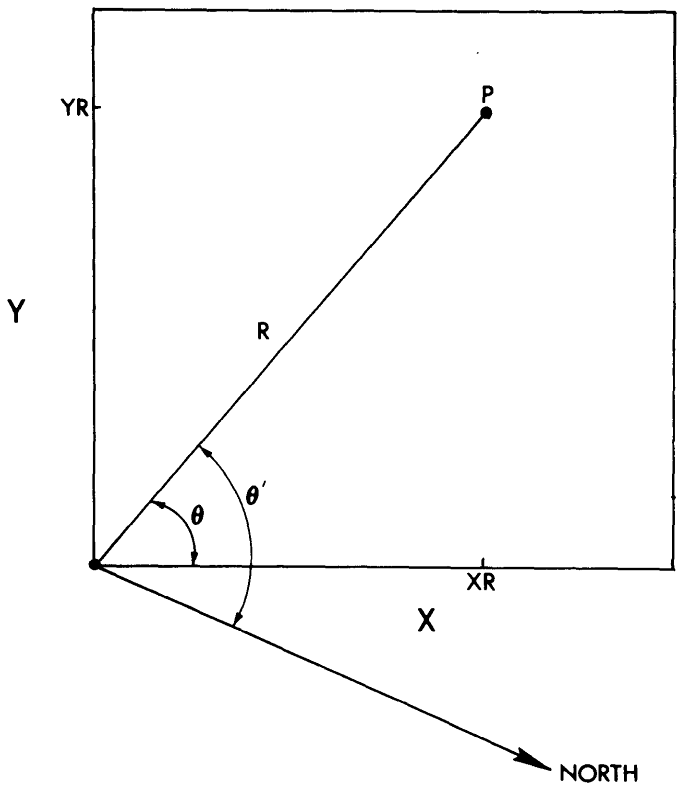

Fig. 1. *Sample layout illustrating location of a random point within a rectangular area. P = random point; X = X-axis; Y = Y-axis; XR = random abcissa; YR = random ordinate; R = polar distance from XY intercept to P; θ = polar angle to P; θ' = compass bearing to P.*

The author is associate professor of biology, Department of Biology, San Diego State University, San Diego, California 92182.

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$= (XR^2 + YR^2)^{1/2}$. If a transit placed at the X-Y intercept is to be used to locate the point within the study area, no more calculation is needed. If a sighting compass is used, however, θ must be converted to a compass bearing (θ' or θ_p) as shown in the algorithm. The cycle can be repeated as often as desired and yields a new point each time.

Actual points in the study area can be located in either of two ways. If an assistant is available, set a transit or sighting compass located at the X-Y intercept to the indicated angle (θ) or compass bearing (θ') and use a measuring tape or range finder to locate the point on the line of sight at distance R. If no assistant is available, attach the measuring tape to a post at the X-Y intercept and use a compass to sight back toward the post from the point. In this case θ_p is the correct compass bearing.

The algorithm is suitable for any trigonometric calculator, but the process can be greatly speeded and simplified by using a programmable calculator. For example, I have designed a program for a popular reverse polish notation pocket calculator which includes two independent random number generators and displays either θ, θ', or θ_p, depending upon where the program is ended. To conserve battery power most programmable calculator users will probably prefer to generate and list coordinates of all points before actually locating them within the area to be sampled.

A word of caution: if using a calculator which has a built-in random number generator, be sure to discard every other number to avoid serial correlation problems.

A distribution of 100 points generated with the programmable calculator program was tested for randomness with a Fortran subroutine which samples the distribution with circular quadrats, calculates the index of dispersion, and counts the number of individuals in each quadrat. The area was set at 10,000 square units, so density was .01/square unit. Fifty randomly placed quadrats of 100 square units each were used to sample the area in each test, and the test was repeated ten times. The index of dispersion (Pielou 1969) with 49 degrees of freedom ranged from 27.0 to 73.9. Two of the index values indicted the points were aggregated, two that they were regularly distributed, and six values indicated no significant deviation from randomness. However, numbers of individuals per quadrat in all ten repetitions fit the Poisson distribution. (χ^2 probabilities ranged from .09 ro .92), Lloyd's index of patchiness (Lloyd 1967), using an ambit of 5.642 units, was 1.0, again indicating that the points are randomly distributed. These results demonstrate unequivocally that this technique meets the requirement for randomness. Details of the subroutines used for this analysis and others for use in collecting, mapping and analyzing field data will be published later.

Literature Cited

Lloyd, M. 1967. Mean crowding. J. Anim. Ecol. 36:1-30.

Pielou, E. C. 1969. An introduction to mathematical ecology. Wiley-Interscience, New York. 286 p.

Rangeland Films

"Rangelands—An American Heritage" and "Rangelands—The Silent Resource" had their premiere showings at the 30th annual meeting of the Society for Range Management in Portland. The films were made possible through the grant to SRM from the Old West Regional Commission. Both films are about 24 minutes in length.

Society members and nonmembers can obtain prints for showing by contacting the film distribution company which is under contract to SRM.

Piccadilly Films
PO Box 17999, Broadway Station
San Antonio, TX 78217
(Tel. 512/824-7478)

Please note that prints are normally available only for use on *one* day. Prints will be mailed by Piccadilly Films 10 days before the date of showing. They must be returned by mail the *day after* the date of showing unless you make a specific request to use the print for a longer period.

The NACD film library will also be provided with five prints of each film for distribution through their film service. In addition, the film libraries in the land grant universities in the five Old West states will have a print of each film available for distribution and classroom use.

"An American Heritage" is intended primarily as an education and information tool for non-agricultural audiences. Audiences of all ages will find this film interesting and informative. The film is narrated by actor Jim Davis and emphasizes the extent, kinds, uses, products, and management requirements of rangelands. SRM members are encouraged to show this film to civic groups, service clubs, church groups, and other similar organizations. The film will also be useful in elementary through university level classrooms.

"Rangelands—An American Heritage" has already been booked for television showing throughout the United States. Society members are encouraged to contact TV stations managers to request that one or both films be shown.

"Rangelands—The Silent Resource" is intended for those audiences at least partly familiar with range management concepts. Yet, the film should serve as an educational tool in all types of classroom situations. Many of the management techniques required to maintain and improve rangeland productivity are shown. The philosophy of livestock producers toward management of range resources is imparted by way of off-camera narration. This film is narrated by Marvin Miller and will be of interest to a broad spectrum of the public.

SRM members in the Old West Region who wish to use a film print for one or a few days should contact their State Range Coordinator or state university film library. There are many prints available through the various outlets mentioned. Early indications are that the demand will exceed the available supply of prints. Accordingly, members are encouraged to schedule film prints as soon as possible for showing several months in advance.

Members desiring to purchase a print should also contact Piccadilly Films. Other inquiries can be directed to Dave Smith, Executive Secretary, at the SRM Denver headquarters.