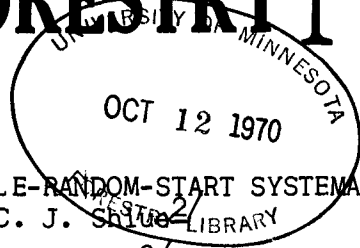


# MINNESOTA FORESTRY NOTES

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## COUNTING DEER PELLET GROUPS WITH A MULTIPLE-RANDOM-START SYSTEMATIC SAMPLE<sup>1/</sup> L. W. Krefting and C. J. Shiue<sup>2/</sup>

The multiple-random-start systematic sampling technique,<sup>3/</sup> now used in forest inventory work, was recently tested for making deer pellet group counts. These tests were made on a 6,000-acre deer yard on the Superior National Forest in northeastern Minnesota and on the Upper Peninsula Experimental Forest, a 11,200-acre tract in Michigan.

The number of circular plots 0.01-acre in size needed to sample each area was determined after consideration was given to the manpower available, the precision of the estimate expected, and the predicted coefficient of variation of the pellet group counts. For example, on the 11,200-acre experimental forest it was felt that 450 plots were needed to obtain an adequate sample. Five random starts were used; so each start had 90 plots. A single plot in each random start represented 124.4 acres (11,200 ÷ 90 = 124.4) or 1,244 square chains.

To obtain 90 systematic plots on the map each time a start was made, an overlay grid with lines at 35 chain (√1244 = 35) intervals was used. A square (35 x 35 chains) was also drawn on the field map and subdivided into 100<sup>4/</sup> smaller units (3.5 x 3.5 chains) and numbered 1 to 100. Units numbered 93, 11, 42, 48 and 36, which were drawn from a table of random numbers, made up the five starts. After the plots were located with the overlay grid for the first start, the grid was shifted each time for the second, third, fourth and fifth starts.

Figure 1 shows the layout for each start and the final layout when the starts were put together. The starts fell into groups, and the groups formed rows designated as courses. Each course and group was given a number. Within each group the plots were designated as A, B, C, D and E. In some instances the groups were incomplete because some plots fell outside the map boundaries. The direction and distance between each plot was determined prior to field work. For example, on the Michigan area, the direction from plot A to B was N 45° E, and the distance was 10 chains. Between groups (E to A) the distance was 18 chains, and the direction was N 50° W. A box compass was used for this work, and the distances between plots were paced.

This new sampling method provides a valid means of determining sampling error which is not afforded by a strictly systematic method of sampling. It gave highly satisfactory results, and was practical from the standpoint of time and ease of application.

<sup>1/</sup> Acknowledgment is made for field assistance provided by the Minnesota Department of Conservation, the U. S. Forest Service (Lake States Forest Experiment Station and Superior National Forest), and W. Leslie Robinette, Bureau of Sport Fisheries and Wildlife, U.S.D.I.

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<sup>3/</sup> Shiue, Cherng-jiann. 1960. Systematic Sampling with Multiple Random Starts. For.Sci.6:42-50.

<sup>4/</sup> Theoretically, the number of units, k, on the selected area on the map should be:

$$k = \frac{m A}{n B}, \text{ where: } A = \text{total acreage to be sampled; } B = \text{size of plot;}$$

m = number of random starts; and n = total number of plots to be taken.

The selected area should be divided into  $\sqrt{k}$  columns and  $\sqrt{k}$  rows. Five pairs of random numbers smaller than  $\sqrt{k}$  should be chosen. Units with corresponding coordinates (column and row positions) to the five pairs of random numbers should be used as the starts. In practice, it is very difficult to lay out so many lines within such a small selected area. For this reason, the method of locating the starts was modified for this study. Actually, the results obtained by either method may not be any different.

The following table shows the number of pellet groups found on the plots for each of the five random starts and the method used for computing the 95% confidence limits.

| Upper Peninsula Experimental Forest |                      |              |                                       | Jonvik Deer Yard     |              |                                       |
|-------------------------------------|----------------------|--------------|---------------------------------------|----------------------|--------------|---------------------------------------|
| Random Start                        | No. of Pellet Groups | No. of Plots | Average No. of Pellet Groups Per Acre | No. of Pellet Groups | No. of Plots | Average No. of Pellet Groups Per Acre |
| A                                   | 64                   | 92           | 69.6                                  | 425                  | 68           | 625.0                                 |
| B                                   | 60                   | 93           | 64.5                                  | 396                  | 68           | 582.4                                 |
| C                                   | 50                   | 89           | 56.2                                  | 301                  | 68           | 442.6                                 |
| D                                   | 70                   | 93           | 75.3                                  | 355                  | 68           | 522.0                                 |
| E                                   | 45                   | 89           | 50.6                                  | 342                  | 68           | 502.9                                 |
| Total                               |                      | 456          | 316.2                                 |                      | 340          | 2,674.9                               |
| Average                             |                      |              | 63.2                                  |                      |              | 535.0                                 |
| 95% confidence limits               |                      |              | $\pm 19.9\%$                          |                      |              | $\pm 16.4\%$                          |

For data from the Experimental Forest.

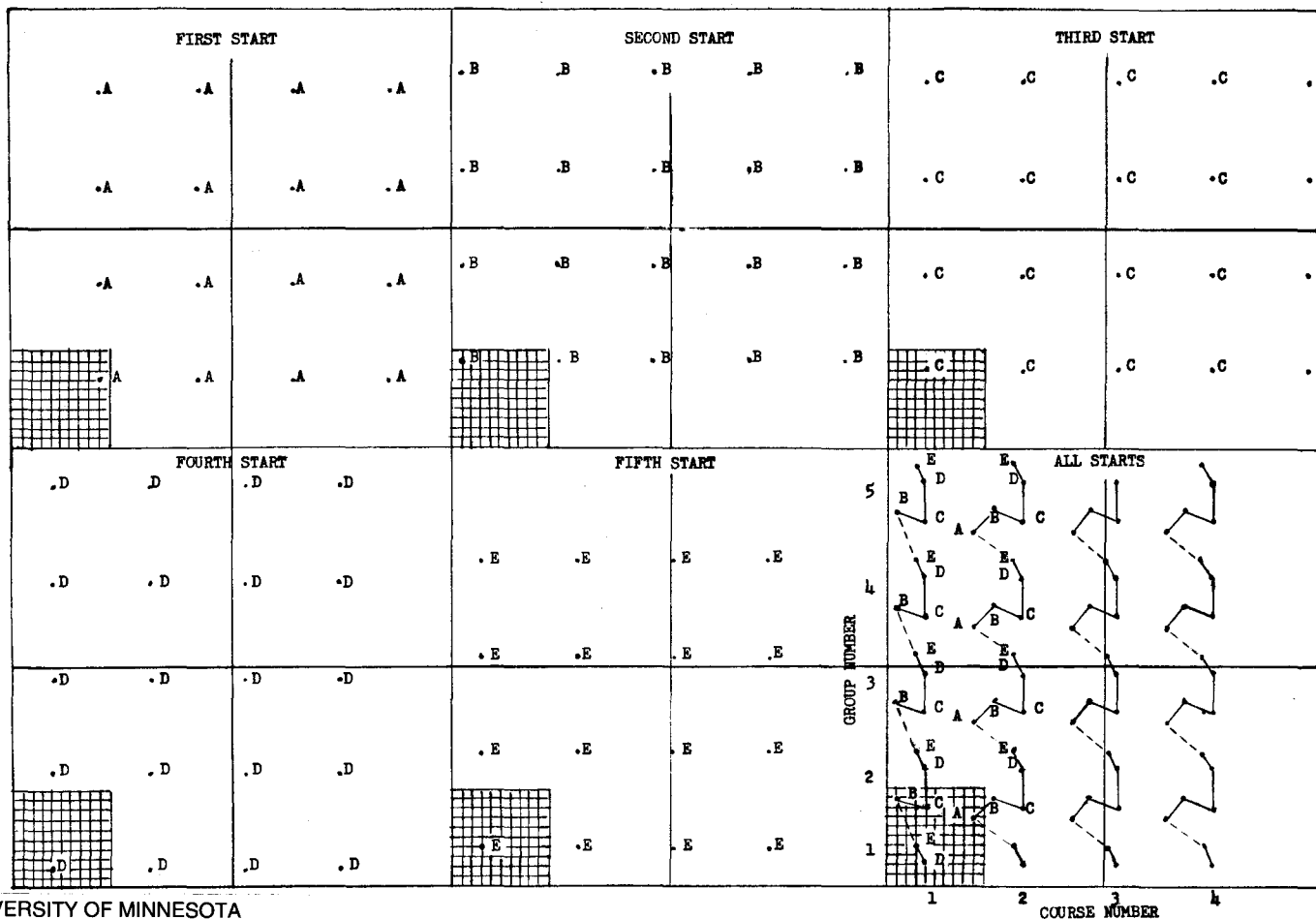
$$\bar{x} = 63.2 \text{ (No. of pellet groups per acre)}$$

$$s_x^2 = (69.6^2 + 64.5^2 + 56.2^2 + 75.3^2 + 50.6^2 - 316.2^2/5)/5(5 - 1) = 19.84$$

$$s_x = \sqrt{19.84} = 4.54$$

$$95\% \text{ confidence limits} = \bar{x} \pm t(.05, df = 4) s_x = 63.2 \pm 2.776 \times 4.54 = 63.2 \pm 12.6$$

The 95% confidence limits will be within 19.9% of the mean value.



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Figure 1. Layout of Multiple Random Starts



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