Plot Spacing in Systematic Sampling

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ABSTRACT—Determination of sample size and calculation of plot spacing in systematic sampling have in the past been accomplished in two steps. This article presents simple equations that explicitly demonstrate the effect of allowable error, level of significance, and plot size on plot spacing in systematic sampling designs.

In many applications of systematic sampling the number of plots to be measured is determined from simple formulas for random sampling. Plot spacing is subsequently determined by calculating the sampling intensity and inserting the result into the traditional spacing formulas (Husch et al. 1972). My objective here is to show explicitly the relationship between plot spacing and the determinants of sample size, level of confidence, plot size, coefficient of variation, allowable error, and size of the unit to be inventoried.

Barton and Stott (1946) published the relationship:

$$n = \frac{At_{\alpha/2}{}^2C^2}{AE^2 + pt_{\alpha/2}{}^2C^2} \quad (1)$$

where n is the number of plots sampled,
A is the area of the tract in square units,
p is plot size in the same units as A,
E is the allowable error in percent,
$t_{\alpha/2}$ is the upper critical value of Student's t-statistic at level of significance α, and
C is the coefficient of variation in percent.

With some relatively simple algebra, Barton and Stott's formulation can be united with the traditional systematic sampling spacing equations. For a systematic square spacing, the relationship between plot spacing, D, and the determinants of sample size is given by the relationship:

$$D = \sqrt{\frac{AE^2}{t^2_{\alpha/2}C^2} + p} \quad (2)$$

For a rectangular systematic grid the relationship between distance between lines, L, and distance between plots along a line B, and the determinants of sample size is:

$$L \times B = \frac{AE^2}{t^2_{\alpha/2}C^2} + p \quad (3)$$

In practice when a sampler selects a rectangular grid, either B or L is specified and the other is solved for.

In a systematic square grid, the relationship between sample size, n, and plot spacing is given by the relationship:

$$n = \frac{A}{D^2} \quad (4)$$

When a rectangular grid is utilized, the relationship between sample size and spacing is given by the relationship:

$$n = \frac{A}{B \times L} \quad (5)$$

where either B or L is specified, the other being determined from equation 3.

The relationship between plot spacing in a square grid and its determinants, A, p, $t_{\alpha/2}$, E, and C is shown in *figure 1*. Plot size influences spacing directly by its

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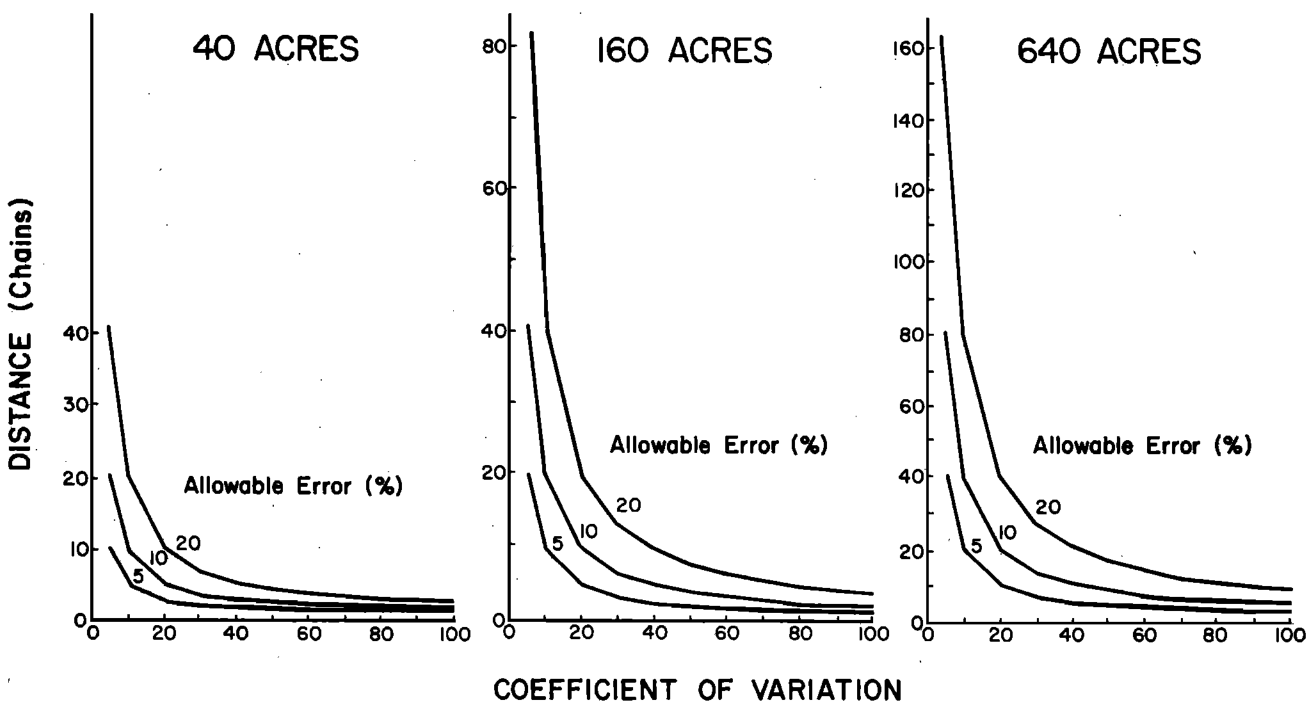

Figure 1. Distance between 0.2-acre plots in a square grid when $t_{\alpha/2}$ = 1.96; the area cruised is 40, 160, or 640 acres; and the allowable error is 5, 10, or 20 percent for coefficents of variation ranging from 0 to 100 percent.

number of parties launching each day. In a study on Oregon's Illinois River (Shelby and Colvin 1981), 79 percent of river runners said they would be willing to have less chance of getting a permit on a weekend day, knowing that when they did get a permit there would be fewer people on the river.

These are, of course, hypothetical questions. Do people still support regulations when it means losing their opportunity to participate? In a study of backpackers in Rocky Mountain National Park, an on-site survey of visitors who had just been denied permits found that 67 percent still felt the permit system was necessary (Fazio and Gilbert 1974). In a similar study of California's San Gorgonio Wilderness, 81 percent of the unsuccessful applicants supported the permit system. People giving reasons for their support were evenly split between protecting the resource and protecting the experience (Stankey 1979).

These studies indicate that users generally support management policies designed to protect the quality of backcountry experiences. When managers decide to limit use, however, allocation becomes an issue. The present study suggests that characteristics of different areas or activities affect user assessments of allocation systems. The presumption is that systems should be tailored to the expected clientele. ■

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inclusion in the spacing equations and indirectly by its influence on the size of the coefficient of variation. As expected, when the coefficient of variation increases the distance between plots decreases, and as the area to be inventoried increases the distance between plots increases when the other determinants on the plot spacing are held constant.

The spacing equations presented provide a method of determining alternative plot spacing when fixed area plots are laid out in a systematic square or rectangular grid. The spacing equations in no way circumvent the theoretical objections that have been raised to the use of systematic sampling. ■

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Mountain Pine Beetle Outbreaks in Rocky Mountain Lodgepole Pine Forests *(from page 413)*

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local fire protection. In addition, common-channel communication, central dispatching, training, aerial detection, and simplified alarm reporting procedures can be improved or added where lacking. The common goal of providing fire protection to people transcends unilateral prerogatives, and necessitates commonality of planning, training, and operations at the local level. The writers believe Texas Forest Service is among the leaders in this endeavor. ■

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