U. S. FOREST SERVICE

RESEARCH NOTE NC-19

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

Folwell Avenue, St. Paul, Minnesota 55101

Shortleaf Pine Seedling Inventory Methods On Broadcast-Seeded Areas In the Missouri Ozarks

The success of broadcast-seeding of shortleaf pine *(Pinus echinata Mill.)* after one or several years can be determined with specified precision by a systematic sampling procedure. Seeding results often are expressed as the total number of seedlings per acre, but good distribution is equally important. The total stocking and the stocked milacre methods described here provide these data.

A single random-start systematic sampling procedure is recommended for both methods, using circular milacre plots (radius 3.72 feet) equally spaced over the entire area. The number of plots needed depends on the precision desired and the estimated variance among samples.

Total Stocking Method

To find total stocking, estimate the number of sample milacres needed per uniform area, count the number of seedlings in each sample milacre, and multiply the average number per milacre by 1,000.

The number of sample milacres per uniform area (one in which treatments, such as seedbed preparation, degree of release, time of seeding, or seed source, are the same over the entire area) is obtained by the following formula:

$$\text{Sample milacres needed per uniform area} = \frac{t^2\, cv^2}{E^2}$$

where t is Student's t, cv is the coefficient of variation in percent, and E is the precision desired in percent.

The coefficient of variation of seedlings per acre for seeding studies in the Missouri Ozarks over the years has averaged 114 percent. To estimate the number of seedlings per acre with a precision of $\pm$ 10 percent (and a probability of being within that figure 2 out of 3 times) the number of milacres needed is: $114^2/10^2 = 130$ milacres, since t is approximately one at this probability. If $\pm$ 5 percent precision is desired, four times as many milacres must be inventoried, or 520 in this case. If some other degree of confidence is desired, use the appropriate value of t in the formula.[1]

Stocked Milacre Method

Obtain the percentage of milacres stocked with at least one seedling. The number of sample milacres needed is computed by the same formula as for total stocking. The coefficient of variation of stocking percentage has been found to be about 50 percent. Thus, the probability is that 2 out of 3 times a precision of $\pm$ 5 percent in the percentage of stocked milacres will be attained if $50^2/5^2$ or 100 milacres are counted.

The percentage of stocked milacres is directly related to the number of seedlings per acre (fig. 1). This can be expressed by the equation $Y = 163 + 0.548\ X^2$, where Y=seedlings per acre and X=stocking percentage.

This equation can be used to estimate the number of seedlings per acre from a stocked plot inventory, or the number of seedlings corresponding to the stocking percentage can be read from figure 1. For example, if an area is found to be 60-percent stocked ($\pm$ 5 percent), then the estimated number of seedlings per acre is 2,135. The actual number of seedlings per acre may range from 1,500 to 2,800. This range is obtained from the lower confidence band at 55-percent stocking and the upper confidence band at 65-percent stocking in figure 1.

---

1 *For a table of t values, see p. 46 of the 5th edition of "Statistical Methods" by G. W. Snedecor. Iowa State College Press, Ames. 1956.*

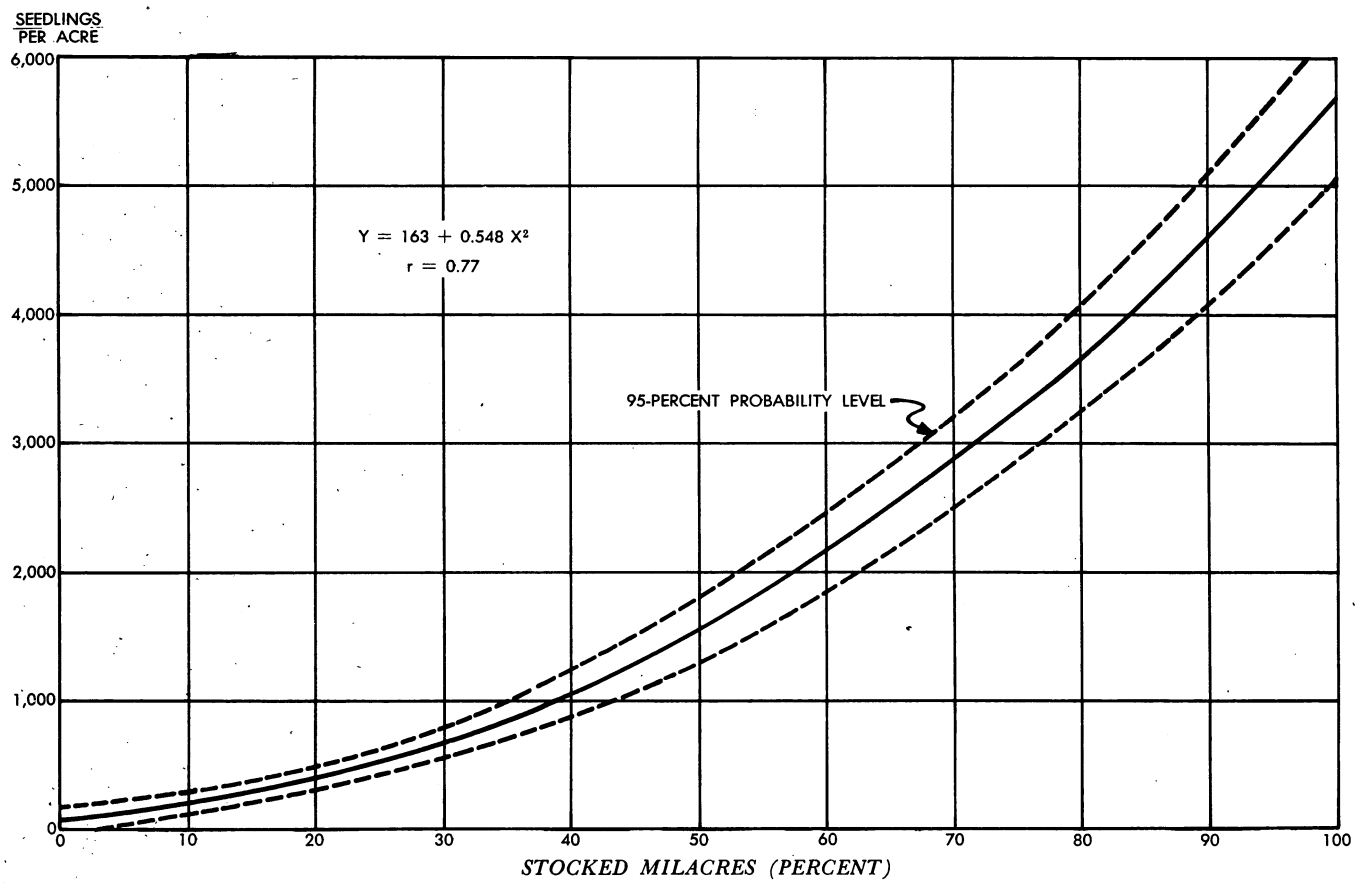

Figure 1.—Relationship between percentage of stocked milacres and number of seedlings per acre. Basis: 163 X and Y values; each value computed from a group of 20 milacre plots.

The size of the area being inventoried has no effect on the number of milacres needed as long as conditions are uniform over the entire area. In a large tract, however, variation in seedling numbers is expected because of differences in degree of release, seedbed preparation, or time of seeding. If known differences exist, divide the area into uniform subunits and inventory each unit separately.

The stocked milacre method is faster than the total stocking method but, for any given number of sample milacres, a more precise estimate of the number of seedlings per acre is obtained by the total stocking method.

KENNETH W. SEIDEL
Associate Silviculturist
NELSON F. ROGERS
Associate Silviculturist

December 1966