

What Per Cent Cruise?

Cruising timber is ordinarily a job of sampling, in which the quantity of timber on a tract is estimated from the quantity on a part of the tract. The difficulty is to determine what part (per cent) of the tract should be sampled to attain a given level of accuracy. This article gives a rule-of-thumb that can be applied with fair reliability to most Southern forests.

Before the rule can be applied, the cruiser must decide how close an estimate is needed. That is, can he accept an error of 5 per cent, 10 per cent, or what? Once the per cent of acceptable error in the results has been decided, the procedure is simple:

- Step 1. Square the acceptable error.
- Step 2. Multiply by the total acreage in the tract.
- Step 3. Add 8,000.
- Step 4. Divide 800,000 by the sum obtained in Step 3.

For example, a cruiser might be willing to accept an error of 10 per cent in cruising a 500-acre tract of low-value hardwoods. His calculations would be:

- Step 1. $10 \times 10 = 100$
- Step 2. $100 \times 500 = 50,000$
- Step 3. $50,000 + 8,000 = 58,000$
- Step 4. $800,000 \div 58,000 = \text{about } 14 \text{ per cent.}$

The rule is designed so that the allowable error of the results will be exceeded, on the average, in only one cruise in twenty. Two-thirds of the time, the actual error will be less than half the chosen limit, and in only one per cent of the cases will it be larger than $5/4$ times the chosen limit.

This means, for example, that the cruiser choosing the 10-per cent limit of acceptable error will come within five per cent of the true volume on two-thirds of his cruises. On 95 per cent of his cruises he will be in error less than 10 per cent, but one time in every 100 he may be off more than $12\frac{1}{2}$ per cent. His average error will thus tend to be lower than the plus or minus 10 per cent at which he is shooting.

In the tabulation below the rule is worked out for a range of tract sizes and allowable errors:

Allowable error (per cent)	Acreage of tract			
	100	500	1,000	2,000
2	100	100	100	50
5	100	39	24	14
10	44	14	7	4
15	26	7	3	2
20	17	4	2	1

When more than 50 per cent of an

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area must be cruised, it is usually more convenient to make a 100-per cent cruise than to take the time to locate plot boundaries. In the table, therefore, cruising intensities above 50 per cent have been rounded up to 100 per cent.

Error of a Completed Cruise

For tracts that may already have been cruised, the rule can be arranged to show how reliable the cruise data are likely to be:

- Step 1. Subtract the per cent of cruise from 100.
- Step 2. Multiply the tract acreage by the per cent of cruise.
- Step 3. Divide the answer from Step 2 into the answer from Step 1.
- Step 4. Multiply by 8,000.
- Step 5. Extract the square root.

The result is a difference between estimated and actual volume (in per cent) that will be exceeded, on the average, only once in twenty times. Two-thirds of the time the actual error will be less than half this percentage.

For a ten per cent cruise of a 200-acre tract, the error (in per cent) would be calculated as follows:

- Step 1. $100 \text{ minus } 10 = 90$
- Step 2. $200 \times 10 = 2,000$
- Step 3. $90 \div 2,000 = 0.045$
- Step 4. $0.045 \times 8,000 = 360$
- Step 5. Square root of $360 = 19 \text{ per cent.}$

Caution!

Many assumptions are involved in the procedures described in this article. Both forms of the rule should be useful as guides, but must not be taken as concrete guarantees of accuracy.

The rule is designed for cruises using $1/5$ -acre plots located at random. It may, however, also be used with plots of some other size, and on systematic cruises made with strips or lines of plots. A well-distributed systematic sample is usually more reliable than a sample taken purely at random. For example, line-plot cruises made with plots $1/4$ -acre or less in size will probably be slightly more accurate than indicated by the rule, provided the distance between the lines is not more than four times the distance between plots along the lines. Lines farther apart than this, or strip cruises, are likely to give a poorer sampling pattern than a random-plot cruise that covers an equal per cent of the tract to be cruised. Consequently, the rule may over-estimate the accuracy of such cruises.

It must also be emphasized that the error referred to in this article is what is commonly called the sampling error. It is the error that arises because the volume per acre on the sample plots or strips may differ from the volume per acre on the rest of the tract. Bias of the cruiser in estimating diameters, heights, taper, cull, and the like is another matter, and cannot be reduced by increasing the per cent of the tract that is sampled.

*In cooperation with Mississippi Agricultural Experiment Station.



Ten per cent cruise? Twenty per cent? This article gives a handy rule for resolving such dilemmas. (U. S. Forest Service photo)