United States Department of Agriculture

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FORESTRY/WOODLAND TECHNICAL NOTE NO. NM 39

SUBJECT: ECS – FOREST INVENTORY SYSTEMS

Effective Date: Effective when received.

Purpose: To distribute information on how to properly perform fixed area and variable radius forest inventories. The attached document will assist the planner in completing the Forest Stand Improvement (666) specifications and job sheet where information is required on current stand conditions and on sites where the zigzag transect inventory method is not appropriate or desired.

Background: This material was written and complied by Greg Shore (NM State Forestry Division, State Timber Management Officer) in 1983 and is one small part of a Forest Inventory and Analysis Manual. NM State Forestry's district staff has been using this manual as a reference for over 20 years. The attached pages will provide very useful material to supplement the National Forestry Handbook and Manual's limited information on fixed and variable area plots in forest sampling. The SF-11 and SF-12 inventory tables (and their associated calculations) in the job sheet for Forest Stand Improvement also are drawn from the Shore manual. For a complete copy of the manual please contact your local NMSF District Office.

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State Resource Conservationist

TECHNICAL NOTE
FOREST INVENTORY SYSTEM

NM Department of Natural Resources
Forestry Division
Forest Inventory Handbook
Greg Shore - 1983

10.3.6 Development of a Forest Inventory System

10.3.6.4.1 Defining the Sample Unit
In forest inventory, sample units are usually field plots of either a fixed or variable are type. Occasionally, both types of plots are used in the same inventory to sample different components of a forest stand, such as sawtimber versus saplings. The advantages and disadvantages of each much be weighed in order to select the most appropriate type. In addition, size and shape of plots are an important consideration when using fixed area sample units.

1. Fixed area plots
    a. Advantages
        i. Useful when sampling small size class trees, such as seedlings and saplings.
        ii. Useful when sampling special products, such as Christmas trees, houselot trees, posts, residue, wildlings, piñon-juniper fuelwood, etc.
        iii. Useful when estimating volume removal from remaining stumps; e.g., in timer trespass cases
        iv. May be faster than variable plot cruising when sampling in very steep terrain, dense stands, or stands with heavy underbrush.
        v. Measures a fixed area and, therefore, has direct and easily understood expansion factors.

    b. Size and shape considerations
        i. Plot shape is generally a matter of personal preference. However, circular plots are most commonly used today since they are easy to install by one or two people, have the least boundary per unit area, and offer the advantage of sharing a common plot center for variable plot cruising. Layout of square or rectangular plots may be more advantageous in very steep terrain or in stands of dense undergrowth or reproduction.
        ii. Selection of plot size is tied to the goal of maximizing sampling efficiency, which is the highest precision commensurate with time or cost constraints; or the minimum time or cost required to attain a specified precision level.
        iii. Since small plots tend to be relatively more variable than large plots, the tradeoff is between installing many small plots or few large plots. The relationship of travel time between plots and plot measurement time are important considerations here.

iv. Since the relationship between plot size and variability differs for each stand, no specific plot size guidelines are available. However the following may serve as general guidelines:
    1. Plot diameter should exceed the average spacing between trees.
    2. Uniform stands tend to have less variation then clumpy stands and therefore can be sampled with smaller plots. For example, second growth stands are usually more homogeneous than old-growth sawtimber stands and can be sampled with smaller plots.
    3. Dense stands can be more efficiently sampled with smaller plots
    4. Larger plots should be used for sampling sawtimber and poletimber trees, and smaller plots used for saplings and seedlings.
    5. More sophisticated methods are available for determining optimal plot size. (See Wiant and Yandle (1980) and Zeide (1980)).

Plot Size (acres)		
Size Class	**Largest**	**Smallest**
Sawtimber	1/4	1/50
Poletimber	1/20	1/100
Saplings	1/50	1/300
Seedlings	1/100	1/1000

v. NOTE: Once a plot size has been selected, it must be used throughout the sample of a particular stand or stand type. Plot size can not be varied from plot to plot.

2. Variable Plot Areas
    a. Advantages
        i. A very simple and fast method of sampling. Personal errors are generally reduced, and production per person increases.
        ii. Plot boundaries do not have to be measured.
        iii. Useful in obtaining a greater sample of large size class trees in relation to smaller, less valuable trees.
        iv. Quick and easy method of estimating basal area and volume without sacrificing accuracy. Depending on circumstances, height and / or diameter may be measured, or neither.
        v. The number of trees to measure and tally is greatly reduced.

    b. Basal Area Factor (BAF)
        i. Basal Area Factors are somewhat analogous to fixed plot size in that selection of a BAF determines the Plot Radius Factor (PRF) for individual trees. Thus, the plot radius of a tree is equal to the PRF times the tree's DBH. Small BAF's have large PRF's (See Appendix D for PRF's and Plot Limits).

ii. Selection of a BAF depends on the general visibility of trees within the stand and on the desired average number of trees to be sampled at each point.
iii. If brush, topography, or the density of trees adversely affect visibility, then a large BAF should be used to avoid overlooking trees. This is especially necessary if trees are very large.
iv. As with optimum fixed plot size, the proper BAF will result in the smallest possible variance for a given amount of time or effort. Too big a BAF may result in too few trees sampled at each point and vice-versa. The following guidelines are recommended:
    1. A BAF that gives an average count of 4 to 8 trees per point per size class is best. Different BAF's may be used to sample different size classes.
    2. make a preliminary estimate of basal area(BA) per acre either ocularly or by sampling a few random plots.
    3. Divide the BA/acre by the desired average number of trees to point.
    4. Round off result to nearest 5 or 10 BAF.
    5. An alternative method for selecting an appropriate BAF is provided by the following table prepared by the USFS, Region 3 Office:

Stand Size Class	Average Stand Diameter	BAF
Very large sawtimber, dense stands	Over 30"	20-40
Normal-size range of sawtimber, varied stocking of stands	16" – 28"	10-30
Pole-size stands	6" – 14"	5-10
Stands with scattered trees	All	5-10

v. NOTE: Once a BAF has been selected, it must be used throughout the sample of a particular stand or stand type. The BAF <u>cannot</u> be varied from point to point.

3. Other Types of Sample Units
    a. Line Transect
    In the Piñon-Juniper Line-Intersect Sampling Method, each 100 foot line transect is considered a sample unit. This is actually a method of variable area sampling since trees are sampled with a probability proportional to crown size (rather than bole size).
    b. Individual Tree
    In any kind of marking cruise for sale preparation in which a certain number or percentage of trees are sampled for volume and / or value estimation, the individual tree is the sample unit.