636.20 General

The National Planning Procedures Handbook, Part 600.23, describes the resource inventory process. The inventory process is used to collect information about the planning area's resources. This information is used to define the problems and opportunities and to formulate and evaluate alternatives.

Parts 636.2 and 636.3 of this handbook provide a detailed description of the common inventory methods and tools used in forestry and agroforestry applications. This part details the various methods used to conduct resource inventories related to the planning process.

Much of the understanding a client acquires about the nature of their resources, on which they may base many of their decisions, comes during the inventory stage. It is essential to work on the land with the decisionmaker that is empowered to make the necessary resource management decisions.

Forests are rarely homogeneous areas. Prior to conducting an inventory, forested areas should be divided into units that are reasonably uniform with respect to the quality of the land, the density of the trees, the species composition of the stand, and the size and age of the trees. Forestland Ecological Site Descriptions can be a valuable source of information to determine these groupings. Refer to the National Forestry Manual, Part 573.3 for a detailed discussion of Forestland Ecological Site Descriptions.

636.21 Forest Stand Inventory

The zigzag transect method of sampling will normally meet the inventory needs relative to conservation planning. However, there may occasionally be a need to employ other common sampling methods.

In addition to the zigzag transect method, three other common forest stand inventory methods are also discussed in this subpart – strip sampling, fixed plot sampling, and variable plot sampling.

The strip sampling and plot sampling methods are based on a percentage system. A limited proportion of the area is measured, on the assumption that the samples are typical of the entire stand. The percentage of the area sampled depends on the uniformity of the stand and the size of the area to be sampled. In uniform stands, typical sampling percentages range from 20 percent on small areas of from 20 to 40 acres to 5 percent on areas larger than 80 acres. In areas where trees are of irregular distribution, the percentage of the area sampled may need to be increased to give adequate results.

Only a brief explanation of the strip sampling and plot sampling methods is given. Foresters should refer to other sources, such as the Society of American Foresters' *Forestry Handbook*, for a detailed description of these inventory methods.

(a) Zigzag Transect Method

A common inventory procedure used by NRCS foresters is the zigzag transect. The zigzag transect is a simple and rapid forest land inventory system that is used to determine

- Average tree diameter
- Range of tree diameters
- Stocking rates (trees per acre)
- Stand composition
- Stand condition (health)

(1) Zigzag Transect Procedures

The following procedures are used to conduct a zigzag transect.

(i) Step 1 – Select Main Stand

The main stand is usually made up of larger trees. There may be more than one general crown level. Beneath the main stand there is usually an understory of suppressed trees, advanced reproduction, or other plants. The client's principal concern should be with the main stand. (see Figure 636-1).

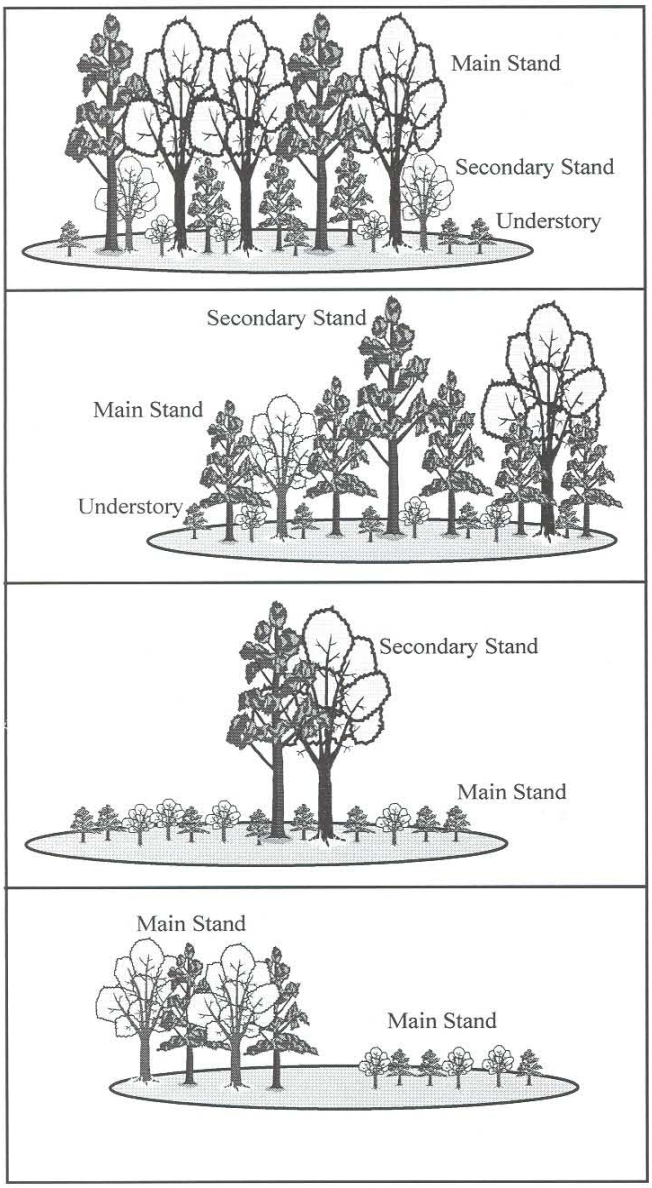
(ii) Step 2 – Choose a Route

Choose a route through the stand so you can sample a good cross section. Generally, this can best be accomplished by crossing the drainageways. On a sunny day you can use the sun as a direction marker by going toward it, away from it, or at some angle to or from it. A visible landmark can also be used as a direction marker.

(iii) Step 3 – Select a Starter Tree

The starter tree may be any tree that is a part of the main stand. No measurements are made of the starter tree. It serves only as a point of beginning.

Figure 636-1 Differentiating Stands



An occasional tree may be borderline between the main stand and the secondary stand. If, in your opinion, the tree offers significant competition to the tree in the main stand, consider it as part of the main stand.

Don't separate large trees as a secondary stand unless they are considerably larger and clearly of an earlier generation than the trees of the main stand.

If the larger trees are numerous, there may be a question as to which is the main stand. In case of doubt, consider the larger trees as the main stand.

A change in the main stand may show need for a field boundary

(iv) Step 4 – Choose a Direction

At the base of the starter tree, face the chosen direction, place your heels together and position your toes to make a 90-degree angle. A line along the direction of travel bisects the angle formed by your feet (see Figure 636-2). A 90-degree arc is printed on some information sticks to help define the angle. When a 25" stick is held horizontally l2" from the eye, the ends of the stick form a 90-degree angle. A compass may also be used.

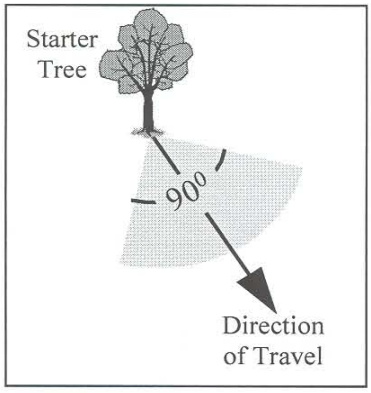
(v) Step 5 – Locate Closest Tree

Locate the closest main stand tree, the center of which is within the 90-degree angle. This is tree #1, as shown in Figure 636-3.

(vi) Step 6 – Determine Distance, Species, and Diameter

Pace or measure the distance from the center of the starter tree to the center of tree # 1. Determine the species of the tree identified in step 5 and measure its diameter at breast height (4.5 feet). Record measurements in the field notes (see Figure 636-5).

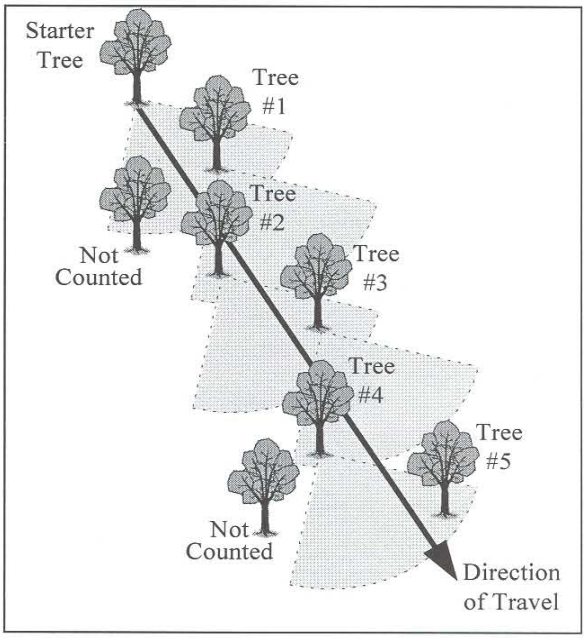
Figure 636-2 Starter Tree



(vii) Step 7 – Rate Tree Condition

Examine the tree and rate its condition as good, fair, or poor. A good tree is reasonably straight, has a sound and full crown, does not have excessive limbs, and does not have evidence of scars, wounds, or disease. A poor tree may have a broken top, a bad crotch, excessive limbs, canker, wounds, scars, disease, or a combination of defects. Use fair as an intermediate rating. Do not confuse species desirability with the condition rating. Rate each tree on its merits, without regard to species.

Figure 636-3 Tree Selection Sequence



Record the condition rating in the field notes as shown in Figure 636-5. Show in the "notes" the reason for rating a tree as fair or poor.

(viii) Step 8 – Repeat Process

Standing at tree # 1, repeat steps 5-7 to select, measure, and rate tree # 2. Continue in this manner until at least 20 trees have been examined. The line of travel will proceed in a zigzag fashion as shown in Figure 636-3.

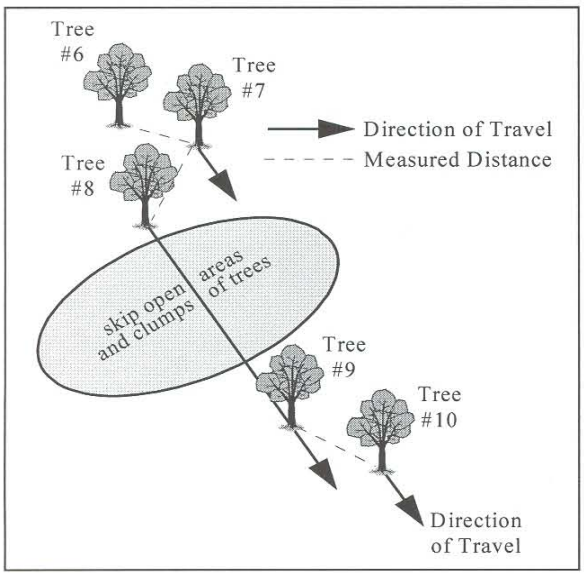
(2) Zigzag Conventions

The following conventions are observed when conducting a zigzag transect.

(i) Clumps and Open Area

Skip over openings and clumps or patches of trees that are not a part of the main stand or are decidedly different in kind or size from the main stand. Do not include spacing measurements or diameter measurements of trees on the edges of openings or clumps. Bypass those trees in the chosen direction of travel and start measurements on the opposite side (see Figure 636-4).

Figure 636-4 Openings and Clumps



(ii) Plantations

In plantations, alternate the direction of travel. Use the direction of the row for the first tree; go at 90^0 to the row for the second; use the direction of the row for the third, and so on.

(iii) Eligible Trees

When two eligible trees are equidistant, select the one closest to the direction of travel. Trees joined at the base are considered separate and individual and both may be counted.

(3) Zigzag Inventory Analysis

(i) Stand Diameter Calculation

Average stand diameter is obtained by dividing the total of diameters by the number of trees sampled. For example: Average diameter = 176 ÷ 20 = 8.8 inches; round to 9 inches.

The range of diameters can be determined by noting the smallest and largest of the trees sampled. (In the example, 6 to 11 inches).

Figure 636-5 Zigzag Transect Field Notes Example

Tree No.	Species	Distance (feet)	Diameter (inches)	Condition	Notes
1	loblolly pine	12	8	good	
2	loblolly pine	9	7	good	
3	loblolly pine	15	10	fair	scar at base
4	loblolly pine	16	11	good	
5	shortleaf pine	14	11	good	
6	shortleaf pine	5	9	good	
7	loblolly pine	13	8	poor	broken top
8	loblolly pine	14	8	good	
9	loblolly pine	9	9	good	
10	loblolly pine	14	6	good	
11	loblolly pine	9	7	fair	cronartium cankers
12	loblolly pine	10	7	good	
13	loblolly pine	11	9	good	
14	shortleaf pine	11	11	good	
15	loblolly pine	11	11	good	
16	loblolly pine	1	8	good	
17	loblolly pine	1	8	good	
18	loblolly pine	9	9	good	
19	loblolly pine	10	8	poor	cronartium cankers
20	shortleaf pine	15	11	good	
TOTALS		238	176		
AVERAGE		11.9	8.8		

(ii) Average Tree Spacing Calculation

Average tree spacing is found by dividing the total of distances by the number of trees sampled. For example: Spacing = 238 ÷ 20 = 11.9 feet; round to 12 feet.

(iii) Trees Per Acre Calculation

The number of trees per acre is calculated as follows:

$$\text{Number of trees per acre} = \frac{43560}{spacing^2}$$

$$\text{For example:} \quad \frac{43560}{12^2} = 303 \text{ trees/acre}$$

(iv) Thinning Determinations

For planning purposes, the D + x "rule of thumb" is adequate to approximate the number of trees that need to be removed from a stand to avoid overcrowding. This rule of thumb is primarily applicable to even-aged stands. According to the D + x rule, the average spacing between trees should equal the average stand diameter (D) plus a constant (x), expressed in feet. The constant x varies, depending on location and tree type. In Southern States, a constant of 6 is most commonly used for southern pines. In Western States, the constant can range from 2 for West Coast Douglas fir, to 4 for ponderosa pine. For stands with average diameters less than 6 inches, constants of 4 in the East and 2 in the West are commonly used. You should consult your local forest specialist to determine the constants applicable to the trees in your locale.

The approximate number of trees to be removed in a D + x thinning is the difference between the number now present and the number that would be present after thinning. For example:

Assume that 6 is the applicable spacing constant for this stand of trees. From the zigzag transect, it is determined that the average tree diameter of the stand is 9 inches, and the average number of trees per acre is calculated to be 303. According the D + x rule, the average trees per acre for 9 inch trees is calculated to be 194, as follows:

D + 6 = 15
$43560/15^2 = 194$

Therefore, approximately 109 trees per acre (303-194) need to be removed to provide adequate spacing.

See Exhibit 636-1 to determine the appropriated number of trees per acres at various D + spacings and tree diameters.

(v) Species Composition Analysis

An approximation of species composition can be made from the zigzag transect. For example: four shortleaf pines were sampled out of 20 trees, indicating 20 percent shortleaf pine and 80 percent loblolly pine as stand composition.

(vi) Stand Condition Analysis

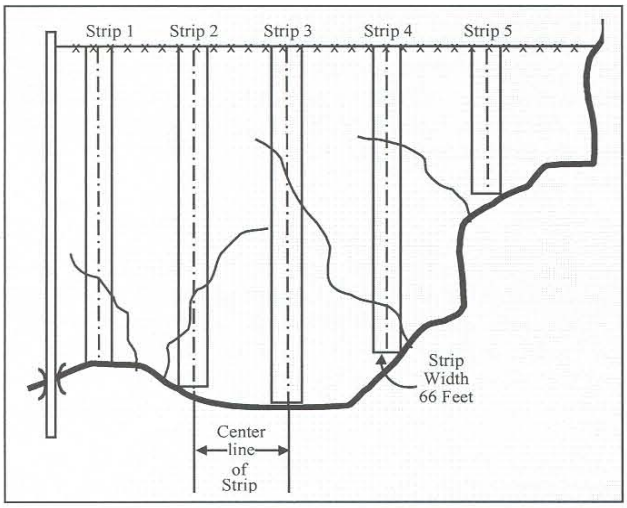
An approximation can be made of the percent of trees in poor condition in the same manner as used to get species composition. The percentage is not as important as making the landowner aware of the condition of the growing stock. The trees in poor condition can be slated for early removal to favor those in better condition.

Transect information can reveal treatment needs and alternatives. Transects need not be taken in every field or at every change in forest condition. Each planning job is different. An experienced planner will need to take fewer transects than a less experienced planner.

(b) Strip Sampling

In strip sampling, the sample units are continuous strips of uniform width, spaced at a predetermined distance apart. The width of the strips and the distance between the centerline of the strips determines the percentage of the area sampled. See Figure 636-6 for an example of a typical 10 percent strip sampling layout.

Figure 636-6 Typical 10 Percent Strip Sampling Layout



(c) Fixed Plot Sampling

In fixed plot sampling, a set of plots, generally all of the same size, is located throughout the area. The sample plots can be located throughout the area in a number of ways. The most common method is to locate the plots at predetermined intervals on lines a set distance apart. Plots can be any shapes but circular plots are most commonly used. The size and number of plots determines the percentage of the area sampled. See Figure 636-7 for an example of a typical 10 percent line-plot layout.

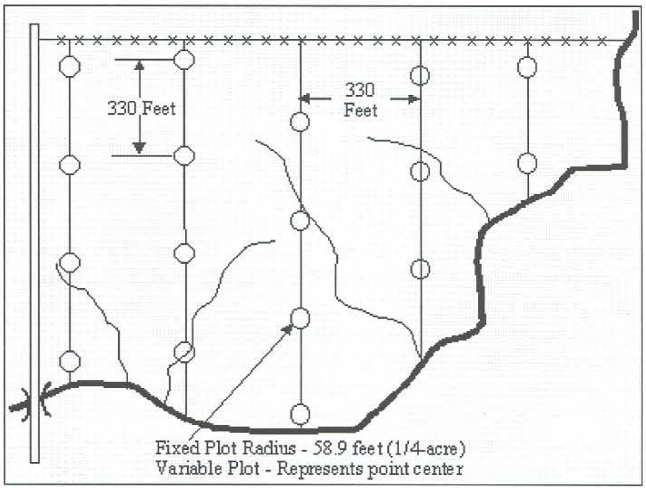
(d) Variable Plot Sampling

Many features of variable plot sampling (sometimes referred to as "point sampling") and fixed plot sampling are similar. The number and location of plot centers are determined in the same manner (see Figure 636-7). Tree measurements (diameter, height, defects, etc.) are also measured or estimated by methods similar to those used in the fixed plot sampling method.

The primary difference in the two sampling methods is that variable plot sampling does not require measurement of the plot radius because each tree has its own plot size dependent on the diameter of the tree. At each plot center, or "sample point," a count is made of the number of "in" trees whose diameter is large enough to subtend the fixed angle of the angle gauge or prism. See Part 636.3 for details on the use of angle gauges and prisms. These "sample points" are analogous to the plot centers used in the fixed plot sampling method.

With variable plot sampling, no tree measurements are required if only basal area is desired. If the number of trees or the volume per unit of area is desired, then the dbh or the height of the "in" trees must be tallied.

Figure 636-7 Typical 10 Percent Line-Plot or Variable Plot Sampling Layout



636.22 Riparian Inventory and Assessment Methods

Reserved for inclusion at a future date.

636.23 Understory Inventory

When an inventory of the production and composition of the understory plant community is needed to adequately plan livestock or wildlife management practices, use the procedures and methods detailed in Chapter 4 of the National Range and Pasture Handbook.