URBAN FHM MANUAL

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FIELD GUIDE LAYOUT

Each section of the field guide corresponds to one of the following sections:

0 General Description
1 Plot level
2 Witness
3 Boundary reference
4 Condition
5 Subplot level
6 Tree level

Each section begins with some general overview of the data elements collected at that level, along with whatever technical background is necessary to prepare the field crews for data collection. Descriptions of most data elements follow, in the following format:

DATA ELEMENT NAME -- <brief variable description>

When collected: <when data element is recorded>
Field width: <X digits or characters>
Tolerance: <range of measurement that is acceptable>
MQO: <measurement quality objective>
Values: <legal values for coded variables>

Field width designates the number of columns (or spaces) needed to properly record the data element.

Tolerances may be stated in +/- terms or a number of classes for ordered categorical data elements (e.g., +/- 2 classes); in absolute terms for some continuous variables (e.g., +/- 0.2 inches); or in terms of percent of the value of the data element (e.g., +/- 10% of the value). For some data elements, no errors are tolerated (e.g., PLOT NUMBER).

MQOs state the percentage of time when the collected data are required to be within tolerance. Percentage of time within tolerance is generally expressed as "at least X percent of the time," meaning that crews are expected to be within tolerance at least X percent of the time.

This guide was written with the primary goal of taking first-time measurements on new plots. However, in some cases we have included some FIA language for remeasurement of plots. ***These instructions are displayed in italics.***

UNITS OF MEASURE:

The field guide will use ENGLISH units as the measurement system.

PLOT DIMENSIONS:

Subplot - for selecting trees with diameter ≥ 1.0 in

Radius = 24.0 ft
Area = 1,809.56 sq. ft or approximately 0.04 ac or approximately 1/24 ac

The distance between subplot centers is 120.0 ft horizontal.

0.0 GENERAL DESCRIPTION

The CORE field plot consists of four subplots approximately 1/24 ac in size with a radius of 24.0 ft. **The center subplot is subplot 1. Subplots 2, 3, and 4 are located 120.0 ft horizontal at azimuths of 360, 120, and 240 degrees, respectively from the center of subplot 1.** See Figure on Datasheet.. Subplots are used to collect data on trees with a diameter (at breast height "DBH") of 1.0 in or greater. Throughout this manual, use of the word 'plot' refers to the entire set of four subplots. "Plot center" is defined as the center of subplot 1.

Data are collected on field plots at the following levels:

Subplot	Data that describe a single subplot of a cluster.
Condition Class	A discrete combination of landscape attributes that describe the environment on all or part of the plot. These attributes include CONDITION STATUS, LAND USE, and OWNERSHIP.
Boundary	An approximate description of the demarcation line between two condition classes that occur on a single subplot. There is no boundary recorded when the demarcation occurs beyond the fixed radius plots.
Tree	Data describing trees with diameter ≥ 1.0 in

0.1 PLOT SETUP

Plots will be established according to the regional guidelines of each FIA program. In cases where an entire subplot cannot be occupied due to safety hazards or lack of access, but some of the other subplots can be occupied, those subplots which can be established should be established and sampled according to normal procedures. In cases where an entire subplot cannot be occupied, no data will be collected from that subplot; instead, the entire subplot should be classified according to the condition preventing occupancy. In cases where only portions of the subplot cannot be accessed due to obstructions, follow Offset Procedures detailed in Section 5.2.

The table provided below can assist in locating subplot 2-4 from a subplot other than subplot 1.

Subplot From	Numbers To	Azimuth	Backsight	Distance
		degrees		*feet*
2	3	150	330	207.8
2	4	210	030	207.8
3	4	270	090	207.8

0.2 PLOT INTEGRITY

Each FIA program is responsible for prohibiting damage to current or prospective sample trees and for specifying how these trees are monumented for remeasurement. The following field procedures are prohibited:

- Scribing and nailing tags on witness trees so that subplot centers can be relocated.
- Boring of trees for age on subplots to determine tree age, site index, stand age, or for other reasons.
- Nailing and tagging of trees on subplots so that these trees can be identified and relocated efficiently and positively at times of remeasurement.
- Nailing, scribing, or painting subplot trees so that the point of diameter measurement can be accurately relocated and remeasured.
- Chopping vines from tally trees. When possible, vines should be pried off trunks to enable accurate measure. If this is not possible, alternative tools (calipers, biltmore sticks) should be used.

1.0 PLOT LEVEL DATA

In general, plot level data apply to the entire plot.

1.1 PLOT NUMBER

Record the identification number for each plot, unique within a county (survey unit in AK).

When collected: All plots
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 0001 to 9999

1.2 PANEL NUMBER

Record Panel Number

When collected: All plots
Field width:
Tolerance:
MQO:
Values:

1.3 CREW NUMBER

Record Crew Number

When collected: All plots
Field width:
Tolerance:
MQO:
Values:

1.4 DATE COMPLETED

Record the year, month, and day that the current plot visit was completed as follows:

1.4.1 YEAR

Record the year that the plot was completed.

When collected: All plots
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: Beginning with 1998, constant for a given year

1.4.2 MONTH

Record the month that the plot was completed.

When collected: All plots
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

January	01	May	05	September	09
February	02	June	06	October	10
March	03	July	07	November	11
April	04	August	08	December	12

1.4.3 DAY

Record the day of the month that the plot was completed.

When collected: All plots
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 01 to 31

1.5 CONTACTS

Record **NAME, ADDRESS, CITY, ZIP CODE, PHONE #** and related **NOTES** for up to 5 contacts

1.6 GPS COORDINATES

Use a global positioning system (GPS) unit to determine the coordinates of all field visited subplot locations.

1.6.1 GPS UNIT SETTINGS, DATUM, and COORDINATE SYSTEM

Consult the GPS unit operating manual or other regional instructions to ensure that the GPS unit internal settings, including Datum and Coordinate system, are correctly configured.

Each FIA unit will determine the Datum to be used in that region. Use the NAD 83 Datum, but coordinates collected using any appropriate datum can be converted back to a national standard for reporting purposes.

Each FIA unit will also determine which coordinate system to use. Regions using a Geographic system will collect coordinates in Degrees, Minutes, and Seconds of Latitude and Longitude; those using the UTM coordinate system will collect UTM Easting, Northing, and Zone. On datsheet, note which coordinate system was used.

1.6.2 LATITUDE

Record the latitude of the plot center to the nearest hundredth second, as determined by GPS.

When collected: When COORDINATE SYSTEM = 1
Field width: 8 digits (DDMMSSSS)
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values:

1.6.3 LONGITUDE

Record the longitude of the plot center, to the nearest hundredth second, as determined by GPS.

When collected: When COORDINATE SYSTEM = 1
Field width: 9 digits: (DDDMMSSSS)
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values:

1.6.4 UTM ZONE

Record a 2-digit and 1 character field UTM ZONE as determined by GPS.

When collected: When COORDINATE SYSTEM = 2
Field width: 3 digits: (##C)
Tolerance: No errors
MQO: At least 99% of the time
Values: 03-19Q and 03-19W

1.6.5 EASTING (X) UTM

Record the Easting coordinate of the plot center as determined by GPS.

When collected: When COORDINATE SYSTEM = 2
Field width: 7 digits
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values:

1.6.6 NORTHING (Y) UTM

Record the Northing coordinate of the plot center as determined by GPS.

When collected: When COORDINATE SYSTEM = 2
Field width: 7 digits
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values:

2.0 WITNESS

3 Witness objects must be identified for each subplot center so that it can be relocated for future remeasurements. Identify objects that are visible when standing at subplot center. Try to use objects that are likely to be present 5 to 15 years from now, e.g. streetsigns, utility poles, structures. Trees can be used but should not be used if there are other alternatives.

2.1 SUBPLOT NUMBER

Record the code corresponding to the number of the subplot. **(Already recorded on datasheet.)**

When collected: All boundaries
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1	Center subplot
2	North subplot
3	Southeast subplot
4	Southwest subplot

2.2 SPECIES/OBJECT

Record the code to specify Witness Object or **TREE NUMBER**, if a tree is being used.

When collected:
Field width:
Tolerance:
MQO:
Values:

C	Corner of House/Building
E	Electric Meter
F	Fire Hydrant
G	Gas Meter
M	Mailbox
P	Fence Post
S	Street Sign
U	Utility Pole
X	Sewer Cover

2.3 DIAMETER

Record diameter @ 1', if using tree for witness

When Collected:
Field width: 4 digits (xxx.y)
Tolerance: *+/- 0.1 in per 20.0 in of diameter on trees with a measured diameter*
MQO: At least 95% of the time. For example: a tree with a diameter of 41.0 in would have a tolerance of plus or minus 0.3 in. (Note: the MQO for point of measurement is +/- 0.2 in when the tree is first measured and within 1 ft of the location established by the previous crew when the tree is remeasured.)
Values: 0001 to 9999

2.4 AZIMUTH

Record the azimuth from the subplot center to the **SPECIES/OBJECT**.

When collected:
Field width: 3 digits
Tolerance: +/- 10 degrees
MQO: At least 90% of the time
Values: 001 to 360

2.5 HORIZONTAL DISTANCE

Record the horizontal distance, to the nearest 1 ft., from the subplot center to the **SPECIES/OBJECT**.

When collected:
Field width: 2 digits
Tolerance: +/- 1 ft
MQO: At least 90% of the time
Values:

3.0 BOUNDARY REFERENCE

Boundary reference data are used to remeasure plots and to compute the area for the condition classes sampled on a plot. Record all boundaries between condition classes that occur within the sampled (fixed-radius) area on subplots. Boundaries outside sampled (fixed-radius) areas are not referenced.

In addition to the recording procedures described herein, sketch maps of condition class boundaries onto the pre-printed plot diagrams on field tally sheets.

3.1 REFERENCE PROCEDURE

Reference, within the sampled area on each subplot the approximate boundary of each condition class that differs from the condition class at a subplot center. Trees selected on these fixed-radius plots are assigned to the actual condition in which they lie regardless of the recorded approximate boundary.

Boundary referencing is done by recording azimuths and distances from subplot center to the reference points (Figures 3-1 and 3-2). Each boundary is marked by a maximum of three points - two where the boundary intersects the subplot circumference, and one "corner" point between the two end points, if necessary. Only the corner point requires a distance, since the distance from the center to the circumference is always equal to the fixed plot radius

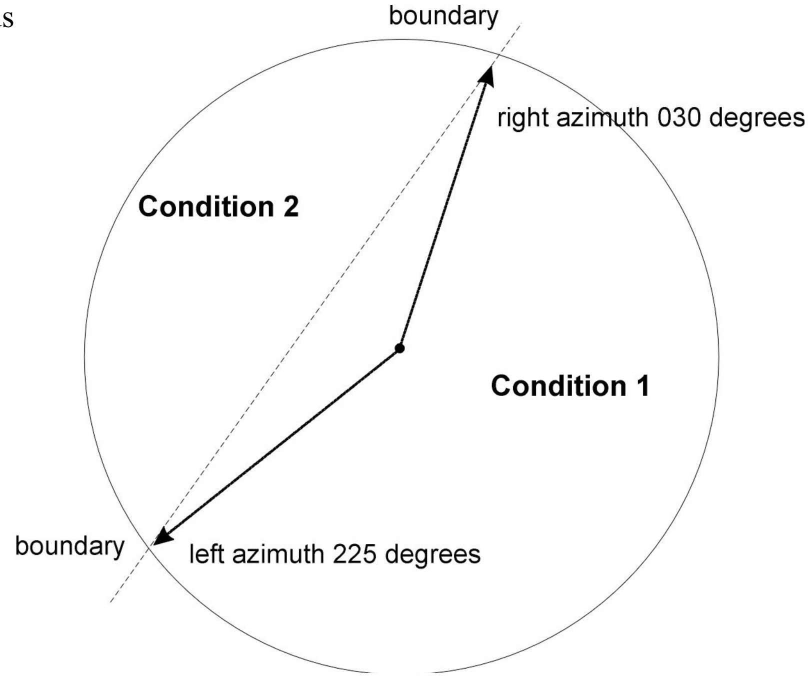


Figure 3-1. How to measure a straight boundary on a subplot.

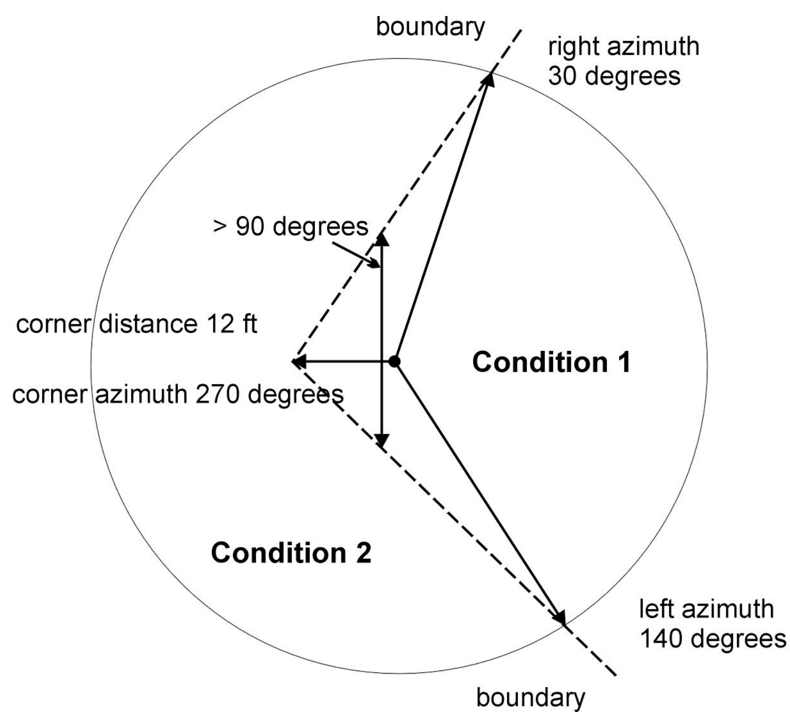


Figure 3-2. How to measure a boundary with a corner on a subplot.

Refer to Section 4.3 for general condition class delineation guidelines. The following additional rules apply when referencing a boundary within a subplot:

1. When a boundary between accessible forest land and nonforest land or between two contrasting accessible forest land condition classes is clearly marked, use that feature to define the boundary. Examples of clear demarcation are a fence line, plowed field edge, sharp ridge line, and water's edge along a stream course, ditch, or canal.

2. When a boundary between forest land and nonforest land is not clearly marked by an obvious feature, the boundary should follow the nonforest side of the stems of the trees at the forest edge.

3. When a boundary between two contrasting forest land condition classes is not clearly marked, map along the stems of the contrasting condition. When the boundary between two contrasting forest land condition classes is separated by a narrow linear inclusion (creek, fire line, narrow meadow, unimproved road), establish the boundary at the far edge, relative to subplot center, of the inclusion.

4. *When a plot is remeasured, the crew will examine the boundaries referenced at last inventory. If no change has occurred, the current crew will retain the boundary data that were recorded at last inventory. If a boundary has changed, or a new boundary is present, or the previous crew made an obvious error, record new or updated boundary data. Delete boundaries that are no longer distinct.*

5. *Although individual MQOs are specified for the azimuths and distances, in practice a crew will be considered 'correct' when the difference in areas as mapped by the original crew and by the QA crew is less than 10% of the subplot. This allows for slight variations in azimuths or distances due to the approximate nature of our mapping procedures.*

3.2 BOUNDARY DATA

Record the appropriate values for each boundary mapped on the subplot as follows:

3.2.1 SUBPLOT NUMBER (Already recorded on datasheet)

Record the code corresponding to the number of the subplot.

When collected: All boundaries
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time

Values:

1	Center subplot
2	North subplot
3	Southeast subplot
4	Southwest subplot

3.2.2 CONTRASTING CONDITION

Record the **CONDITION CLASS NUMBER** of the condition class that contrasts with the condition class located at the subplot center (for boundaries on the subplot), e.g., the condition class present on the other side of the boundary line.

When collected: All boundaries
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 12

3.2.3 LEFT AZIMUTH

Record the azimuth from the subplot to the farthest left point (facing the contrasting condition class) where the boundary intersects the subplot circumference.

When collected: All boundaries
Field width: 3 digits
Tolerance: +/- 10 degrees
MQO: At least 90% of the time
Values: 001 to 360

3.2.4 RIGHT AZIMUTH

Record the azimuth from subplot to the farthest right point (facing the contrasting condition) where the boundary intersects the subplot circumference.

When collected: All boundaries
Field width: 3 digits
Tolerance: +/- 10 degrees
MQO: At least 90% of the time
Values: 001 to 360

3.2.5 CORNER AZIMUTH

Record the azimuth from the subplot to a corner or curve in a boundary. If a boundary is best described by a straight line between the two circumference points, then record 000 for **CORNER AZIMUTH** (000=none).

When collected: All boundaries

Field width: 3 digits
Tolerance: +/- 10 degrees
MQO: At least 90% of the time
Values: 000 to 360

3.2.6 CORNER DISTANCE

Record the horizontal distance, to the nearest 1 ft, from the subplot to a boundary corner point.

When collected: All boundaries when **CORNER AZIMUTH** > 000
Field width: 2 digits
Tolerance: +/- 1 ft
MQO: At least 90% of the time
Values:

microplot	1	to	7 ft
subplot	1	to	24 ft
annular plot	1	to	59 ft

4.0 CONDITION CLASS

The Forest Inventory and Analysis (FIA) plot is cluster of four subplots in a fixed pattern. Subplots are never reconfigured or moved in order to confine them to a single condition class; a plot may straddle more than one condition class. Every plot samples at least one condition class: the condition class present at plot center (the center of subplot 1). Delineation and mapping of condition classes is a major departure from past inventory practices, and is intended to allow flexible post stratification of data for a variety of purposes.

4.1 DETERMINATION OF CONDITION CLASS

4.1.1 Step 1: Delineate the plot area by **CONDITION STATUS**

The first attribute considered when defining a condition class is **CONDITION STATUS**. The area sampled by a plot is assigned into condition classes based upon the following differences in **CONDITION STATUS**:

1. Accessible forest land
2. Nonforest land
3. Noncensus water
4. Census water
5. Denied access area
6. Area too hazardous to visit

4.1.2 Step 2: Further subdivide Accessible Forest Land and Nonforest Land by **LAND USE**:

Any condition class sampled as accessible forest land or nonforest land may be further subdivided, into smaller condition classes if distinct, contrasting land use classes are present because of variation within the sampled area:

1. Agriculture
2. Cemetery
3. Commercial/Ind.
4. Forest
5. Golf Course
6. Institutional
7. Multi Family Residential
8. Park
9. Residential
10. Transportation
11. Utility
12. Vacant
13. Right of Way

4.1.3 Step 3. Further subdivide land use classes by **OWNERSHIP** status:

1. Forest Service
2. Other Federal
3. State and Local Government
4. Private

4.2 CONDITION CLASS ATTRIBUTES

A **CONDITION CLASS NUMBER** and a classification for **CONDITION STATUS**, **LAND USE**, and **OWNERSHIP** is required for every condition class sampled on a plot.

4.2.1 CONDITION CLASS NUMBER (Already recorded on the dataheet)

On a plot, assign and record a unique identifying number for each condition class. At the time of the plot establishment, the condition class at plot center (the center of subplot 1) is designated condition class 1. Other condition classes are assigned numbers sequentially at the time each condition class is delineated. On a plot, each sampled condition class must have a unique number that can change at remeasurement to reflect new conditions on the plot.

When collected: All condition classes
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 12

4.2.2 CONDITION CLASS STATUS

Record the code that describes the status of the condition. Record for all condition classes sampled on a plot. The instructions in Section 2.3 apply when delineating condition classes that differ by **CONDITION CLASS STATUS.**

When collected: All condition classes
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1. Accessible forest land
2. Nonforest land
3. Noncensus water
4. Census water
5. Denied access area
6. Area too hazardous to visit

4.2.3 LAND USE

Record the code for the appropriate land use for the condition status of the condition class:

When collected: All condition classes
Field width: 2 digits
Tolerance:
MQO:
Values:

1. Agriculture
2. Cemetery
3. Commercial/Ind.
4. Forest
5. Golf Course
6. Institutional
7. Multi Family Residential
8. Park
9. Residential
10. Transportation
11. Utility
12. Vacant
13. Right of Way

4.2.4 OWNERSHIP

Record the **OWNERSHIP** code identifying the ownership (or the managing Agency for public lands) of the land in the condition class. Conditions will be delineated based on changes in **OWNERSHIP** only; separate conditions due to changes in **OWNERSHIP** are recognized only where differences can be clearly identified on the ground when visiting the plot.

When collected: All condition status classes classes (**CONDITION STATUS** = 1-6)
Field width: 2 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

10	Forest Service
20	Other Federal
30	State and Local Government
40	Private

4.3 DELINEATING CONDITION CLASSES DIFFERING IN CONDITION STATUS:

The first step in delineating condition classes is to recognize differences in CONDITION STATUS. The most common difference is adjacent accessible forest land and nonforest land. Adjacent accessible forest land and nonforest land condition classes are recognized only if each of the two prospective condition classes is at least 1.0 ac in size, and each is at least 120.0 ft in width. These size and width minimums apply to both accessible forest land and nonforest land.

Within an accessible forest land condition class, unimproved roads, rock outcrops, and natural nonforest openings less than 1.0 ac in size and less than 120.0 ft in width are considered forest land and are not delineated and classified as a separate nonforest condition class.

Within a nonforest land condition class, forested areas or linear strips of trees less than 1.0 ac in size and less than 120.0 ft in width are considered part of the nonforest condition class.

Five exceptions to these size and width requirements apply:

1. Developed nonforest condition: human-caused nonforest land condition classes such as homes or cabins that are less than 1.0 ac in size and 120.0 ft in width and are surrounded by forest land. All extensions from developed nonforest inclusions are nonforest condition classes regardless of length or width. There are three kinds of developed nonforest conditions that do not have to meet area or width requirements.

a) Improved roads: paved roads, gravel roads, or improved dirt roads regularly maintained for long-term continuing use. Unimproved traces and roads created for skidding logs are not considered improved roads

b) Maintained rights-of-way: corridors created for railroads, power lines, gas lines, and canals that are periodically treated to limit the establishment and growth of trees and shrubs.

c) Developments: structures and the maintained area next to a structure, all less than 1.0 ac in size and surrounded by forest land. Examples of developments are houses or trailers on very small lots, communication installations in a small cleared area within forest land, and barns and sheds.

2. Distinct, alternating strips of forest and nonforest land: this situation occurs when a plot or subplot samples a condition class that is less than 1.0 ac in size and less than 120.0 ft in width. The condition class is one of a series of parallel strips of forest and nonforest land in which none of the strips meet the minimum width requirement.

   For many small intermingled strips, determine the total area that the alternating strips occupy, and classify according to the **CONDITION STATUS** (forest land or nonforest land) that occupies the greater area. If the area of alternating strips is so large or indistinct as to make a total area determination impractical, then classify the sample as forest land.

   For two alternating strips of forest and nonforest between two qualifying areas of nonforest land and forest land, see Figure 4-1. Any subplot that falls in the alternating strips uses the rule. Any subplot that falls in assigned nonforest / forest is assigned that type.

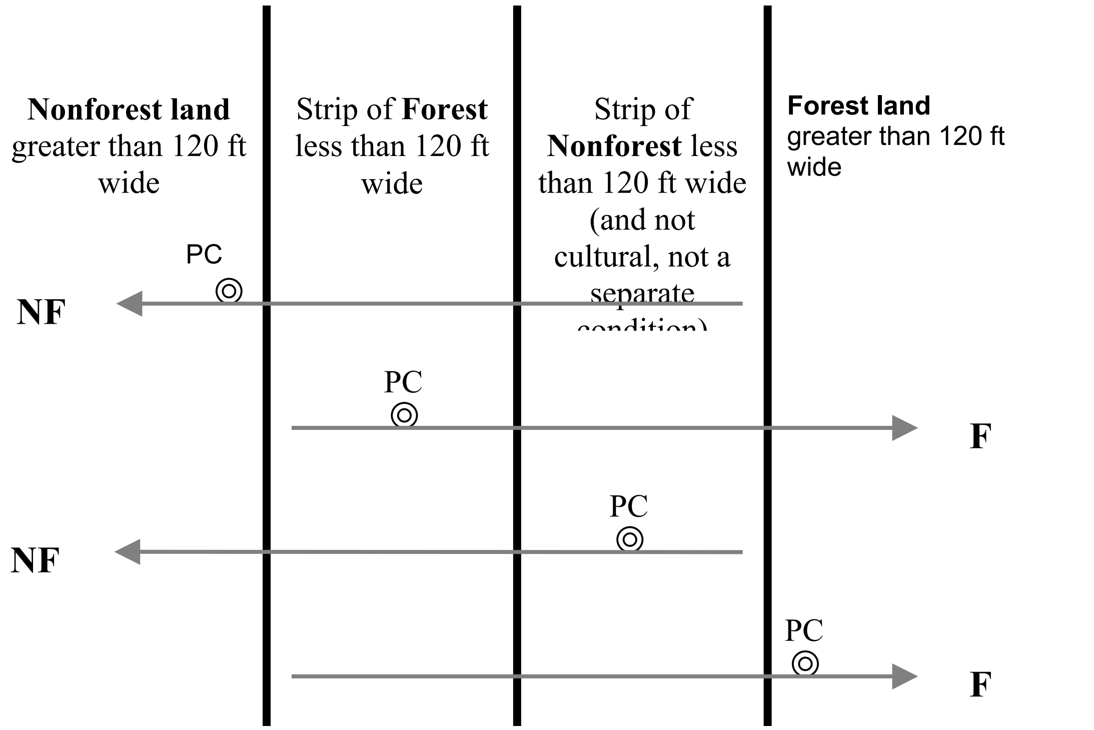


Figure 4-1. Example of alternating strips of forested and nonforested conditions.

3. The 120 foot minimum width for delineation does not apply when a corner angle is 90 degrees or greater (Figure 4-2).

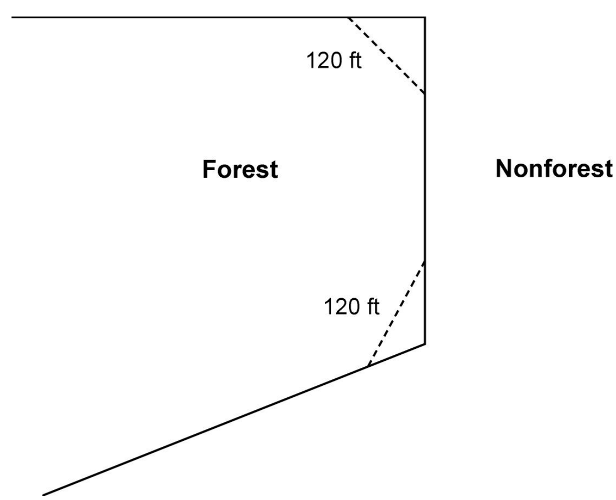


Figure 4-2. Illustration of the 90 degree corner rule. The dotted lines do not create nonforest conditions.

4. Linear water features: natural water features that are linear in shape such as streams and rivers. A linear water feature must meet the definition for Census or noncensus water to be nonforest area. Therefore, a linear water feature must be at least 30.0 ft wide and cover at least 1.0 ac. The width of a linear water feature is measured across its channel between points on either side up to which water prevents the establishment and survival of trees. To determine whether a linear water feature qualifies as nonforest, rely on all available information on hand such as aerial photos, topographic maps, past survey land calls, and ocular estimates at the current survey visit. Linear water features which do not meet the definition for Census or noncensus water should be classified as forest land only if bounded by forest land on both shores. Crews are NOT expected to measure the length of a linear water feature to determine if it meets the 1.0 ac requirement; use professional judgment and common sense on any linear water feature.

5. Hazardous or denied access conditions within accessible forest land are delineated, regardless of size, as a separate condition.

CONDITION STATUS DEFINITIONS:

4.3.1 ACCESSIBLE FOREST LAND

Land that is within the population of interest, is accessible, is on a subplot that can be occupied at subplot center, can safely be visited, and meets at least one of the two following criteria:

(a) the condition is at least 10-percent stocked by trees of any size (Appendix 1) or has been at least 10-percent stocked in the past. Additionally, the condition is not subject to nonforest use(s) that prevent normal tree regeneration and succession such as regular mowing, intensive grazing, or recreation activities;

or

(b) in several western woodland types where stocking cannot be determined, and the condition has at least 5 percent crown cover by trees of any size, or has had at least 5 percent cover in the past. Additionally, the condition is not subject to nonforest use that prevents normal regeneration and succession such as regular mowing, chaining, or recreation activities.

To qualify as forest land, the prospective condition must be at least 1.0 ac in size and 120.0 ft wide measured stem-to-stem. Forested strips must be 120.0 ft wide for a continuous length of at least 363.0 ft in order to meet the acre threshold. Forested strips that do not meet these requirements are classified as part of the adjacent nonforest land.

Transition zones and forest/nonforest encroachment. When an accessible forest land condition encroaches into a nonforest condition, the border between forest and nonforest is often a gradual change in tree cover or stocking with no clear and abrupt boundary. In addition, it may be difficult to determine exactly where the forested area meets the minimum stocking criteria and where it does not. For these cases, determine where the land clearly meets the 10% minimum forest land stocking, and where it clearly is less than required stocking; divide the zone between these points in half, and determine the side of the zone on which the subplot center is located. Classify the condition class of the subplot based on this line (Figure 4-3).

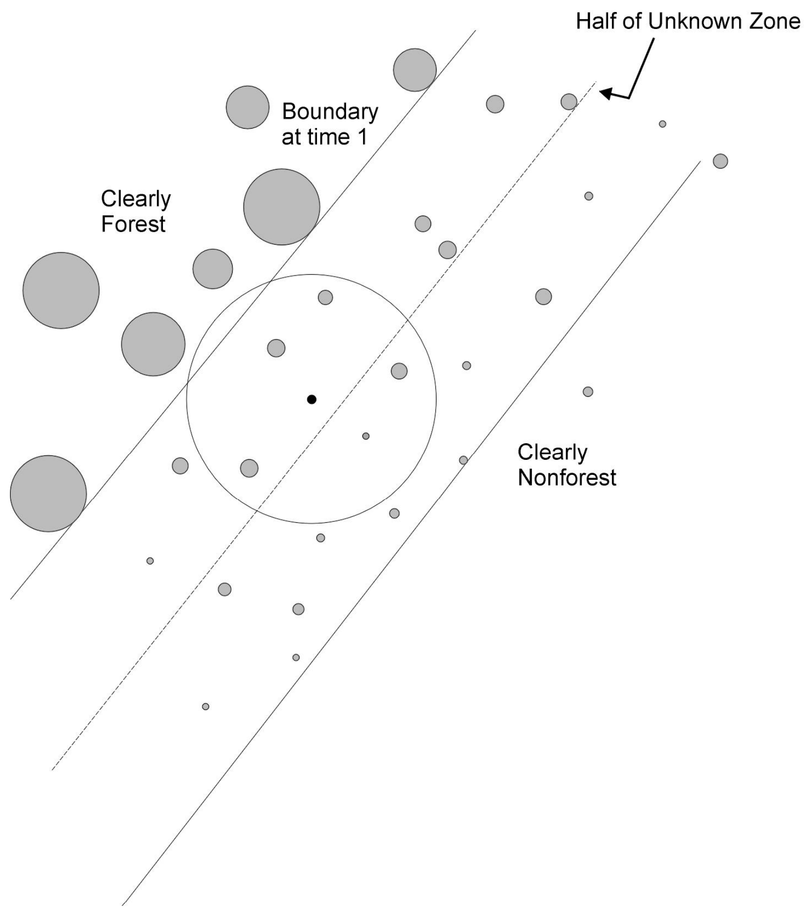


Figure 4-3. Example of classifying the condition class of subplot in a transition zone with forest/nonforest encroachment.

For example, at measurement time 1, a clear and distinct boundary existed between the forest and nonforest condition classes. At time 2, however, there now exists a zone of regeneration or small diameter trees between the previous forest condition and where the nonforest clearly remains. If the zone of encroachment is clearly stocked where it meets the nonforest, classify the entire zone as forest. If the zone is clearly nonforest up to the original stand, call it all nonforest. If the encroachment or transition zone is not clearly stocked where it meets the nonforest, determine where it is clearly stocked (forest) and where it is clearly not stocked (nonforest); divide this zone in half, and classify the entire subplot based on which side of the line the subplot center falls.

Treated strips – Occasionally, crews will come across plantations of trees, in which rows of trees alternate with strips of vegetation that have been bulldozed, mowed, tilled, treated with herbicide, or crushed. Because these strip treatments are conducted to optimize growth or to release the stand, the areas are considered forest land, and the treatment is considered a timber stand improvement operation. Do not confuse these practices with similar treatments on nonforest lands such as yards or rights-of-way. Contact with the land owner may help determine the intent of a treatment.

<u>Indistinct boundary due to the condition minimum-width definition</u>: Do not subdivide subplots where a condition class may change due only to the forest vs. nonforest minimum width (120.0 ft) definition. Although the point where the definition changes from forest to nonforest creates an invisible "line" between conditions, **this definitional boundary is not distinct and obvious**. See Figures 4-4 and 4-5. Where the point of the definition change occurs on the subplot, determine only if the subplot center is on the forest or nonforest side of that approximate boundary, and classify the entire subplot based on the condition of the subplot center. If the boundary crosses through the center of the subplot, classify the subplot as the condition it most resembles. If the boundary occurs between subplots, classify each subplot based on its relation to the definitional boundary.

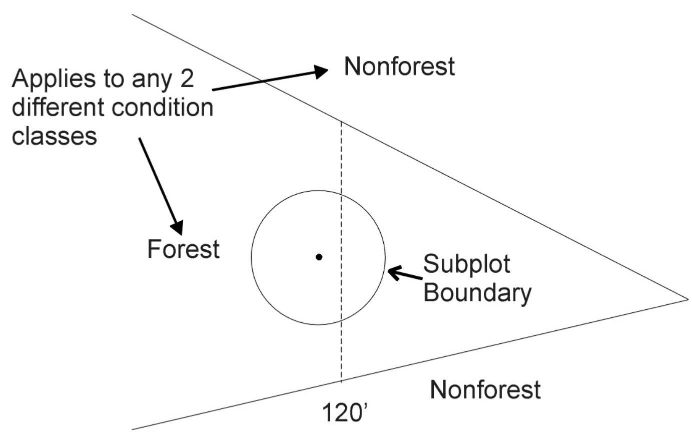


Figure 4-4. Forest condition narrows within a nonforest condition. Examine the location of the subplot center in reference to the approximate line where the forest narrows to 120 ft wide. In this example, the entire subplot is classified as forest.

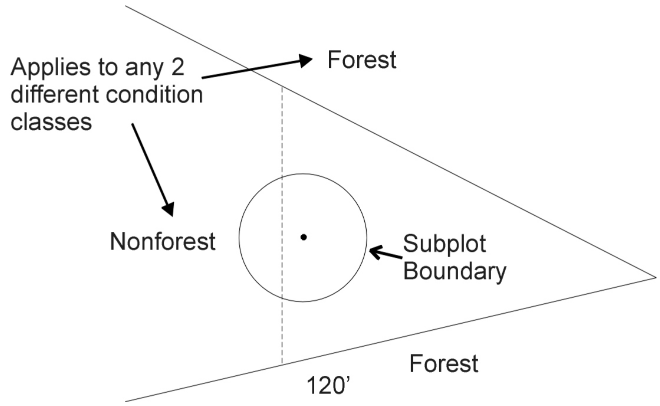


Figure 4-5. Nonforest condition narrows within a forest condition. Examine the location of the subplot center in reference to the approximate line where the nonforest narrows to 120 ft wide. In this

4.3.2 NONFOREST LAND

Nonforest land is any land within the sample that does not meet the definition of accessible forest land or any of the **CONDITION STATUS** values defined in Sections 4.3.3 through 4.3.7.

4.3.3 NONCENSUS WATER

Lakes, reservoirs, ponds, and similar bodies of water 1.0 ac to 4.5 ac in size. Rivers, streams, canals, etc., 30.0 ft to 200 ft wide.

4.3.4 CENSUS WATER

Lakes, reservoirs, ponds, and similar bodies of water 4.5 ac in size and larger; and rivers, streams, canals, etc., more than 200 ft wide (1990 U.S. Census definition).

4.3.5 DENIED ACCESS

Any area within the sampled area on a plot on which access is denied by the legal owner of the land the plot falls on, or by an owner of the only reasonable route to the plot. There are no minimum area or width requirements for a condition class delineated by denied access. Because a denied-access condition can become accessible in the future, it remains in the sample and is re-examined at the next occasion to determine if access is available.

4.3.6 HAZARDOUS

Any area within the sampled area on plot that cannot be accessed because of a hazard or danger, for example cliffs, quarries, strip mines, illegal plantations, temporary high water, etc. Although the hazard is not likely to change over time, a hazardous condition remains in the sample and is re-examined at the next occasion to determine if the hazard is still present. There are no minimum size or width requirements for a condition class delineated by a hazardous condition.

5.0 SUBPLOT INFORMATION

Each subplot is described by a series of area parameters relating to topographic features and existing cover type. If access (permission) to the subplot is denied, do not collect and record data on the subplot except for **SUBPLOT NUMBER** and **SUBPLOT CENTER CONDITION.**

ALL SUBPLOT LEVEL DATA IS TO BE COLLECTED ON ACCESSIBLE FOREST LAND AND NONFOREST LAND (CONDITION STATUS CLASSES 1 AND 2)

5.1 SUBPLOT NUMBER (Already recorded on datasheet.)

Record the code corresponding to the number of the subplot.

When Collected: All subplots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1	Center subplot
2	North subplot
3	Southeast subplot
4	Southwest subplot

5.2 OFFSET POINT PROCEDURES

Because subplot locations are fixed and cannot be moved or rotated, the subplot center may fall in the middle of a tree, stream, building, or some other obstruction. Since it is impossible to occupy the point under these circumstances, distances and azimuths to boundaries and trees cannot be measured. Instead, four points can be established on the subplot perimeter, offset 24.0 ft (7.32 m) in the four cardinal directions from the subplot center. These serve as reference points for tree selection, instead of the subplot center.

Procedure

When a subplot cannot be established because of an obstruction, any one of four subplot offset points can be used to reference boundaries or trees. That is, all distances and azimuths that would normally be taken from a subplot center are instead taken from one or more subplot offset points. Subplot offset points are located on the perimeter of the subplot in one of the four cardinal directions (360, 090, 180, and 270°) from the subplot center (Figure 5-1). **(Ignore microplot in figure.)**

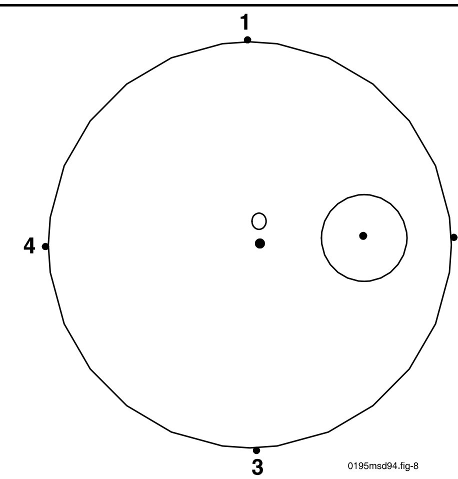


Figure 5-1. location of four subplot offset points.

5.2.1 OFFSET POINT

Record appropriate code for the offset point for each subplot, if needed.

When Collected: All subplots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

Code	Definition
0	Normal position (subplot center)
1	North offset point
2	East offset point
3	South offset point
4	West offset point

Obstructions that necessitate the use of offset points can also make travel to and around the plot difficult. The following illustrations provide information that facilitate plot establishment and measurement in such cases.

Case 1: An obstruction occurs at the center of Subplot 1.

If an obstruction prevents access to the center of Subplot 1, then stop at or before the obstruction, offset 24.0 ft (7.32 m) in one of the cardinal directions (360, 090, 180, or 270°), and complete the course to arrive at one of the offset points. For example, say the course to plot center is 375 ft

(114 m) at 34°, the obstruction extends 17 ft (5.2 m) from plot center, and the most convenient offset point is #3. Stop at 358.0 ft (109.1 m), proceed 24.0 ft (7.32 m) at 180°, and then go 17.0 ft (5.2 m) at 34°. This will position you at Offset Point 3 (Figure 5-2).

If Subplot 1 cannot be occupied, Subplot centers 2, 3, and 4 must be found by starting from one of Subplot 1's offset points. Travel 120.0 ft (36.6 m) in the prescribed direction (360, 120, or 240°) to arrive at the same offset point at the next subplot 1. Then measure 24.0 ft (7.32 m) back to subplot center.

Case 2: An obstruction hinders travel from Subplot 1 to Subplots 2, 3, and 4.

If an obstruction occurs at the center of Subplot 1 or between Subplot 1 and Subplots 2, 3, or 4, then Subplots 2-4 can be reached from each other (e.g., travel from Point 2 to Point 3) (Figure 5-3). The azimuths and distances between subplots are given in Table 5-1. If the direction is reversed from what is shown in the Table 5-1 (e.g., subplot 3 to subplot 2), then use the backsight for the azimuth.

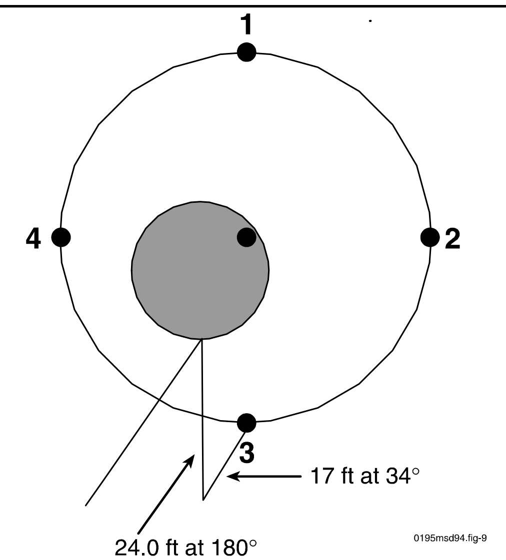


Figure 5-2. Locating offset point#3.

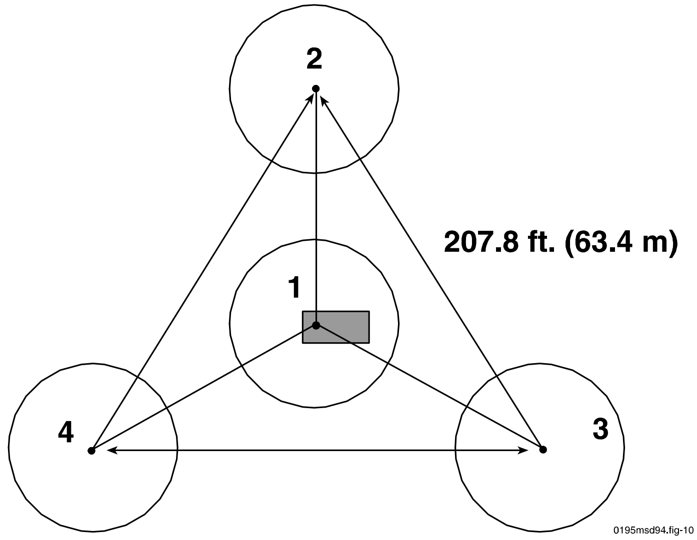


Figure 5-3. Locating other subplot centers.

Table 5-1 Distances and Azimuths Between Subplots 2-4

Subplot Numbers		Azimuth	Backsight	----Distance---	
From	To	----------degrees-----------		feet	meters
2	3	150	330	207.8	63.4
2	4	210	030	207.8	63.4
3	4	270	090	207.8	63.4

Case 3: An obstruction occurs at the center of Subplot 2, 3, or 4.

This situation is handled the same as Case 1. Stop at or before the obstruction, proceed 24.0 ft (7.32 m) in one of the cardinal directions, and then finish chaining to the subplot. This will position you at the targeted offset point.

Case 4: No portion of Subplot 1 can be occupied, not even the offset points.

This situation is handled similarly to Case 1 except that instead of proceeding to an offset point on Subplot 1, proceed directly to another subplot center. Stop at or before the obstruction, proceed 120 ft (36.6 m) in one of the prescribed directions (360, 120, or 240o), and then finish chaining to the subplot. This will position you at the center of the selected subplot.

Case 5: Locating offset points from each other on the same subplot.

Once one offset point is determined, the location of other offset points can be found as indicated in Table 5-2 (Figure 5-4).**(Ignore microplot in figure)**

Table 5-2 Distances and Azimuths Between Offset Points

	To offset point							
	North (1)		East (2)		South (3)		West (4)	
From Offset Point	Azi	Dist	Azi	Dist	Azi	Dist	Azi	Dist
English Units								
	deg	ft	deg	ft	deg	ft	deg	ft
North (1)	-	-	135	33.9	180	48.0	225	33.9
East (2)	315	33.9	-	-	225	33.9	270	48.0
South (3)	360	48.0	045	33.9	-	-	315	33.9
West (4)	045	33.9	090	48.0	135	33.9	-	-
Metric Units								
	deg	m	deg	m	deg	m	deg	m
North (1)	-	-	135	10.3	180	14.6	225	10.3
East (2)	315	10.3	-	-	225	10.3	270	14.6
South (3)	360	14.6	045	10.3	-	-	315	10.3
West (4)	045	10.3	090	14.6	135	10.3	-	-

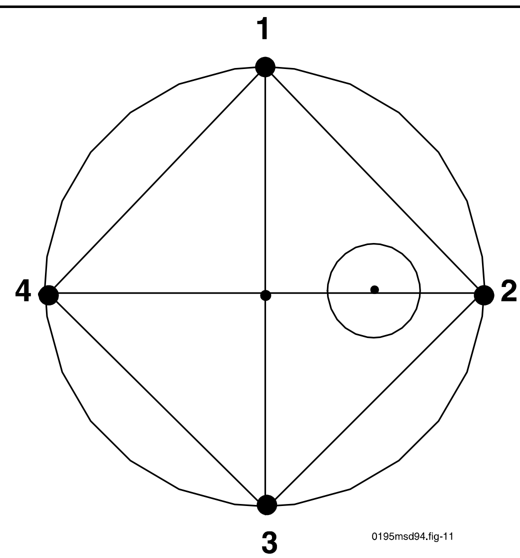


Figure 5-4. Locating offset points from each other on the same subplot.

Case 6: Tallying trees from offset points.

Not all trees may be visible from the initial offset point. It is permissible to use more than one offset point to Tally trees. Subplot trees can be tallied from the subplot offset (Figure 5-5). **(Ignore microplot in figure)**

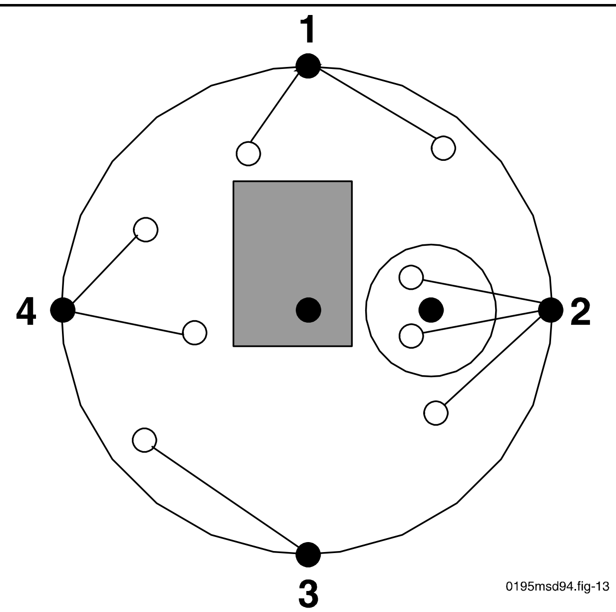


Figure 5-5. Referencing trees to offset points.

Case 7: Recording boundaries from offset points.

Choose one offset point from which the left, right, and corner azimuths and distances can be measured. If possible, select an offset point which is on the same side of the boundary as the subplot center.

When referenced to an offset point, it is difficult to pinpoint where a boundary crosses the subplot perimeter. Left and right azimuths and distances from an offset point to the edge of the subplot will often have to be estimated and should be measured to points on the boundary that are close to the subplot perimeter (Figure 5-6). **(Ignore microplot in figure)** From the recorded data, the exact points of intersection will be computed at the time of data processing.

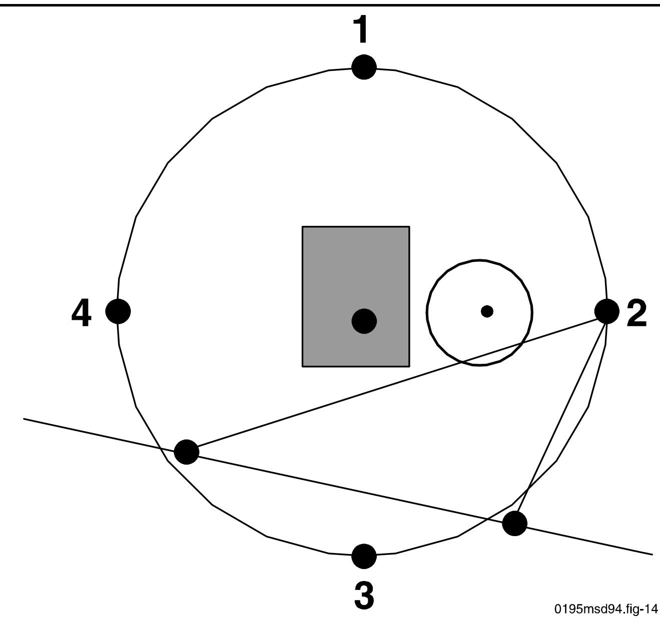


Figure 5-6. Estimating boundaries from offset points.

Case 8: Checking limiting distances from offset points without a PDR.

Table 5-3 lists the angle and limiting distance to 18 perimeter points on the subplot (Figure 5-7). The angle is the difference between the azimuth to subplot center (180, 270, 360, or 90^{o}) and the azimuth to the tree. This angle should never be more than 90^{o}. Borderline trees should be tallied and will be checked later during data processing.

Table 5-3 Limiting Distances to 18 Points on the Subplot

Angle	--Distance--		Angle	--Distance--	
deg	ft	m	deg	ft	m
0	48.0	14.64	45	33.9	10.33
5	47.8	14.57	50	30.8	9.39
10	47.2	14.39	55	27.5	8.38
15	46.3	14.11	60	24.0	7.32
20	45.1	13.75	65	20.3	6.16
25	43.5	13.26	70	16.4	5.00
30	41.6	12.68	75	12.4	3.78
35	39.3	11.98	80	8.3	2.53
40	36.8	11.27	85	4.2	1.28

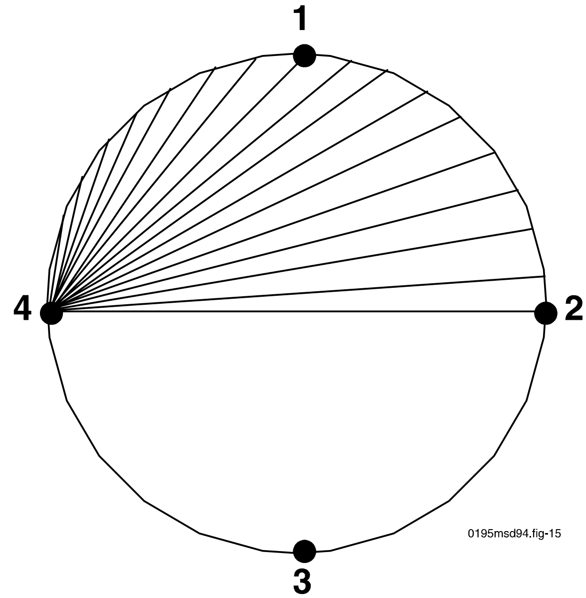


Figure 5-7. Subplot limiting distances from offset point #4.

5.3 SUBPLOT CENTER CONDITION

Record the **CONDITION CLASS NUMBER** of the condition class at the subplot center.

When collected: All subplots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 12

5.4 SUBPLOT SLOPE

Record the angle of slope across the subplot to the nearest 1 percent. **SUBPLOT SLOPE** is determined by sighting the clinometer along a line parallel to the average incline (or decline) of each subplot. This angle is measured along the shortest pathway down slope before the drainage direction changes. To measure **SUBPLOT SLOPE**, Observer 1 should stand at the uphill edge of the subplot and sight Observer 2, who stands at the downhill edge of the subplot. Sight Observer 2 at the same height as the eye-level of Observer 1. Read the slope directly from the percent scale of the clinometer.

If slope changes gradually across the subplot, record an average slope. If slope changes across the subplot but the slope is predominately of one direction, code the predominate slope percentage rather than the average. If the subplot falls directly on or straddles a canyon bottom or narrow ridge top, code the slope as follows:

- If the subplot falls directly between two side hills, code the average slope of the side hill(s).
- If the subplot falls on a canyon bottom or on a narrow ridge top, but most of the area lies on one side hill, code the slope of the side hill.

When collected: All subplots with an accessible forest land or nonforest land condition class (**CONDITION STATUS** = 1 and 2)
Field width: 3 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values:

000	0-4% Slope
005	5% Slope
006	6% Slope
.	.
.	.
XXX	XXX% Slope

5.5 SUBPLOT ASPECT

Record the aspect across the subplot, to the nearest 1 degree. **SUBPLOT ASPECT** is determined along the direction of slope for land surfaces with at least 5 percent slope in a generally uniform direction. **SUBPLOT ASPECT** is measured with a hand compass along the same direction used to determine slope. If aspect changes gradually across the subplot, record an average aspect. If aspect changes across the subplot but the aspect is predominately of one direction, code the predominate direction rather than the average.

If the subplot falls on or straddles a canyon bottom or narrow ridge top, code aspect as follows:

- Code the aspect of the ridge line or canyon bottom.
- If the subplot falls on a canyon bottom or on a narrow ridge top, but most of the area lies on one side hill, code the aspect of the side hill.

When collected: All subplots with an accessible forest land or nonforest land condition class (**CONDITION STATUS** = 1and 2)
Field width: 3 digits
Tolerance: +/- 10 degrees
MQO: At least 90% of the time
Values:

000	no aspect, slope < 5 percent
001	1 degree
002	2 degrees
.	.
.	.
360	360 degrees, due north

5.6 SUBPLOT COVER

Tree, shrub/seedling, and ground cover will be measured for each subplot.

5.6.1 TREE, SHRUB/SEEDLING COVER

Definitions: Tree species (Appendix 1) with stem diameter 1” or greater are considered TREES. Tree species (Appendix 1) with stem diameter <1” are defined as SEEDLINGS. SHRUB species (Appendix 1) are never classified as a tree, no matter how large the stem diameter.

5.6.1.1 PERCENT TREE COVER

The amount of tree canopies covering the sub plot. When looking upward from within the sub plot, one will see tree canopies or open sky areas between the canopies. This data is the proportion of the sky that is obscured by tree crowns within the sub plot and will range from 0 to 100 percent.

When collected: All subplots with an accessible forest land or nonforest land condition class (**CONDITION STATUS** = 1 and 2)
Field width: 3 digits
Tolerance:
MQO:
Values: 000 to 100

5.6.1.2 PERCENT SHRUB/SEEDLING COVER

The amount of the sub plot area covered by shrub/seedling canopies. Values will range from 0 to 100 percent.

When collected: All subplots with an accessible forest land or nonforest land condition class (**CONDITION STATUS** = 1 and 2)
Field width: 3 digits
Tolerance:
MQO:
Values: 000 to 100

5.7 SUB PLOT GROUND COVER

Within the sub plot, various materials will cover the ground (trees, shrubs/seedlings are considered separately; tree stems as a ground cover are ignored). The crew will measure and record what proportion of the sub plot ground area is covered by the following materials: **BUILDINGS, IMPERVIOUS, PERMEABLE, HERBACEOUS,** and **WATER**. A particular material must cover a minimum of 1% of the sub plot area to be recorded. **The sum of the cover types listed above MUST sum to 100% for each sub plot.** Objects that can be moved (not permanent) (e.g. picnic tables, sheet of metal on ground, inflatable swimming pool) are not considered ground cover. Cover goes to the lowest permanent cover type. **IMPERVIOUS** is defined as non-building material occupying at least 1% of the sub plot that does not allow water to percolate through. (e.g. rock, tar, cement). Examples of **PERMEABLE** include soil and grave. **HERBACEOUS** cover overrides **PERMEABLE**. **WATER** includes swimming pools.

5.7.1 PERCENT BUILDINGS

Record the percent of sub plot area covered by buildings. Values will range from 1 to 100 percent.

When collected: All subplots with an accessible forest land or nonforest land condition class (**CONDITION STATUS** = 1 and 2)
Field width: 3 digits
Tolerance:
MQO:
Values: 000 to 100

5.7.2 PERCENT IMPERVIOUS

Record the percent of sub plot area covered by impervious materials. Values will range from 1 to 100 percent.

When collected: All subplots with an accessible forest land or nonforest land condition class (**CONDITION STATUS** = 1 and 2)
Field width: 3 digits
Tolerance:
MQO:
Values: 000 to 100

5.7.3 PERCENT PERMEABLE

Record the percent of sub plot area covered by permeable materials. Values will range from 1 to 100 percent.

When collected: All subplots with an accessible forest land or nonforest land condition class (**CONDITION STATUS** = 1 and 2)
Field width: 3 digits
Tolerance:
MQO:
Values: 000 to 100

5.7.4 PERCENT WATER

Record the percent of sub plot area covered by water. Values will range from 1 to 100 percent.

When collected: All subplots with an accessible forest land or nonforest land condition class (**CONDITION STATUS** = 1 and 2)

Field width: 3 digits
Tolerance:
MQO:
Values: 000 to 100

6.0 TREE DATA

Trees at least **1.0 inches in diameter** are sampled within the subplot. 'Tally trees' are defined as all live and standing dead trees in accessible forest land and nonforest land condition classes (**CONDITION STATUS CODES** 1 and 2) encountered on the subplot the first time a subplot is established, and all trees that grow into a subplot thereafter. (Refer to APPENDIX 1 for Tree and Shrub species listing.) These data yield information on tree growth, mortality, removals; coarse woody debris; wildlife habitats; forest structure and composition; biomass; and carbon sequestration.

Trees with less than 1.0 inch diameter, termed seedlings, are quantified under the COVER DATA Section. **(5.6 SUB PLOT COVER).**

Trees are alive if they have any living parts (leaves, buds, cambium) at or above the point of diameter measurement, either diameter at breast height (DBH) or diameter at root collar (DRC). Trees that have been temporarily defoliated are still alive.

Once tallied, dead trees over 1.0 in diameter are tracked until they fall down. **Working around dead trees is a safety hazard - crews should exercise extreme caution! Trees that are deemed unsafe to measure should be estimated.**

To qualify as a standing dead tally tree, dead trees must be standing (LEAN ANGLE = 0) at least 4.5 ft tall and be at least 1.0 inches in diameter. Broken portions of trees that are completely separated from their base are not treated as separate trees.

Whether live or dead, standing trees do not have to be self-supported. They may be supported by other trees.

High stumps (trees that have been cut) do not qualify as standing dead trees.

Begin tallying trees at an azimuth of 001 degrees from subplot center and continue clockwise around the subplot. Repeat this sequence for trees on the microplot and again on the annular plot.

The following elements are recorded for all tally trees:

6.1 SUBPLOT NUMBER

Record the subplot number where the tree occurs.

When Collected: All live and dead tally trees ≥ 1.0 in DBH
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1	Center subplot
2	North subplot
3	Southeast subplot
4	Southwest subplot

6.2 TREE NUMBER

Record a code to uniquely and permanently identify each tree on a given subplot. The **TREE NUMBERS** must be unique within a subplot – being unique is more important than being sequential. In general, work clockwise from azimuth 001 to 360, and work outwards from subplot center to subplot edge. *On remeasured plots, use the tree number assigned at the previous visit.* . Missed trees will be assigned the next available tree number. DO NOT renumber all plot trees in order to assign a more "correct" tree number to a missed tree. Numbers assigned to trees that are subsequently found to be extra will be dropped and not reused.

When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000, 001 to 999

6.3 TREE STATUS

Record a current **TREE STATUS** for each tallied tree; this code is used to track the status of sample trees over time. This information is needed to correctly assign volume information to the proper component of volume change.

When Collected: All new live tally trees ≥ 1.0 in DBH
All new dead tally trees ≥ 1.0 in
On remeasurement plots, all previously tallied trees
Field width: 1 digit
Tolerance: No errors
MQO: At least 95% of the time
Values:

1 Live tree – any live tree *(new, remeasured or ingrowth)*

2 <u>Dead tree</u> -- any dead tree *(new, remeasured, or ingrowth),* regardless of cause of death, which does not qualify as a removal.

3 <u>Removal</u> - a tree that has been cut or killed by direct human activity related to harvesting, silviculture or land clearing (remeasurement plots only). The tree may, or may not, have been utilized. Only code trees killed by fire as removals if it was a prescribed burn.

4 <u>Missing</u> – tree was tallied in previous inventory but now is missing due to natural causes such as landslide, fire, etc. (remeasurement plots only).

6.4 CONDITION CLASS NUMBER

Record the **CONDITION CLASS NUMBER** in which each tree is located. Often, a referenced boundary is approximate, and trees selected for tally are assigned to the actual condition in which they lie regardless of the recorded approximate boundary (Figure 6-1). (Ignore microplot in figure.)

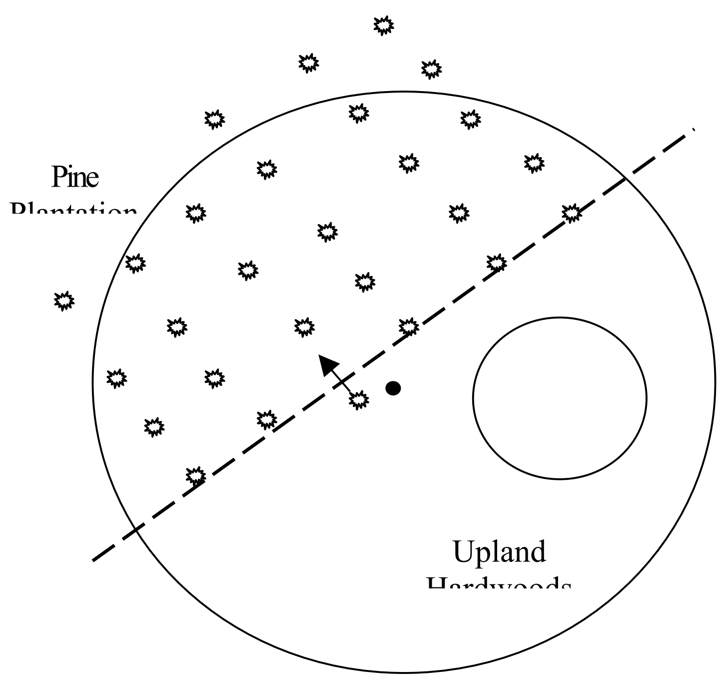


Figure 6-1. Ragged CONDITION CLASS boundary and tree condition class designation.

When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time

Values: 1 to 9

6.5 HORIZONTAL DISTANCE

Record the measured **DISTANCE**, to the nearest 0.1 ft, from the subplot center (for trees ≥ 1.0 in DBH) to the pith of the tree at the base.

When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
Field width: 3 digits (xx.y)
Tolerance: +/- 1.0 ft
MQO: At least 90% of the time
Values: 00.1 to 24.0

6.6 AZIMUTH

Record the **AZIMUTH** from the subplot center (for trees ≥ 1.0 in DBH), sight the center of the base of each tree with a compass. Record **AZIMUTH** to the nearest degree. Use 360 for north.

When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
Field width: 3 digits
Tolerance: +/- 10 degrees
MQO: At least 90% of the time
Values: 001 to 360

6.7 DIAMETER

Unless one of the special situations described below is encountered, measure diameter at 4.5 ft above the ground line (DBH) on the uphill side of the tree. Round each measurement down to the last 0.1 inch. For example, a reading of 3.68 inches is recorded as 3.6 inches. For forked or multi stemmed trees where pith union is below ground, each fork or stem is treated as a separate tree. If pith union is above ground, measure diameter at narrowest point below fork. If tree forks above dbh, measure diameter at dbh.

When Collected: All live tally trees ≥ 1.0 in DBH and standing dead tally trees ≥ 1.0 in DBH
Field width: 4 digits (xxx.y)
Tolerance: +/- 0.1 in per 20.0 in of diameter on trees with a measured diameter
MQO: At least 95% of the time. For example: a tree with a diameter of 41.0 in would have a tolerance of plus or minus 0.3 in. *(Note: the MQO for point of measurement is +/- 0.2 in when the tree is first measured and within 1 ft of the location established by the previous crew when the tree is remeasured.)*
Values: 0001 to 9999

Special DBH situations:

Trees forked at or above 4.5 ft. Trees forked in this region count as one single tree (Figure 6-2). If a fork occurs at or immediately above 4.5 ft, measure diameter below the fork just beneath any swelling that would inflate DBH.

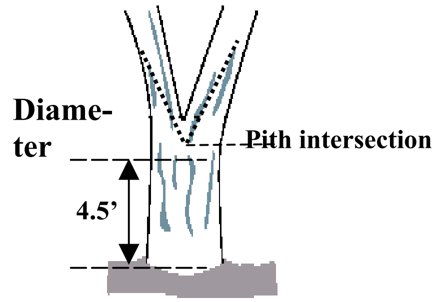


Figure 6-2. One tree

Tree with butt-swell or bottleneck: Measure these trees 1.5 ft above the end of the swell or bottleneck if the swell or bottleneck extends 3.0 ft or more above the ground (Figure 6-3).

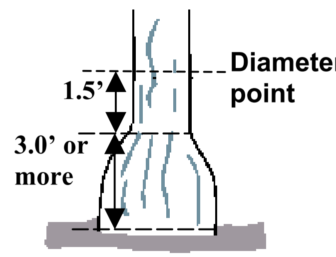


Figure 6-3. Bottleneck tree.

Tree on slope: Measure diameter at 4.5 ft from the ground along the bole on the uphill side of the tree (Figure 6-4).

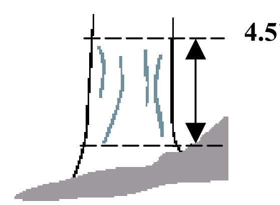


Figure 6-4. Tree on a slope

Leaning tree: Measure diameter at 4.5 ft from the ground along the bole. The 4.5 ft distance is measured along the underside face of the bole (Figure 6-5).

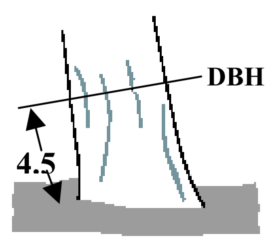


Figure 6-5. Leaning tree

Independent trees that grow together: If two or more independent stems have grown together at or above the point of DBH, continue to treat them as separate trees. Estimate the diameter of each, set the "**DIAMETER CHECK**" code to 1, **(see Section 6.9)** and explain the situation in the notes.

Missing wood or bark. Do not reconstruct the DBH of a tree that is missing wood or bark or at the point of measurement. Record the diameter, to the nearest 0.1, of the wood and bark that is still attached to the tree (Figure 6-6).

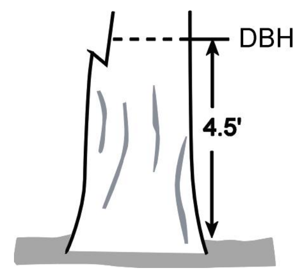


Figure 6-6. Tree with broken stem

Live windthrown tree: Measure from the top of the root collar along the length to 4.5 ft (Figure 6-7).

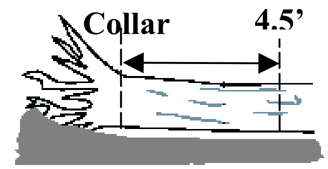


Figure 6-7. Tree on the ground

Down live tree with tree-form branches growing vertical from main bole. When a down live tree, touching the ground, has vertical (<45° from vertical) tree-like branches coming off the main bole, first determine whether or not the pith of the main bole (averaged along the first log of the tree) is above or below the duff layer.

- If the pith of the main bole is above the duff layer, use the same forking rules specified for a forked tree, and take all measurements accordingly (Figure 6-8).
  - If the pith intersection of the main down bole and vertical tree-like branch occurs below 4.5' from the stump along the main bole, treat that branch as a

separate tree, and measure DBH 3.5 ‘ above the pith intersection for both the main bole and the tree-like branch.

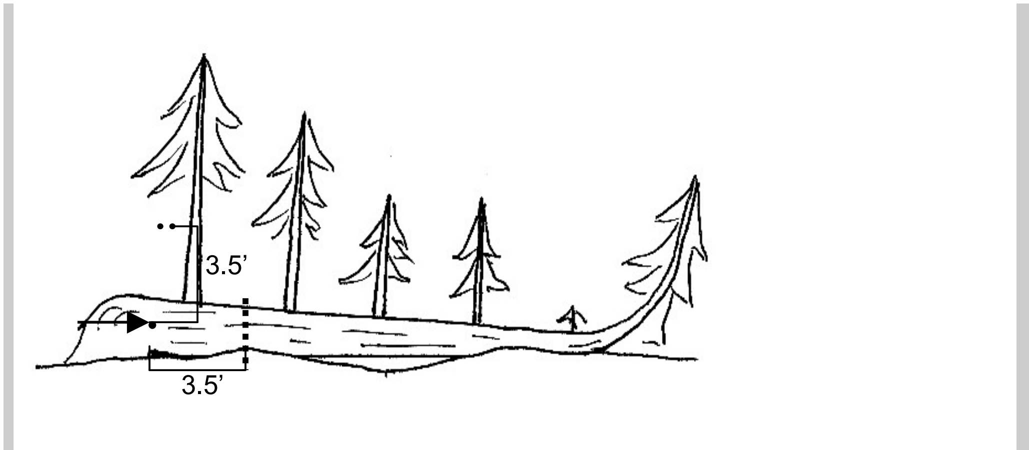


Figure 6-8. Down tree above duff

- If the intersection between the main down bole and the tree-like branch occurs beyond the 4.5’ point from the stump along the main bole, treat that branch as part of the main down bole.

- If the pith of main tree bole is below the duff layer, ignore the main bole, and treat each tree-like branch as a separate tree; take DBH and length measurements from the ground, not necessarily from the top of the down bole (Figure 6-9). However, if the top of the main tree bole curves out of the ground towards a vertical angle, treat that portion of that top as an individual tree originating where the pith leaves the duff layer.

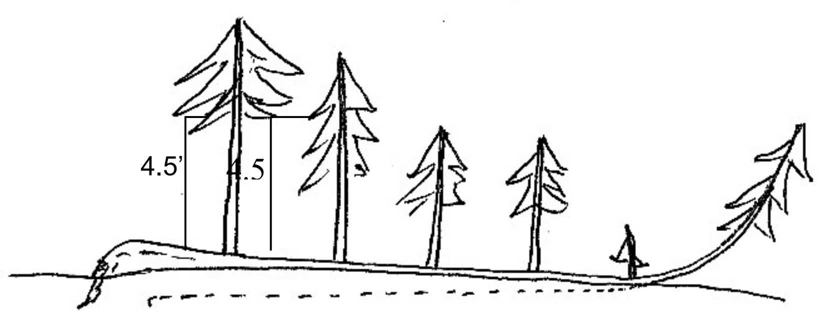


Figure 6-9. Down tree below duff

6.8 LENGTH TO DIAMETER

In order to accurately remeasure diameter at the same point on the tree bole at successive visits, measure and record the distance from the ground to the point of diameter, if not taken at 4.5 ft. Record lendth to nearest 0.1 in.

> When Collected: All live tally trees ≥ 1.0 in DBH and standing dead tally trees ≥ 1.0 in DBH
> Field width: 3 (xx.y)
> Tolerance:
> MQO:
> Values: 001 to 999

<u>*Remeasurement trees*</u>*:*

When remeasuring the diameter of a tree tallied at a previous survey, always take the measurement at the location monumented by the previous crew unless it is not physically possible (e.g., tree buried by mudslide), or the previous location is more than 12 inches beyond where the diameter should be measured according to current protocols (either because protocols have changed or the previous crew made a mistake). Assign a DIAMETER CHECK code of 2 whenever the point of measurement is moved.

> *When Collected: All live tally trees ≥ 1.0 in DBH and standing dead tally trees ≥ 1.0 in DBH*
> *Field width: 4 digits (xxx.y)*
> *Tolerance: +/- 0.1 in per 20.0 in of diameter on trees with a measured diameter*
> *MQO: At least 95% of the time. For example: a tree with a diameter of 41.0 in would have a tolerance of plus or minus 0.3 in. (Note: the MQO for point of measurement is +/- 0.2 in when the tree is first measured and within 1 ft of the location established by the previous crew when the tree is remeasured.)*
> *Values: 0001 to 9999*

6.9 DIAMETER CHECK

Record this code to identify any irregularities in diameter measurement.

> When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
> Field width: 1 digit
> Tolerance: No errors
> MQO: At least 99% of the time
> Values:
> 0 Accurate: If diameter is measured
> 1 Estimated: If diameter cannot be measured for some reason and must be visually estimated.

6.10 SPECIES

Record the appropriate **SPECIES** code from the list in Appendix 1. If you encounter a species not listed in Appendix 1 and are not sure if it should be tallied as a tree, consult your Field Supervisor. If the species cannot be determined in the field, tally the tree, but bring branch samples, foliage, cones, flowers, bark, etc. to your supervisor for identification. If possible, collect samples outside the subplots from similar specimens and make a note to correct the **SPECIES** code later. Use code DESH1, DESH2, DESH3, etc for unknown deciduous shrubs and EVSH1, EVSH2, EVSH3, etc. forr unknown evergreen shrubs. The generic code should only be used when you are sure the species is on the species list, but you cannot differentiate among acceptable species. In this case use the sample collections procedures described earlier in this paragraph.

When Collected: All live and standing dead tally trees $\geq$ 1.0 in DBH
Field width: 6 characters
Tolerance: No errors
MQO: At least 99% of the time for genus, at least 95% of the time for species
Values: See Appendix 1

6.11 CROWN MEASUREMENT OVERVIEW

Crown indicators are designed to be used together. Each indicator comprises a piece of information that can be used individually or as a factor in combination with other indicators. Each variable, alone or in combination with others, adds to the overall rating given each tree. It is important to realize that models are designed to rate trees on how they look, from thriving to almost dead and to help predict future conditions of trees and forest ecosystems.

.Crown evaluations are made on all trees with DBH 1.0 in or larger. Crown evaluations allow for the quantitative assessment of current tree conditions and provide an integrated measure of site conditions, stand density and influence of external stresses. All crown measurements are taken during plot establishment *and whenever plot remeasurement occurs*.

Two persons make all crown measurements. Individuals should be ½ to 1 tree length from the base of the tree to obtain a good view of the crown. Move away from each other at least 10 feet to take these measurements. A position of 90 degrees to each other from the tree base is ideal. When estimates made by two individuals disagree, they should discuss the reasons for their ratings until an agreement is reached, or use the methods below to resolve the situation.

If the numbers for a crown measurement estimated by two crew members do not match, arrive at the final value by:

- Averaging the two estimates for those trees that actually have different ratings from the two viewing areas (ratings of 30 and 70 would be recorded as 50).
- Taking an average, if the numbers differ by 10% (2 classes) or less.
- Changing positions, if the numbers differ by 15 % or more and attempt to narrow the range to 10% or less.

6.12 CROWN DEFINITIONS

Crown Shape
Crown shape is the silhouette of a tree, drawn from branch tip to branch tip, which contains all of a tree's foliage as it grows in a stand. Exclude abnormally long branches beyond the edge of the crown for this silhouette. Silhouettes are derived from vigorous, open grown trees and tend to be species-specific. Silhouettes vary with age and spacing. Tree crowns tend to flatten out with age and be more slender when growing in crowded conditions. Crown shape is important when measuring **CROWN DENSITY** and is used to estimate crown biomass. Crown shape is used as an outline for the sides of the trees.

Crown Top
The crown top is the highest point of a standing tree. Young trees usually have more conical-shaped crowns and the main terminal is the top. Older trees and many hardwoods have globose and flat-topped crowns, where a lateral branch is the highest point. For some measurements the highest live foliage is considered the live crown top. Other measurements include a dead top. Some crown measurements assess how much of the expected crown is present and include broken or missing tops.

Dieback
This is recent mortality of branches with fine twigs, which begins at the terminal portion of a branch and proceeds toward the trunk. Dieback is only considered when it occurs in the upper and outer portions of the tree. When whole branches are dead in the upper crown, without obvious signs of damage such as breaks or animal injury, assume that the branches died from the terminal portion of the branch. Dead branches in the lower portion of the live crown are assumed to have died from competition and shading. Dead branches in the lower live crown are not considered as part of crown dieback, unless there is continuous dieback from the upper and outer crown down to those branches.

Epicormic
Shoot growth, from latent or suppressed buds, that arises from old branches, from the trunk or near large branch wounds or breaks.

Live Branch
A live branch is any woody lateral growth supporting foliage, and is 1.0 in or larger in diameter at the base above the swelling where it joins a main stem or larger branch. Small trees or certain tree species greater than 1.0 in DBH may have only live twigs which have not yet reached 1.0 in or larger at the point of attachment. If the death of larger branches is not the cause of these twigs, the twigs are considered branches until the tree reaches a point where twigs have attained live branch size.

Live Crown Base
The live crown base is an imaginary horizontal line drawn across the trunk from the bottom of the lowest live foliage of the "obvious live crown" for trees and from the lowest live foliage of the lowest twig for saplings. The "obvious live crown" is described as the point on the tree where

most live branches/twigs above that point are continuous and typical for a tree species (and/or tree size) on a particular site. Include most crown branches/twigs, but exclude epicormic twigs/sprigs and straggler branches that usually do not contribute much to the tree's growth. The base of the live branch/twig bearing the lowest foliage may be above or below this line.

For trees 1.0 in DBH or greater, if any live branch is within 5 ft below this "obvious live crown" line, a new horizontal line is established. Create the new line at the base of live foliage on that branch. Continue this evaluation process until no live branches are found within 5 ft of the foliage of the lowest qualifying branch (Figure 6-10).

Occasionally, all original major crown branches/twigs are dead or broken and many new twigs/sprigs develop. These situations are likely to occur in areas of heavy thinning, commercial clearcuts and severe weather damage:

- Trees that had an "obvious live crown" with live branches now have no crown to measure until the new live twigs become live branches. When these new live branches appear, draw the new live crown base to the live foliage of the lowest live branch that now meets the 5 ft rule.

- Saplings and small trees that had only live twigs should establish the crown base at the base of the live foliage on the new lowest live twig. If no live twigs are present, there is no crown to measure.

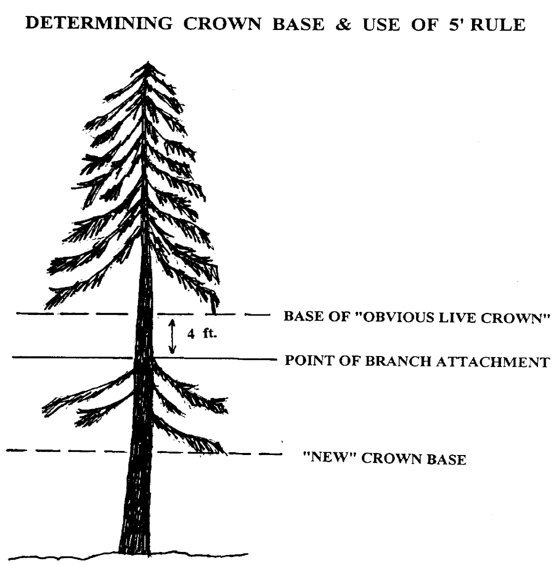


Figure 6-10. Determining the base of the live crown.

Overstory Canopy Zone
The area delineated by the average live crown height is used to determine **UNCOMPACTED LIVE CROWN RATIO** for overstory trees. The bottom of the overstory canopy zone is the

average height of the live crown bases. The top of the zone is the average height for the live crown tops.

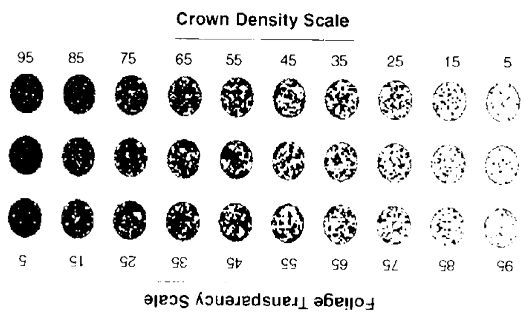
Snag Branch
A dead upper crown branch without twigs or sprigs attached to it.

Sprig
Any woody or non-woody lateral growth, without secondary branching, less than 1.0 inch in diameter at the base above the swelling at the point of attachment to a branch or crown stem.

Twig
Any woody lateral growth, with secondary branching, less than 1.0 inch in diameter at the base above the swelling at the point of attachment to a branch or crown stem.

6.13 CROWN DENSITY-FOLIAGE TRANSPARENCY CARD

Front



Back

Density of Tree, Present

Percent of Tree Missing	5	15	25	35	45	55	65	75	85	95
10	5	15	25	35	45	50	60	70	80	90
20	5	15	20	30	40	45	55	60	70	80
30	5	15	20	25	35	40	50	55	60	70
40	5	10	15	25	30	35	40	45	55	60
50	5	10	15	20	25	30	35	40	45	50
60	5	10	10	15	20	25	30	30	35	40
70	5	5	10	15	15	20	20	25	30	30
80	5	5	5	10	10	15	15	15	20	20
90	5	5	5	5	5	10	10	10	10	10

Scale to estimate live crown ratio

99 90 80 70 60 50 40 30 20 10 00

Figure 6-11. Density-Transparency card

The Crown Density - Foliage Transparency card (Figure 6-11) should be used as a training aid until crew personnel are comfortable with all ratings. White areas of the card represent skylight visible through the crown area and black areas represent a portion of the tree that is blocking skylight. After training, use the card to calibrate your eyes at the start of each day and rate those trees that do not fit into an obvious class. For **CROWN DENSITY**, hold the card so that "Crown Density" is right side up. ("Foliage Transparency" should be upside down.) Use the numbers that are right-side up. Conversely, for **FOLIAGE TRANSPARENCY**, make sure that "Foliage Transparency" is right-side up. Crews should refer to specific **CROWN DENSITY** or **FOLIAGE TRANSPARENCY** sections for a definition of aspects that are included in the crown rating.

The back of the crown density - foliage transparency card has two uses: for **CROWN DENSITY** when a portion of the crown is missing and a general scale for estimating **UNCOMPACTED LIVE CROWN RATIO**. Crews should refer to the **CROWN DENSITY** and **UNCOMPACTED LIVE CROWN RATIO** sections for the use of this side of the card.

6.14 CROWN RATING PRECAUTIONS

Crews must be especially careful when making evaluations, and pay special attention to certain factors that may affect measurements in the field. These factors include:

- Distance and slope from the tree
- View of the crown
- Climatic conditions
- Heavy defoliation
- Leaning trees
- Trees with no "crown" by definition

Distance and slope from the tree -
Crews must attempt to stay at least 1/2 to 1 tree length from the tree being evaluated. Some ratings change with proximity to the tree. In some situations, it is impossible to satisfy this step, but the crew should do the best it can in each case. All evaluations are made at grade (same elevation as base of the tree) or up slope from the tree. This may not be possible in all cases but never get in the habit of evaluating trees from the down slope side.

View of the crown -
Crew members should evaluate trees when standing at an angle to each other, striving to obtain the best view of the crown. The ideal positions are at 90 degrees to each other on flat terrain (Figure 6-12). If possible, never evaluate the tree from the same position or at 180 degrees. In a thick canopy forest, getting a good perspective of the crown becomes difficult. Overlapping branches, background trees and lack of a good viewing area can cause problems when rating some trees. Crews need to move laterally to search for a good view. Take special care when rating such trees.

VIEWING THE CROWN

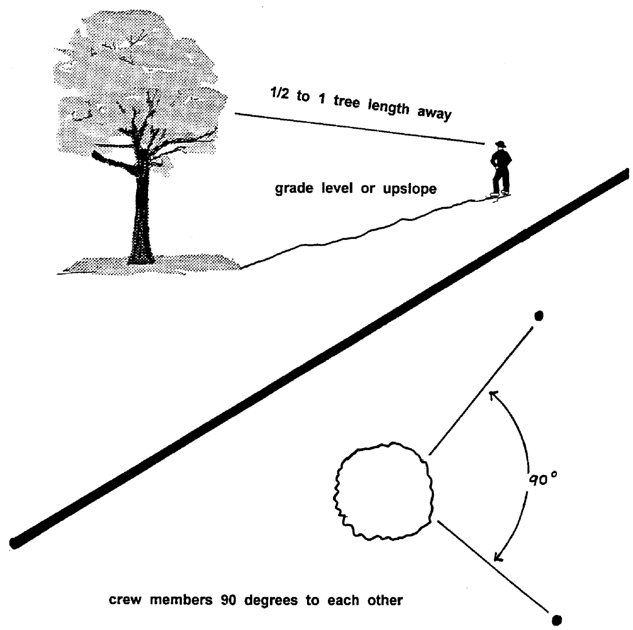


Figure 6-12. Crew positions for viewing crowns.

Climatic conditions -
Cloudy or overcast skies, fog, rain and poor sun angles may affect estimates. **UNCOMPACTED LIVE CROWN RATIO** may be affected but to a lesser degree than other crown indicators. **CROWN DENSITY** tends to be overestimated or underestimated because light does not project well through the foliage or, in some cases, the light may be too bright for a good estimate. **CROWN DIEBACK** may be underestimated, because it is difficult to see dead twigs and/or to differentiate defoliated twigs from dead twigs. **FOLIAGE TRANSPARENCY** estimates could be affected in either direction, because it is hard to separate foliage from branches. The data quality expectation standard helps, because crews can normally be within +/-10 percent, even in poor weather. However, crews need to be especially careful during poor lighting conditions. Crews should move around a tree to get another view, even if the view appears adequate at a specific location.

Heavy defoliation -
During heavy defoliation, **CROWN DIEBACK** may be overestimated and **FOLIAGE TRANSPARENCY** may be underestimated due to the difficulty in differentiating dead twigs from defoliated twigs. The use of binoculars may help in separating dead twigs from defoliated twigs.

Leaning trees -
Leaning trees cause a major problem in estimating crown variables. Record crown variables as accurately as possible for the **tree as it actually occurs** rather than as it might appear if standing upright and also record in the notes section that it is leaning. This will allow for better data interpretation.

Trees with no "crown" by definition (epicormics or sprigs only) -

After a sudden release or damage, a tree may have very dense foliage, but no crown. These situations are coded as follows: **CROWN LIGHT EXPOSURE - 0, CROWN POSITION - 3, CROWN DENSITY - 00, CROWN DIEBACK - 99, FOLIAGE TRANSPARENCY - 99.**

Epicormics remain epicormics until they regain the size of previous branches for trees with no branches 1.0 in or larger in diameter at the base above the swelling. For trees that had 1.0 in or larger branches when the epicormics formed, epicormics become branches once they reach 1.0 inch in diameter.

6.15 UNCOMPACTED LIVE CROWN RATIO

UNCOMPACTED LIVE CROWN RATIO is a percentage determined by dividing the live crown height by the total live tree height (Figure 6-13).

****** Uncompacted live crown ratio is not recorded on the field datasheet. However it is a useful measure when determining CROWN LIGHT EXPOSURE, CROWN DENSITY, and CROWN DIEBACK*******

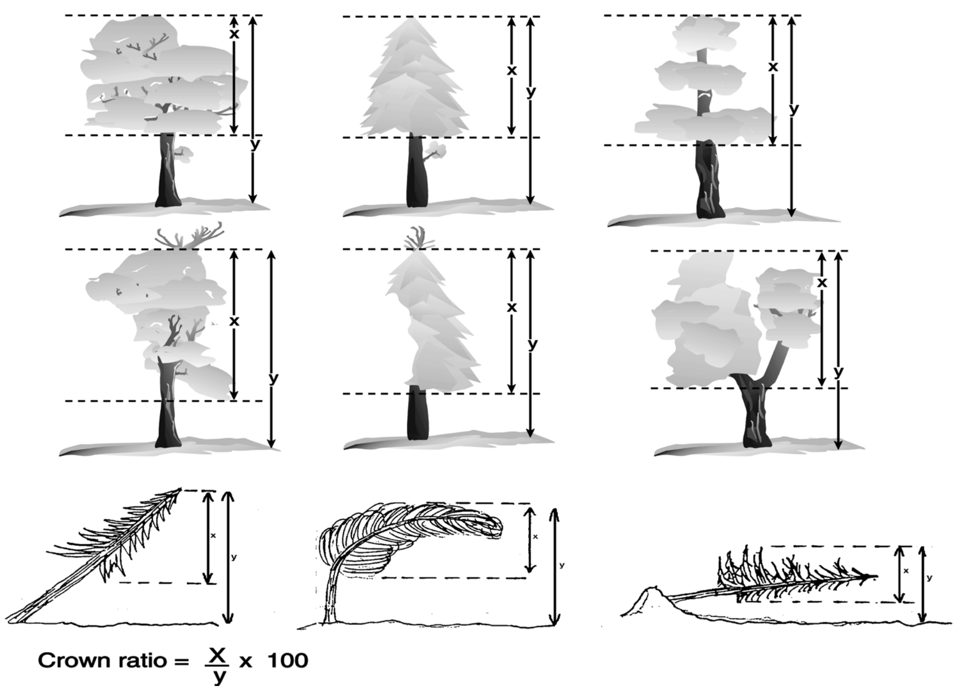


Figure 6-13. UNCOMPACTED LIVE CROWN RATIO examples.

Trees

Live crown height is the distance from the live crown top (dieback in the upper portion of the crown is not part of the live crown) to the "obvious live crown" base. Many times there are additional live branches below the "obvious live crown". These branches are only included if they have a basal diameter greater than 1.0 in and are within 5.0 ft of the base of the obvious live crown

(Figure 6-10). The live crown base becomes that point on the main bole perpendicular to the lowest live foliage on the last branch that is included in the live crown. The live crown base is determined by the live foliage and not by the point where a branch intersects with the main bole. Occasionally, small trees or certain species may not have 1.0 in diameter branches. If this occurs, use the 5.0 ft rule, and apply it to branches that you feel contribute significantly to tree growth. Two people measure **UNCOMPACTED LIVE CROWN RATIO**.

An individual can use the **UNCOMPACTED LIVE CROWN RATIO** scale on the back of the crown density - foliage transparency card to help estimate ratios (Figure 6-11). **Hold the card in one hand, parallel to the trunk of the tree** being evaluated and move the card closer or farther from your eye until the 0 is at the live crown top and the 99 is at the base of the tree where it meets the ground. Then place your finger at the live crown base. The number on the scale provides the **UNCOMPACTED LIVE CROWN RATIO**. Interpolate to the nearest 5 percent if the point is between two values on the scale. A clinometer can also be used to verify the **UNCOMPACTED LIVE CROWN RATIO** by determining the values of both heights and determining the ratio of the two values.

When estimates between crew members do not agree, follow the guidelines listed at the end of section 6.11. The estimate is placed into one of 21 percentage classes.

After a sudden release or damage, a tree may have very dense foliage, but no crown. These situations are coded as follows: UNCOMPACTED LIVE CROWN RATIO - 00, CROWN LIGHT EXPOSURE - 0, CROWN POSITION - 3, CROWN DENSITY - 00, CROWN DIEBACK - 99 and FOLIAGE TRANSPARENCY - 99.

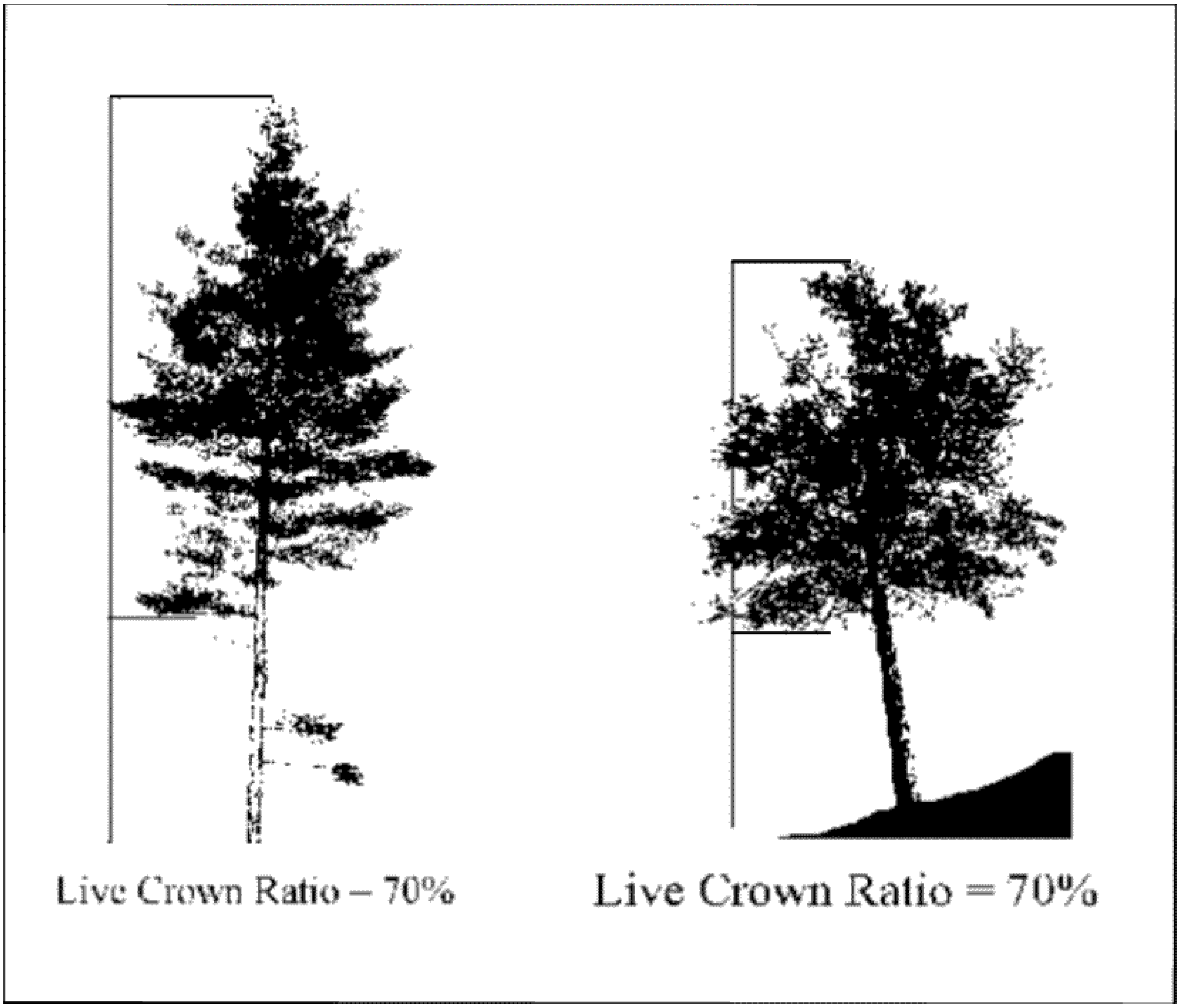


Figure 6-14. Uncompacted Live Crown Ratio outline and rating examples

6.16 HEIGHT (GRND-TOP OF TREE)

Height to highest point of tree (dead or alive) measured in ft. Height must be recorded for all trees, including dead trees. For downed living trees or severely leaning trees, height is considered the distance along the main stem from ground to tree top. Record height to nearest 0.1 ft.

When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
Field width: 4 digits (xxx.y)
Tolerance:
MQO:
Values: 0000 to 9999

6.17 HEIGHT (GRND-LIVE CROWN BASE)

Height to base of live crown measured in ft. Height must be recorded for all trees, including dead trees. Record dead trees as 0. For downed living trees or severely leaning trees, height is considered the distance along the main stem from ground to base of live crown. Record height to nearest 0.1 ft.

When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
Field width: 4 digits (xxx.y)
Tolerance:
MQO:
Values: 0000 to 9999

6.18 HEIGHT (GRND-LIVE CROWN TOP)

Height to highest live point of tree (live crown) measured in ft. Height must be recorded for all trees, including dead trees. Record dead trees as 0. For downed living trees or severely leaning trees, height is considered the distance along the main stem from ground to top of live crown. Record height to nearest 0.1 ft.

When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
Field width: 4 digits (xxx.y)
Tolerance:
MQO:
Values: 0000 to 9999

6.19 CROWN DIAMETER WIDE

Crown width measured at it's widest point. Record measurement to nearest 0.1 ft. Dead trees always have a crown width of 0. If tree is downed or leaning, take width measurements perpendicular to tree bole.

When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
Field width: 4 digits (xxx.y)
Tolerance:
MQO:
Values: 0000 to 9999

6.20 CROWN DIAMETER 90 DEGREES

Crown width measured 90 degrees (perpendicular) to **CROWN DIAMETER WIDE** measurement. Record measurement to nearest 0.1 ft. Dead trees always have a crown width of 0. If tree is downed or leaning, take width measurements perpendicular to tree bole.

When Collected: All live and standing dead tally trees ≥ 1.0 in DBH
Field width: 4 digits (xxx.y)
Tolerance:
MQO:
Values: 0000 to 9999

6.21 CROWN LIGHT EXPOSURE

When collected: All live trees $\geq$ 1.0 in DBH
Field width: 1 digit
Tolerance: within 1 if > 0
MQO: 85% agreement
Values:

Code	Definition
0	The tree receives no full light because it is shaded by trees, vines, or other vegetation.
1	The tree receives full light from the top or 1 side.
2	The tree receives full light from the top and 1 side (or 2 sides without the top).
3	The tree receives full light from the top and 2 sides (or 3 sides without the top).
4	The tree receives full light from the top and 3 sides.
5	The tree receives full light from the top and 4 sides.

Dead trees use Code 0.

Rate the UNCOMPACTED LIVE CROWN RATIO for each side of the tree separately using the criteria for estimating total UNCOMPACTED LIVE CROWN RATIO. Visually divide the crown vertically into four equal sides. In order for a side to qualify for tally, the side must have an uncompacted live crown ratio of at least 35 percent. Additionally for a side to qualify, a continuous portion of live crown 35 percent or more in length must be completely exposed to direct light. For this measurement, a tree cannot shade itself (e.g., leaning trees or umbrella shaped trees). Try to divide the crown in such a way that as many sides as possible receive full light. Count the number of sides that would receive direct light if the sun were directly above the tree. Add one if the tree receives direct light from the top (Figure 6-15).

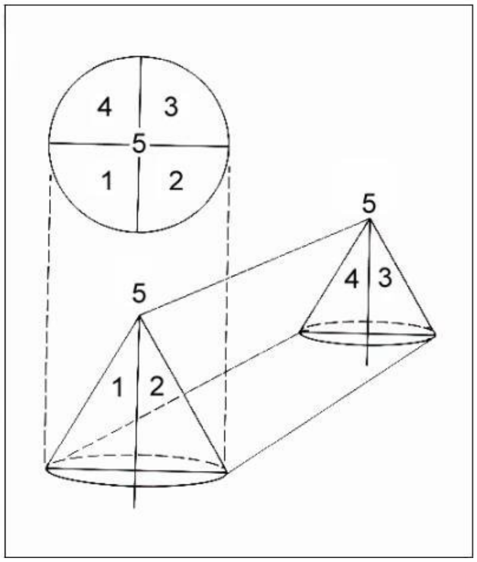


Figure 6-15. Dividing the crown.

Note: The entire side (25% of the crown circumference) must be receiving full light to qualify. A sliver of a side receiving light does not qualify. Trees with all sides having less than a 35% **UNCOMPACTED LIVE CROWN RATIO** can have a maximum crown exposure of one. Individual sides with less than 35% **UNCOMPACTED LIVE CROWN RATIO** should not be counted (Figure 6-16).

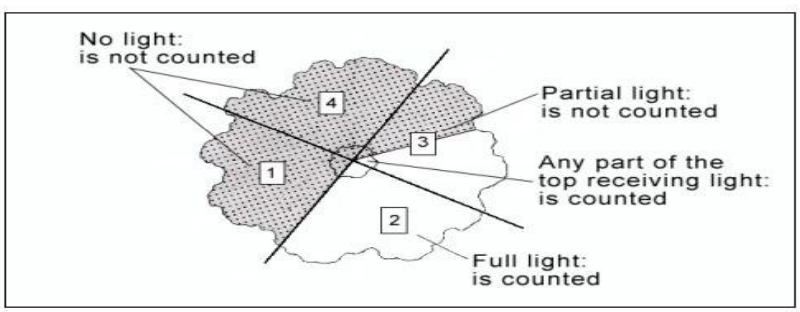


Figure 6-16. CROWN LIGHT EXPOSURE.

6.22 CROWN POSITION

When collected: All live trees ≥ 1.0 in DBH
Field width: 1 digit
Tolerance: No errors
MQO: 85% agreement
Values:

Code	Definition
1	Superstory. The live crown top must be two times the height of the top of the overstory canopy zone. The tree is open grown because most of the crown is above the overstory canopy zone (pioneers, seed trees, whips, remnants from previous stands, etc.).
2	Overstory. The live crown top is above the middle of the overstory canopy zone.
3	Understory. The live crown top is at or below the middle of the overstory canopy zone.
4	Open Canopy. An overstory canopy zone is not evident because the tree crowns in this condition are not fully closed (<50% cover). Most of the trees in this stand are not competing with each other for light.

Determine the relative position of each tree in relation to the overstory canopy zone (Figure 6-17).

Trees

Codes 1-3 should be used in stands where the tree crown cover is closed (>50 percent cover). If the tree crowns are not closed (<50 percent cover) and the area is greater than 1 ac in size, then assign code 4. When code 4 is used, it is always assigned to all trees in the stand. Code 4 is typically used in the following cases:

- Trees in stands, over 1 ac in size, where crown cover is less than 50%.
- Trees in clumps less than 1 ac in size (i.e., not a condition class) when the overall forest (the condition class), over 1 ac in size, is a patchwork of open areas and clumps of trees.

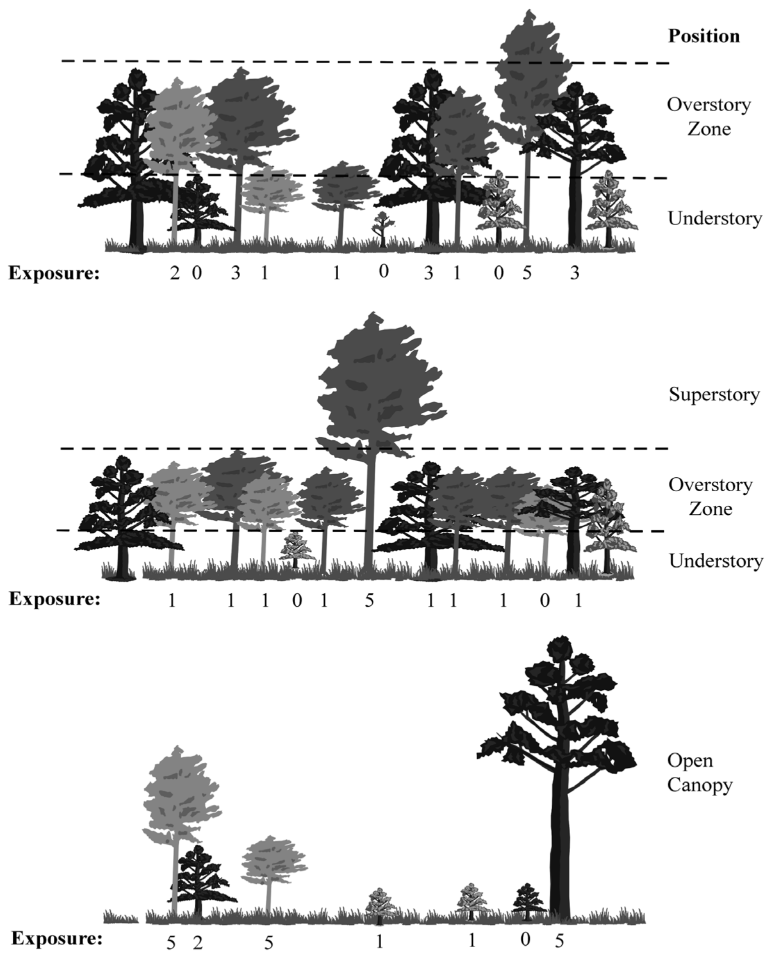


Figure 6-17. CROWN LIGHT EXPOSURE and POSITION.

6.23 FOLIAGE ABSENT

Within the live crown outline (as defined by symmetrical silhouette created by live crown width, height, and height to base of live crown measurements), estimate percent foliage missing due to:
-Pruning
-Dieback
-Defoliation
-Uneven crown
-Dwarf or sparse leaves

Live crown outline (See Figure 6-20) is assumed to be symmetrical and filled with leaves as if it were a healthy tree in excellent condition. This measure estimates the percent of leaf mass that is missing from the outline as compared to a healthy tree with a full symmetrical crown. Take into account the natural crown shape for the particular species.

Two perpendicular measures of missing leaf mass are made and the average result is recorded. Estimate to nearest 5%.

6.24 FOLIAGE TRANSPARENCY

When collected: All live trees ≥ 1.0 in DBH
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: 90% agreement
Values:

Code	Definition	Code	Definition	Code	Definition
00	0%	35	31-35%	70	66-70%
05	1-5%	40	36-40%	75	71-75%
10	6-10%	45	41-45%	80	76-80%
15	11-15%	50	46-50%	85	81-85%
20	16-20%	55	51-55%	90	86-90%
25	21-25%	60	56-60%	95	91-95%
30	26-30%	65	61-65%	99	96-100%

Note: Class code is the percentage of the upper limits of the class, i.e., Code 10 is 6% to 10%, etc. Estimates are recorded to the nearest 5 percent to be consistent throughout this guide with other procedures and to allow estimator flexibility.

Dead tree = Code 99.

FOLIAGE TRANSPARENCY is the amount of skylight visible through the live, normally foliated portion (where you see foliage, normal or damaged, or remnants of its recent presence) of the crown. A recently defoliated tree except for one or two live leaves should have a transparency rating of 99 not 0!! Check with binoculars to assess which branches are alive and should have foliage.

Different tree species have a normal range of **FOLIAGE TRANSPARENCY**, which may be more or less than that of other species. Changes in foliage transparency can also occur because of current damage, frequently referred to as defoliation, or from reduced foliage resulting from stresses during preceding years.

Estimate **FOLIAGE TRANSPARENCY** using the crown density - foliage transparency card (Figure 6-11). Exclude vine foliage from the transparency estimate as best you can. Dead branches in the lower live crown, snag branches, crown dieback and missing branches or areas where foliage is expected to be missing are deleted from the estimate (Figure 6-18).

When defoliation is severe, branches alone will screen the light, but you should exclude the branches from the foliage outline and rate the area as if the light was penetrating those branches. For example, an almost completely defoliated dense spruce may have less than 20 percent skylight

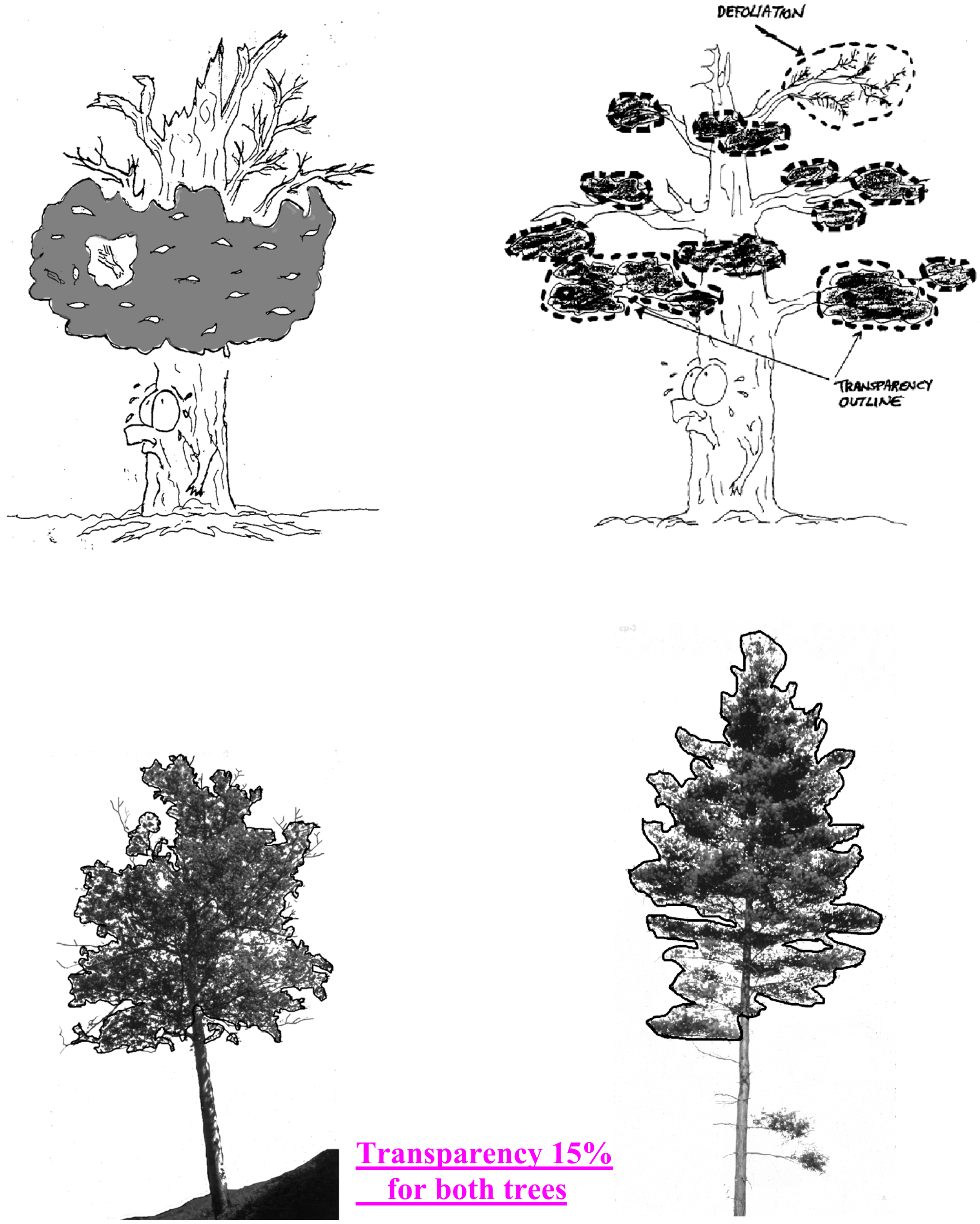


Figure 6-18. CROWN TRANSPARENCY rating outline examples.

coming through the crown, but it will be rated as highly transparent because of the missing foliage. Old trees and some hardwood species, have crowns with densely foliated branches that are widely spaced. These spaces between branches should not be included in the **FOLIAGE TRANSPARENCY** rating. When **FOLIAGE TRANSPARENCY** in one part of the crown differs from another part, the average **FOLIAGE TRANSPARENCY** is estimated.

Two people rate **FOLIAGE TRANSPARENCY** (Figure 6-12). First, each individual will mentally draw a two-dimensional crown outline. Second, the foliated area will be blocked into the crown outline. Third, estimate the transparency of the normally foliated area.

When two individuals disagree with their estimates, follow the guidelines listed at the end of section 6.11. The estimate is placed into one of 21 percentage classes.

6.25 CROWN DENSITY

When collected: All live trees ≥ 1.0 in DBH
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: 90% agreement
Values:

Code	Definition	Code	Definition	Code	Definition
00	0%	35	31-35%	70	66-70%
05	1-5%	40	36-40%	75	71-75%
10	6-10%	45	41-45%	80	76-80%
15	11-15%	50	46-50%	85	81-85%
20	16-20%	55	51-55%	90	86-90%
25	21-25%	60	56-60%	95	91-95%
30	26-30%	65	61-65%	99	96-100%

Note: Class code is the percentage of the upper limits of the class, i.e., Code 10 is 6% to 10%, etc. Estimates are recorded to the nearest 5 percent to be consistent throughout this guide with other procedures and to allow estimator flexibility.

CROWN DENSITY estimates crown condition in relation to a typical tree for the site where it is found. **CROWN DENSITY** also serves as an indicator of expected growth in the near future. **CROWN DENSITY** is the amount of crown branches, foliage and reproductive structures that blocks light visibility through the crown. Each tree species has a normal crown that varies with the site, genetics, tree damage, etc.

Two people measure **CROWN DENSITY** (Figure 6-12). To determine the crown shape, select the crown base on the stem used for **UNCOMPACTED LIVE CROWN RATIO**. Project a full "mirror image" crown based on that tree's shape where it is growing to the crown top (missing, dead or live). Foliage below the crown base is not included (Figure 6-10). If the top is broken or missing, mentally re-establish that portion of the tree before estimating **DENSITY**. Mentally project half-sided trees as full crowns by using the "mirror image" of the existing half of the crown. Include **CROWN DIEBACK** and open areas in this outline (Figures 6-19 and 6-20).

After determining the crown shape, each person should use the crown density - foliage transparency card (Figure 6-11). Along the line of sight, estimate what percentage of the outlined area is blocking sunlight. In cases where portions of the tree may be missing, i.e., half-sided trees, it may be easier to determine the percent of the crown shape missing and the actual density of the tree's remaining portion. Then use the table on the back of the crown density - foliage transparency card to arrive at the final **CROWN DENSITY**. When two individuals disagree with their estimates, follow the guidelines listed at the end of section 6.11. The estimate is placed into one of 21 percentage classes.

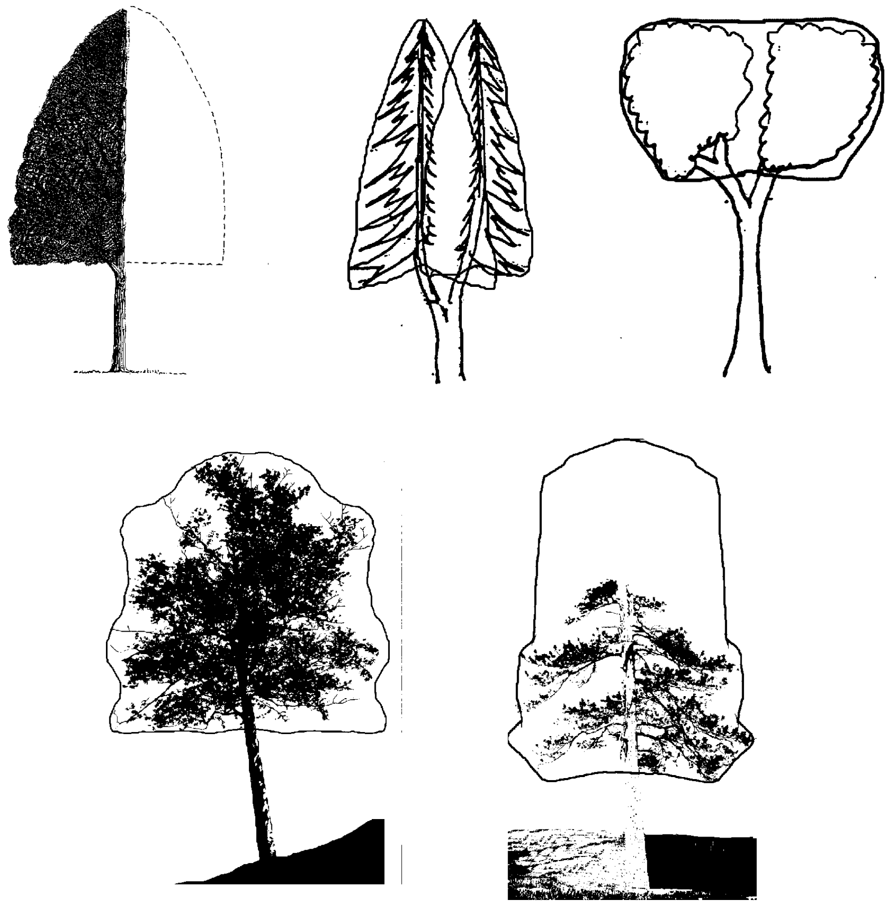


Figure 6-19. CROWN DENSITY rating outline examples.

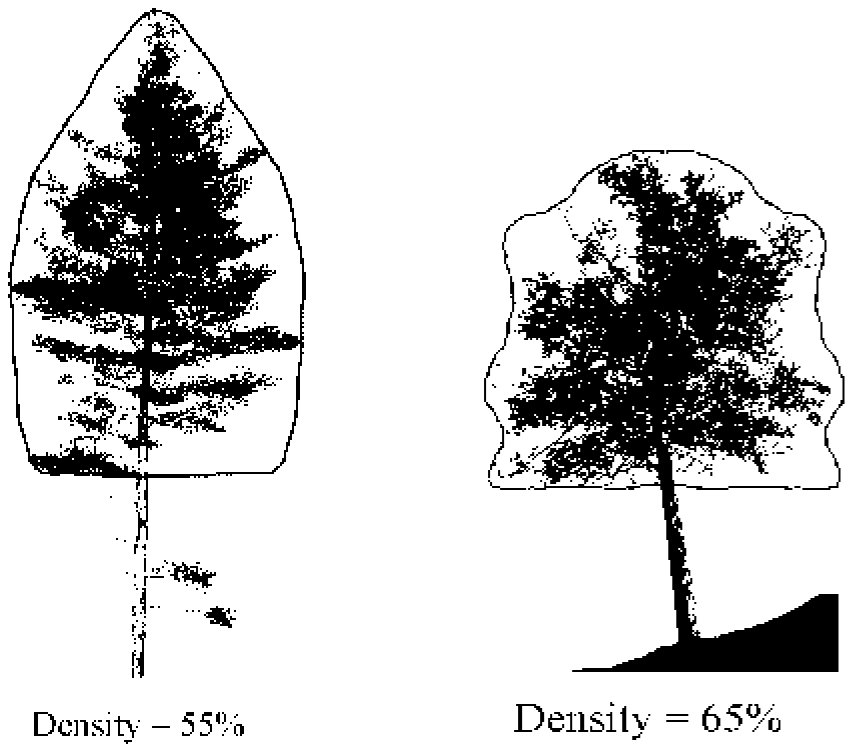


Figure 6-20. Crown density outline (live crown outline) and rating examples

6.26 CROWN DIEBACK

When collected: All live trees ≥ 1.0 in DBH
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: 90% agreement
Values:

Code	Definition	Code	Definition	Code	Definition
00	0%	35	31-35%	70	66-70%
05	1-5%	40	36-40%	75	71-75%
10	6-10%	45	41-45%	80	76-80%
15	11-15%	50	46-50%	85	81-85%
20	16-20%	55	51-55%	90	86-90%
25	21-25%	60	56-60%	95	91-95%
30	26-30%	65	61-65%	99	96-100%

Note: Class code is the percentage of the upper limits of the class, i.e., Code 10 is 6% to 10%, etc. Estimates are recorded to the nearest 5 percent to be consistent throughout this guide with other procedures and to allow estimator flexibility.

Dead tree = CODE 99

CROWN DIEBACK estimates reflect the severity of recent stresses on a tree. Estimate **CROWN DIEBACK** as a percentage of the live crown area, including the dieback area. The crown base should be the same as that used for the **UNCOMPACTED LIVE CROWN RATIO** estimate. Assume the perimeter of the crown is a two-dimensional outline from branch-tip to branch-tip,

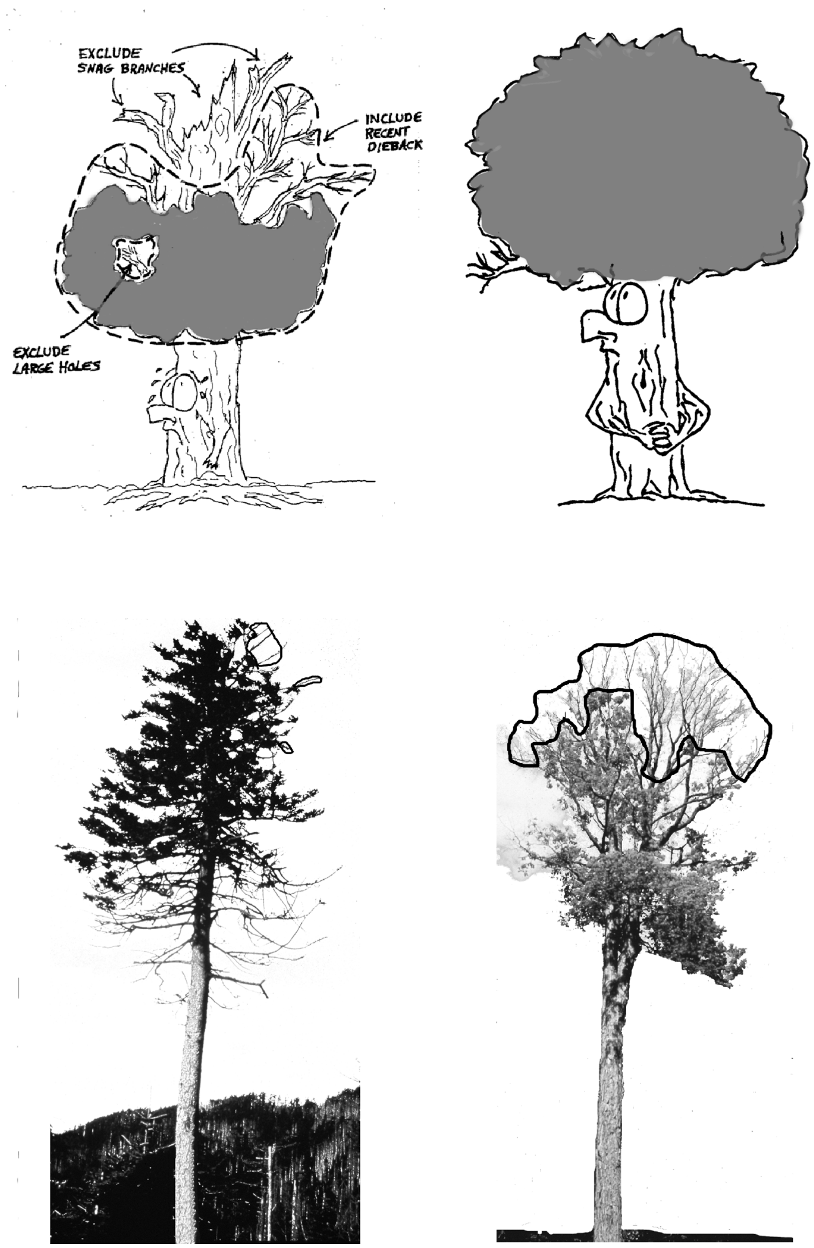


Figure 6-21. CROWN DIEBACK rating outline examples.

excluding snag branches and large holes or gaps in the crown (Figures 6-21 and 6-22).
Two people measure **CROWN DIEBACK** (Figure 6-12). Binoculars should be used to assist in the data collection. Observers should be conscious of lighting conditions and how light affects the day's observations. Under limited-light conditions, observers should take extra time. Poor lighting can make the measurement more difficult.

Each individual should mentally draw a two-dimensional crown outline, block in the dieback and estimate the dieback area. When two individuals disagree with their estimates, follow the guidelines listed at the end of section 6.11. The estimate is placed into one of 21 percentage classes.

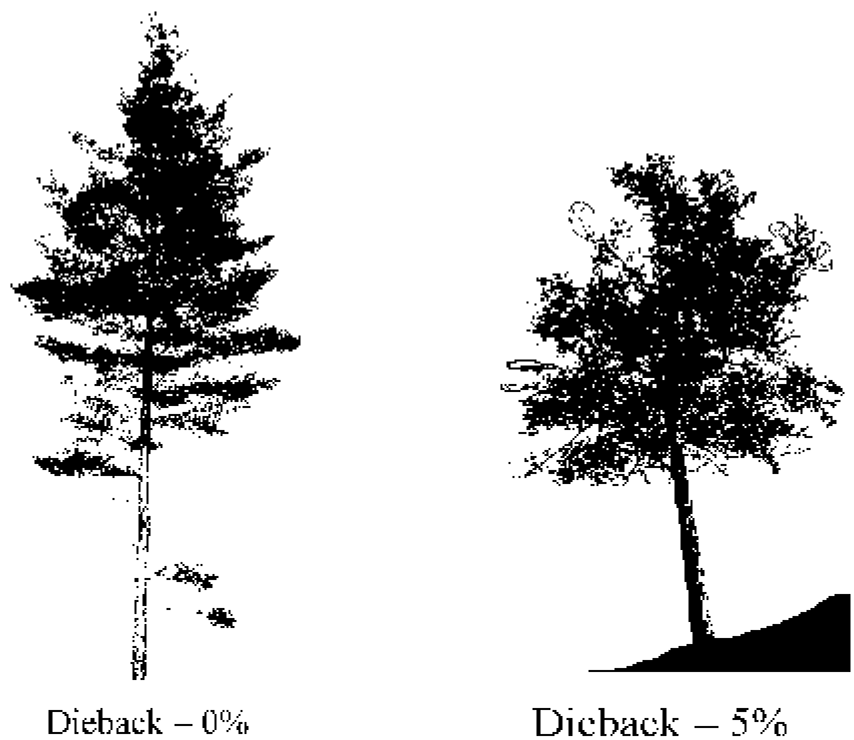


Figure 6-22. Dieback outline and rating examples

6.27 CAUSE OF DEATH

Record a cause of death for all trees that have died *or been cut since the previous survey*. If cause of death cannot be reliably estimated, record unknown/not sure.

When Collected: All TREE STATUS = 2
Field width: 2 digits
Tolerance: No errors
MQO: At least 80% of the time
Values:

10	Insect
20	Disease
30	Fire
40	Animal
50	Weather
60	Vegetation (suppression, competition, vines/kudzu)
70	Unknown/not sure/other (include notes)
80	Human-caused (cultural, logging, accidental, etc.)
90	Physical (hit by falling tree)

6.28 TREE DAMAGE

Record up to two different damages per tree. Damage is characterized according to three attributes: location of damage, type of damage, and severity of damage. Damages must meet severity thresholds (defined in section 6.28.3, **DAMAGE SEVERITY**) in order to be recorded.

The tree is observed from all sides starting at the roots. Damage signs and symptoms are prioritized and recorded based on location in the following order: roots, roots and lower bole, lower bole, lower and upper bole, upper bole, crownstem, and branches recorded as location code 0 (for no damage), or **DAMAGE LOCATION** 1-9.

Within any given location, the hierarchy of damage follows the numeric order of **DAMAGE TYPE** possible for that location. The numeric order denotes decreasing significance as the code number goes up, i.e., **DAMAGE TYPE** 01 is more significant than **DAMAGE TYPE** 25. A maximum of two damages are recorded for each tree. If a tree has more than two damages that meet the threshold levels, the first two that are observed starting at the roots are recorded.

When multiple damages occur in the same place, the most damaging is recorded. For example, if a canker, **DAMAGE TYPE** 02, meets the threshold and has a conk growing in it, record only the canker. Another example: if an open wound meets threshold and also has resinosis, record only the open wound.

6.28.1 DAMAGE LOCATION 1

Record the location on the tree where **DAMAGE TYPE 1** is found (Figure 6-23). If the same damage continues into two or more locations, record the appropriate code listed below, or if the combination of locations does not exist (damage extends from crownstem to roots), record the lowest location that best describes the damage (see Figure 6-24). Multiple damages may occur in the same location, but record the higher priority damage (lower code number) first. If the damages are coincident (a conk within a canker), record only the higher priority damage.

The "base of the live crown" is defined as the horizontal line which would touch the lowest part of the foliage, excluding branches towards the base of the tree which are less than 1.0 inch or more than 5 ft from the rest of the crown. See Section 6.15 **(UNCOMPACTED LIVE CROWN RATIO)** for more details.

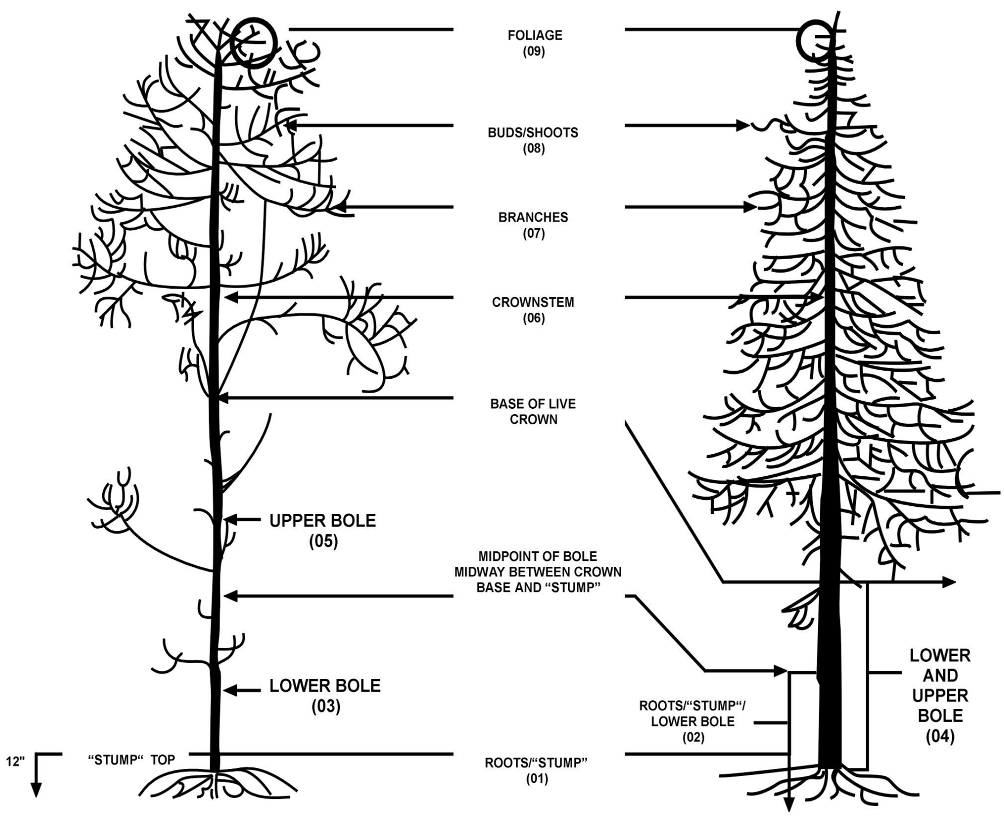


Figure 6-23. Location codes for damage.

When Collected: CORE: All live tally trees $\geq$ 5.0 in DBH
CORE OPTIONAL: All live tally trees $\geq$ 1.0 in DBH
Field width: 1 digit
Tolerance: +/- 1 location class
MQO: At least 80% of the time

Values:

0 No damage

1 Roots (exposed) and stump (12 inches in height from ground level)
For woodland species only: Since branches often originate below 12 in, Location 1 should include the roots but stop where the branches originate, if that occurs below the 12 in stump height. Any damage (open wound, etc.) found on a branch that originates below 12 in should be given Location 7 (branches).

2 Roots, stump, and lower bole

3 Lower bole (lower half of the trunk between the stump and base of the live crown)

4 Lower and upper bole

5 Upper bole (upper half of the trunk between stump and base of the live crown)

6 Crownstem (main stem within the live crown area, above the base of the live crown)

7 Branches (>1 in at the point of attachment to the main crown stem within the live crown area)

8 Buds and shoots (the most recent year's growth)

9 Foliage

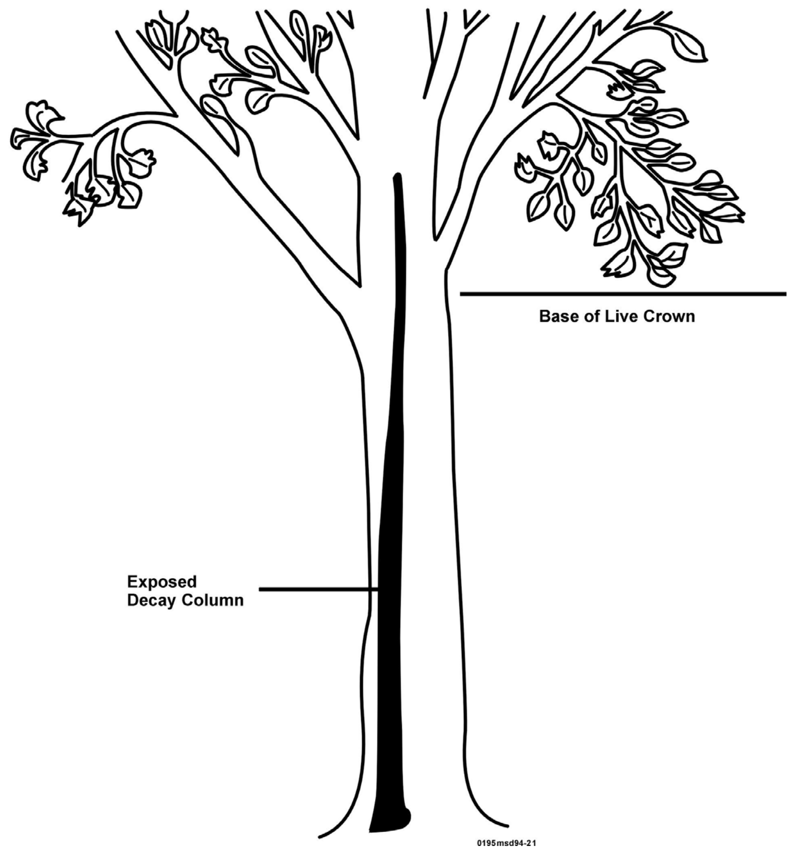


Figure 6-24. The damage runs from stump to crownstem. Code here should be 02 (roots and "stump" and lower bole) which represents the lowest locations of this multi-location damage.

6.28.2 DAMAGE TYPE 1

Record the first damage type observed that meets the damage threshold definition in the lowest location. Damage categories are recorded based on the numeric order that denotes decreasing significance from damage 01 - 31.

When Collected: All tally trees where DAMAGE LOCATION 1 > 0
Field width: 2 digits
Tolerance: No errors
MQO: At least 80% of the time
Values:

1 Canker, gall: Cankers may be caused by various agents but are most often caused by fungi. The bark and cambium are killed, and this is followed by death of the underlying wood, although the causal agent may or may not penetrate the wood.

This results in areas of dead tissue that become deeper and wider, or galling (including galls caused by rusts), on roots, bole, or branches. Due to the difficulty in distinguishing some abnormal swellings (e.g., burls) from classic galls and cankers, all are recorded as damage 01. A canker may be:

Annual (enlarges only once and does so within an interval briefer than the growth cycle of the tree, usually less than one year),

Diffuse (enlarges without characteristic shape or noticeable callus formation at margins), or

Perennial (enlarges during more than one year - often has a target appearance).

2 Conks, fruiting bodies, and signs of advanced decay: Fruiting bodies on the main bole, crownstem, and at the point of the branch attachment are signs of decay. "Punky wood" is a sign of decay and is evidenced by soft, often moist, and degraded tissue.

Cavities into the main bole that are oriented in such a way that they act as catchment basins for water are signs of decay. Bird cavities are signs of decay.

Rotten branches or branches with conks **are not indicators of decay unless** the threshold is met (>20% of branches are affected).

Rotting stumps associated with coppice regeneration (e.g., northern pin oak, maple) are excluded from coding.

3 Open wounds: An opening or series of openings where bark has been removed or the inner wood has been exposed and no signs of advanced decay are present. Improper pruning wounds that cut into the wood of the main stem are coded as open wounds, if they meet the threshold; those which leave the main stemwood intact are excluded.

4 Resinosis or gummosis: The origin of areas of resin or gum (sap) exudation on branches and trunks.

5 Cracks and seams: Cracks in trees are separations along the radial plane greater than or equal to 5 ft. When they break out to the surface they often are called frost cracks. These cracks are not caused by frost or freezing temperature, though frost can be a major factor in their continued development. Cracks are most often caused by basal wounds or sprout stubs, and expand when temperatures drop rapidly. Seams develop as the tree attempts to seal the crack, although trees have no mechanism to compartmentalize this injury.

Lightning strikes are recorded as cracks when they do not meet the threshold for open wounds.

11 Broken bole or roots (less than 3 ft from bole): Broken roots within 3 ft from bole either from excavation or rootsprung for any reason. For example, those which have been excavated in a road cut or by animals.

Stem broken in the bole area (below the base of the live crown) and tree is still alive.

12 Brooms on roots or bole: Clustering of foliage about a common point on the trunk. Examples include ash yellows witches' brooms on white and green ash and eastern and western conifers infected with dwarf mistletoes.

13 Broken or dead roots (beyond 3 ft): Roots beyond 3 ft from bole that are broken or dead.

20 Vines in the crown: Kudzu, grapevine, ivy, dodder, etc. smothers tree crowns. Vines are rated as a percentage of tree crown affected.

21 Loss of apical dominance, dead terminal: Mortality of the terminal of the crownstem caused by frost, insect, pathogen, or other causes.

22 Broken or dead: Branches that are broken or dead. Branches with no twigs are ignored and not coded as dead. Dead or broken branches attached to the bole or crownstem outside the live crown area are not coded. 20% of the main, first order portion of a branch must be broken for a branch to be coded as such. For woodland species only: Since dead branches often originate below the 12 in stump height and must be measured for DRC, there is no requirement that damage to branches can only occur to branches that originate within the live crown area.

23 Excessive branching or brooms within the live crown area: Brooms are a dense clustering of twigs or branches arising from a common point that occur within the live crown area. Includes abnormal clustering of vegetative structures and organs. This includes witches' brooms caused by ash yellows on green and white ash and those caused by dwarf mistletoes.

24 Damaged buds, foliage or shoots: Insect feeding, shredded or distorted foliage, buds or shoots >50% affected, on at least 30% of foliage, buds or shoots. Also includes herbicide or frost-damaged foliage, buds or shoots.

25 Discoloration of foliage: At least 30% of the foliage is more than 50% affected. Affected foliage must be more of some color other than green. If the observer is unsure if the color is green, it is considered green and not discolored.

31 Other: Use when no other explanation is appropriate. Specify in the tree notes section. Code 31 is used to maintain consistency with the Phase 3 crown damage protocols.

Legal Combinations of DAMAGE TYPE by DAMAGE LOCATION:

For each of the following location codes, possible damage codes and damage definitions are presented. Minimum damage thresholds are described in Section 6.28.3, DAMAGE SEVERITY.

Location 1: Roots and stump

01	Canker, gall -- exceeds 20% of circumference of stump
02	Conks, fruiting bodies, and signs of advanced decay -- any occurrence
03	Open wounds -- exceeds 20% of circumference of stump
04	Resinosis or gummosis -- origin of flow width exceeds 20% of circumference of stump
05	Cracks and seams -- any occurrence
11	Broken bole or roots less than 3 ft from bole -- any occurrence
12	Brooms on roots or bole -- any occurrence.
13	Broken or dead roots -- exceeds 20% of roots, beyond 3 ft from bole, broken or dead
31	Other

Location 2: Roots, stump, and lower bole

01	Canker, gall -- exceeds 20% of circumference of stump
02	Conks, fruiting bodies, and signs of advanced decay -- any occurrence
03	Open wounds – exceeds 20% at the point of occurrence, or for the portion in root zone, 20% of the circumference of stump
04	Resinosis or gummosis -- origin of flow width exceeds 20% at the point of occurrence, or for the portion in root zone, 20% of circumference of stump.
05	Cracks and seams - any occurrence
11	Broken bole or roots less than 3 ft from bole -- any occurrence
12	Brooms on roots or bole - -any occurrence.
13	Broken or dead roots -- exceeds 20% of roots, beyond 3 ft from bole, broken or dead
31	Other

Location 3: Lower bole

01	Canker, gall -- exceeds 20% of circumference at the point of occurrence
02	Conks, fruiting bodies, and signs of advanced decay -- any occurrence
03	Open wounds -- exceeds 20% of circumference at the point of occurrence
04	Resinosis or gummosis -- origin of flow width exceeds 20% of circumference at the point of occurrence
05	Cracks and seams -- any occurrence
11	Broken bole or roots less than 3 ft from bole -- any occurrence
12	Brooms on roots or bole -- any occurrence
31	Other

Location 4: Lower and upper bole -- same as lower bole.

Location 5: Upper bole - same as lower bole.

Location 6: Crownstem

01 Canker, gall -- exceeds 20% of circumference of crownstem at the point of occurrence
02 Conks, fruiting bodies, and signs of advanced decay -- any occurrence
03 Open wounds - exceeds 20% of circumference at the point of occurrence -- any occurrence
04 Resinosis or gummosis -- origin of flow width exceeds 20% of circumference at the point of occurrence
05 Cracks and seams -- all woody locations -- any occurrence.
21 Loss of apical dominance, dead terminal -- any occurence
31 Other

Location 7: Branches >1 in at the point of attachment to the main or crown stem

01 Canker, gall -- exceeds 20% of circumference on at least 20% of branches
02 Conks, fruiting bodies and signs of advanced decay -- more than 20% of branches affected
03 Open wounds -- exceeds 20% of circumference at the point of occurrence on at least 20% of branches
04 Resinosis or gummosis -- origin of flow width exceeds 20% of circumference at the point of occurrence on at least 20% of branches
05 Cracks and seams -- all occurrences, and on at least 20% of branches
20 Vines in the crown -- more than 20% of live crown affected
22 Broken or dead -- more than 20% of branches affected within the live crown area, except for woodland species where there is no requirement that damage to branches can only occur to branches that originate within the live crown area.
23 Excessive branching or brooms -- more than 20% of branches affected
31 Other

Location 8: Buds and shoots

24 Damaged buds, shoots or foliage - more than 30% of buds and shoots damaged more than 50%.
31 Other.

Location 9: Foliage

24 Damaged buds, shoots or foliage - more than 30% of foliage damaged more than 50%.
25 Discoloration of foliage - more than 30% of foliage discolored more than 50%.
31 Other.

6.28.3 DAMAGE SEVERITY 1

Record a code to indicate the amount of affected area (above threshold) in **DAMAGE LOCATION 1** recorded for **TREE DAMAGE 1**. Severity codes vary depending on the type of damage recorded.

When Collected: All tally trees where DAMAGE LOCATION 1 > 0
Field width: 2 digits
Tolerance: No errors
MQO: At least 80% of the time
Values: The codes and procedures for SEVERITY 1 values are defined for each DAMAGE TYPE 1.

DAMAGE TYPE Code 01 -- Canker, gall

Measure the affected area from the margins (outer edges) of the canker or gall within any 3-ft vertical section in which at least 20% of circumference is affected at the point of occurrence. For location 7, and location 1, 20% of branches and roots beyond 3 ft, respectively, must be affected, then record in 10% classes. See Figure 6-25.

Severity classes for code 01 (percent of circumference affected):

Classes	Code
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

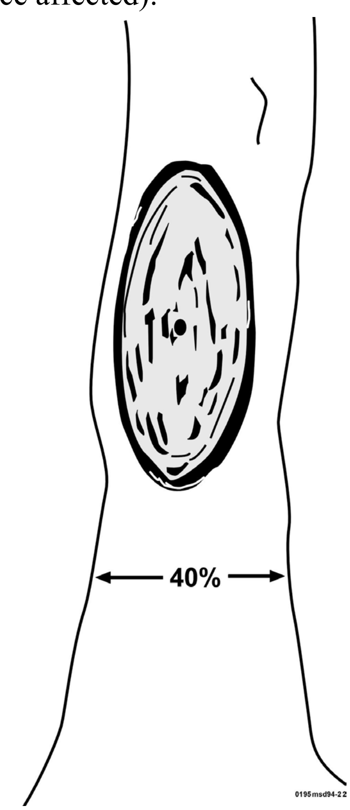


Figure 6-25. A canker which exceeds threshold. Since 40% of circumference is visible from any side, and since over half the visible side is taken up by the canker, it obviously exceeds the 20% minimum circumference threshold.

DAMAGE TYPE Code 02 -- Conks, fruiting bodies, and signs of advanced decay

Severity classes for code 02: **None**. Enter code 0 regardless of severity, except for roots > 3 ft from the bole, or number of branches affected - 20%

DAMAGE TYPE Code 03 -- Open wounds

The damaged area is measured at the widest point between the margins of the exposed wood within any 3-ft vertical section in which at least 20% of the circumference is affected at the point of occurrence. For location 7, and location 1, 20% of branches and roots beyond 3 ft, respectively, must be affected, then record in 10% classes. See Figure 6-26.

Severity Classes for code 03 (percent of circumference affected):

Classes	Code
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

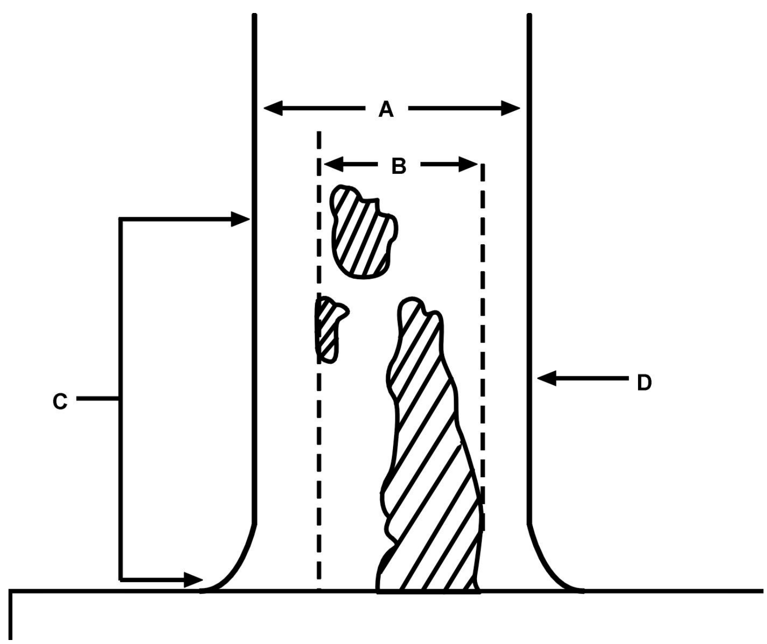


Figure 6-26. Multiple damage in "stump" and lower bole. A=approximately 40% of tree circumference; B=portion of tree circumference affected by damage; C=vertical distance within one meter; D=midpoint of occurence at which circumference is measured.

DAMAGE TYPE Code 04 -- Resinosis or gummosis

Resinosis or gummosis is measured at the widest point of the origin of the flow width in which at least 20% of the circumference is affected at the point of occurrence. For location 7, and location 1, 20% of branches and roots beyond 3 ft, respectively, must be affected, then record in 10% classes.

Severity classes for code 04 (percent of circumference affected):

Classes	Code
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

DAMAGE TYPE Code 05 -- Cracks and seams greater than or equal to 5 ft

Severity class for code 05 -- Record "0" for the lowest location in which the crack occurs. For location 7, and location 1, 20% of branches and roots beyond 3 ft, respectively, must be affected, then record in 10% classes.

DAMAGE TYPE Code 11 -- Broken bole or roots less than 3 ft from bole

Severity classes for code 11: None. Enter code 0 regardless of severity.

DAMAGE TYPE Code 12 -- Brooms on roots or bole

Severity classes for code 12: None. Enter code 0 regardless of severity.

DAMAGE TYPE Code 13 -- Broken or dead roots

At least 20% of roots beyond 3 ft from bole that are broken or dead.

Severity classes for code 13 (percent of roots affected):

Classes	Code
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

DAMAGE TYPE Code 20 -- Vines in crown

Severity classes for code 20 (percent of live crown affected):

Classes	Code
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

DAMAGE TYPE Code 21 -- Loss of apical dominance, dead terminal

Any occurrence (> 1%) is recorded in 10% classes as a percent of the crownstem affected. Use trees of the same species and general DBH/DRC class in the area or look for the detached portion of the crownstem on the ground to aid in estimating percent affected. If a lateral branch has assumed the leader and is above where the previous terminal was, then no damage is recorded.

Severity classes for code 21:

Classes	Code
01-09	0
10-19	1
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

DAMAGE TYPE Code 22 -- Broken or dead branches (> 1in above the swelling at the point of attachment to the main or crown stem within the live crown area)

At least 20% of branches are broken or dead.

For woodland species, severity should be based on volume and not by % (or number of) branches affected. Calculate severity by taking the square of the diameter of each stem, summing them up, and recording the percent of total as the severity class.

Severity classes for code 22 (percent of branches affected):

Classes	Code
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

DAMAGE TYPE Code 23 -- Excessive branching or brooms

At least 20% of crownstem or branches affected with excessive branching or brooms.

Severity classes for code 23 (percent of area affected):

Classes	Code
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

DAMAGE TYPE Code 24 - Damaged buds, shoots or foliage

At least 30% of the buds, shoots or foliage (i.e., chewed or distorted) are more than 50% affected.

Severity classes for code 24:

Classes	Code
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

DAMAGE TYPE Code 25 - Discoloration of Foliage

At least 30% of the foliage is more than 50% affected.

Severity classes for code 25 (percent affected):

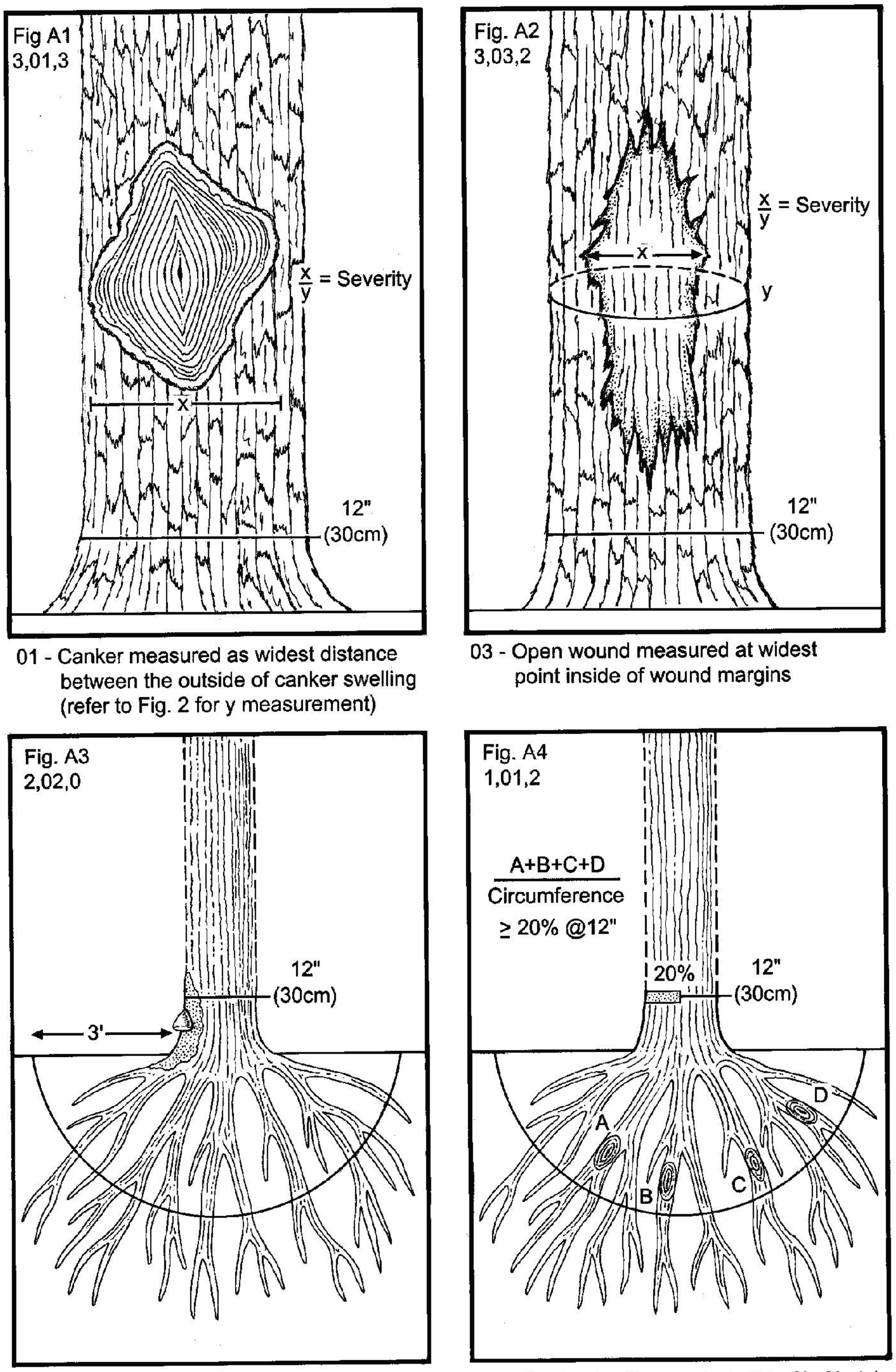
Classes	Code
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

DAMAGE TYPE Code 31 – Other **(Note: Used if damage agent is present, regardless of severity, but damage type of the agent cannot be recorded in another damage class. (e.g. confined space, absent basal trunk flare) See damage agent list.**

Severity classes for code 31:

None. Enter code 0 regardless of severity. Describe condition in tree notes.

Examples are shown in Figures 6-26 through 6-32.



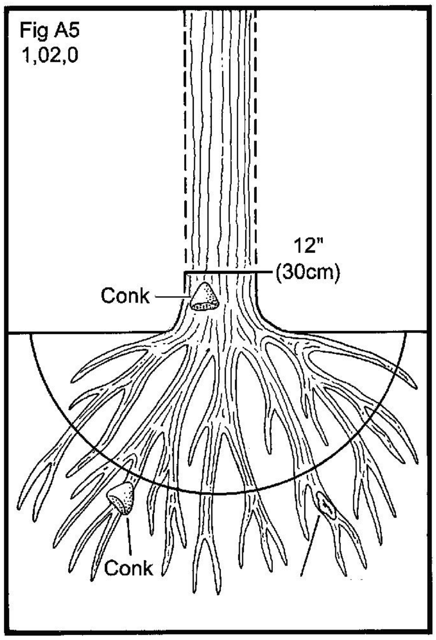
01 - Canker measured as widest distance between the outside of canker swelling (refer to Fig. 2 for y measurement)

03 - Open wound measured at widest point inside of wound margins

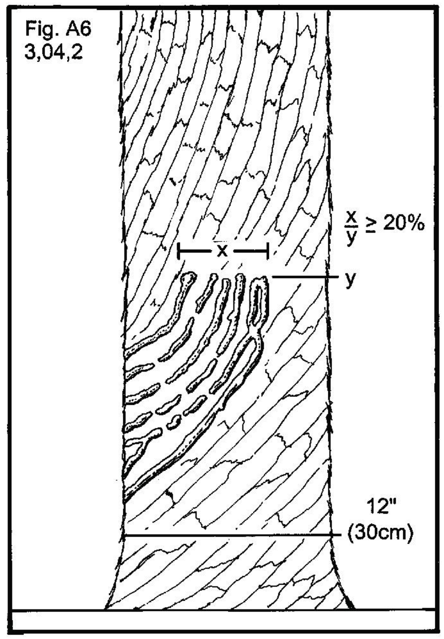
02 - Decay indicator on roots and lower bole

01 - Canker / gall on roots (within 3' of bole)

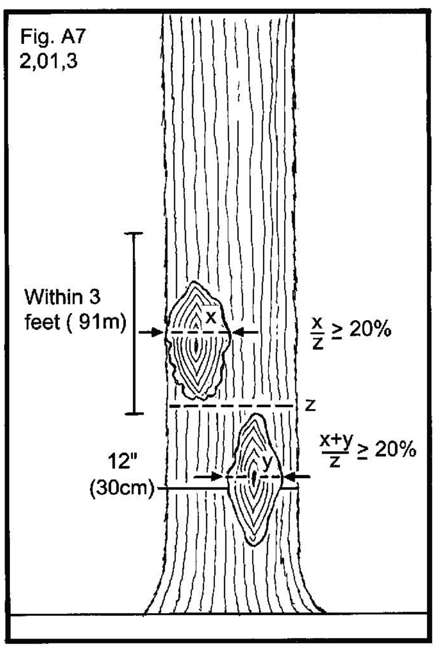
Figure 6-26. Examples of damage coding.



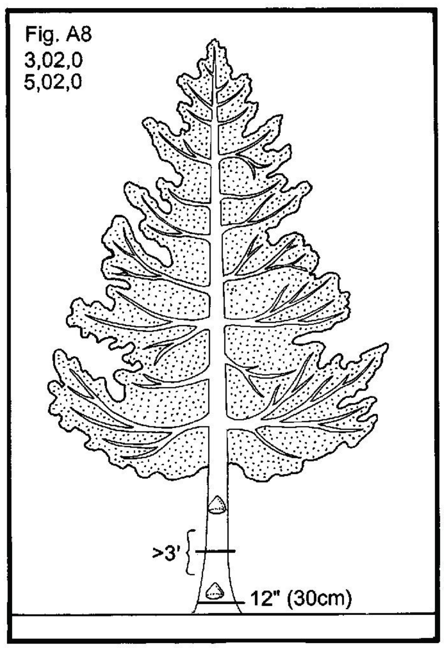
02 - Indicator of decay within 3' of bole. Beyond 3" of bole, indicators must affect ≥ 20% of roots (see fig. 12)



04 - Origin of resinosis in lower bole

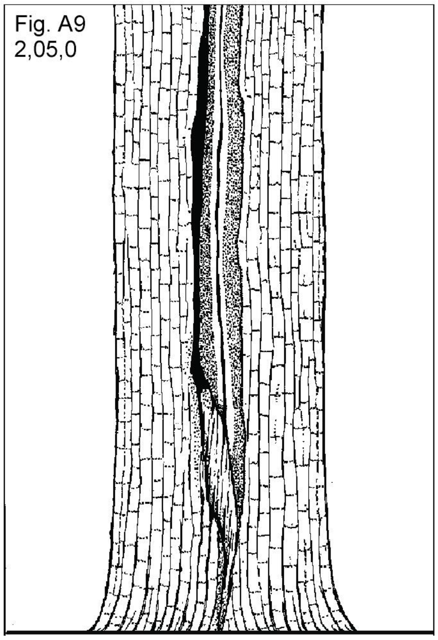


01 - Additive cankers within 3' in roots and lower bole

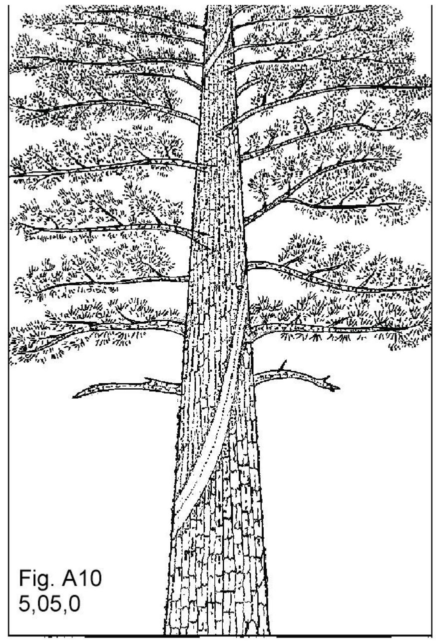


02 - Conks separated by >3'; 2 damages

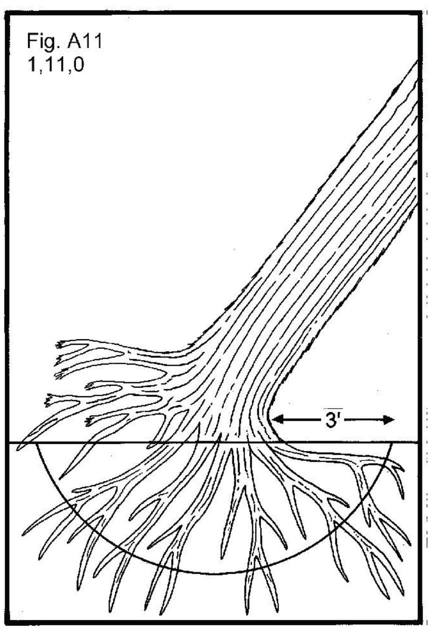
Figure 6-27. Examples of damage coding.



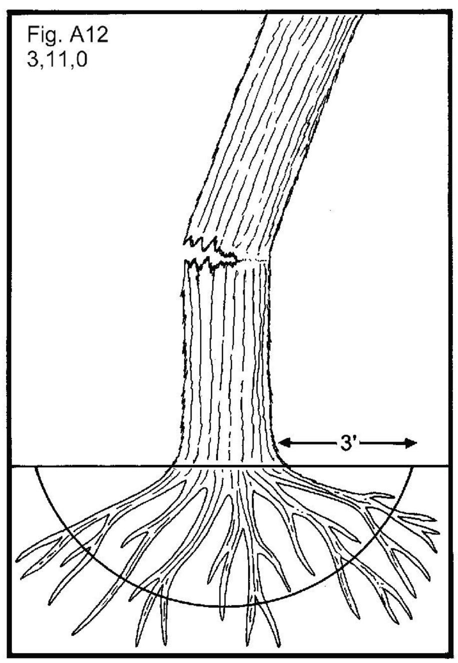
05- Cracks and seams



05 - Lightning strike

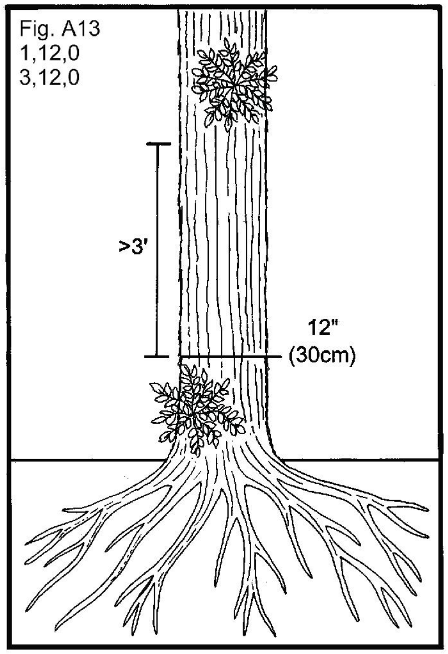


11 - Broken bole or roots <3' from bole, broken roots must be visible

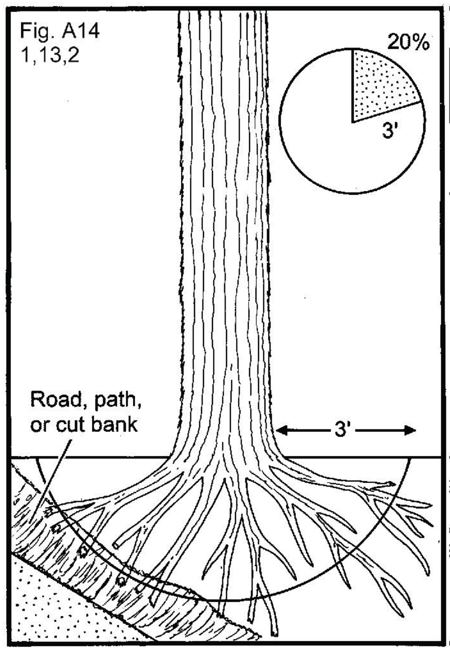


11 - Broken bole or roots <3' from bole

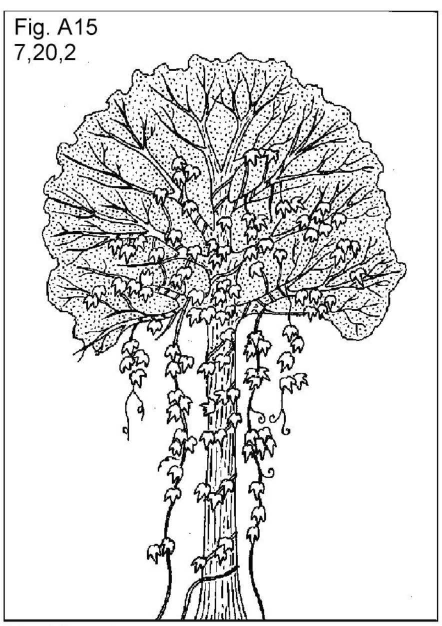
Figure 6-28. Examples of damage coding.



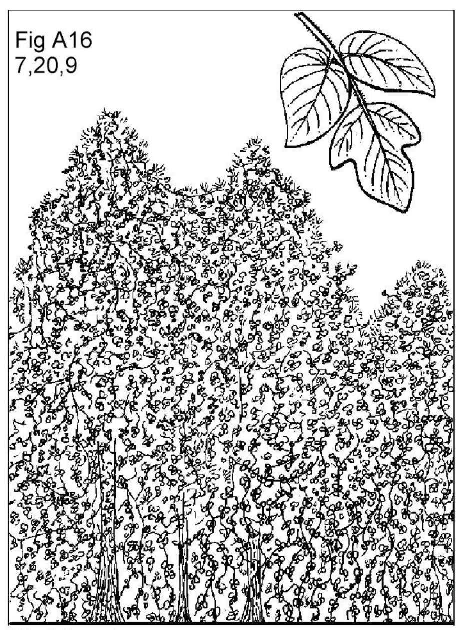
12 - Brooms on roots or bole



13 - Broken or dead roots >3' from bole

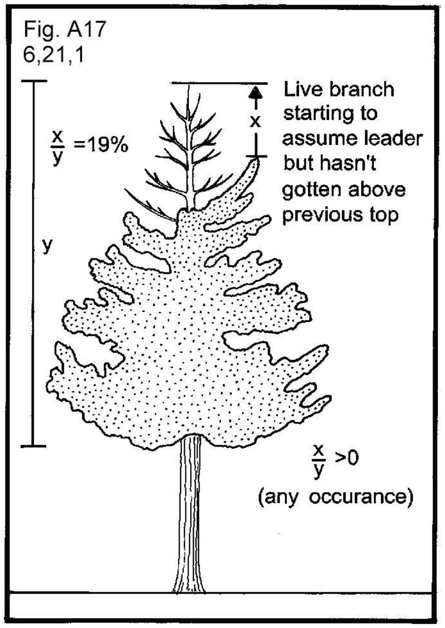


20 - Vines in crown

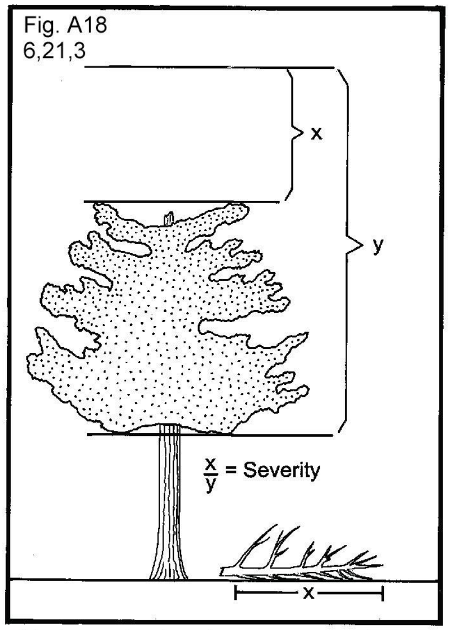


20 - Vines in crown

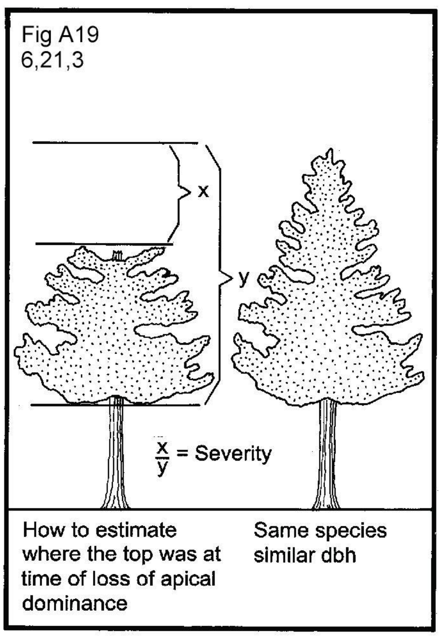
Figure 6-29. Examples of damage coding.



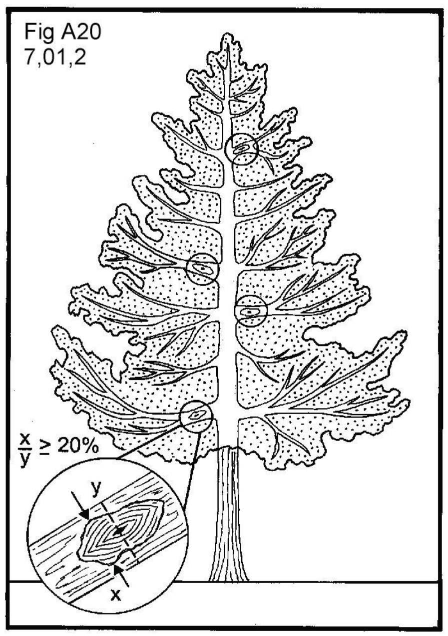
21 - Loss of apical dominance



21 - Loss of apical dominance, look for old top to estimate the top of x and y

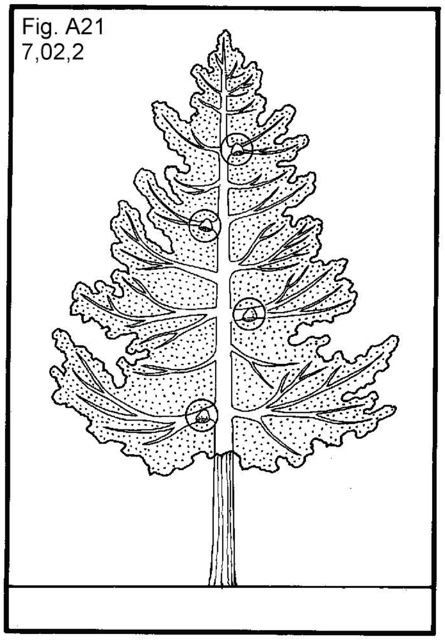


21 - Loss of apical dominance, look for same species of similar dbh

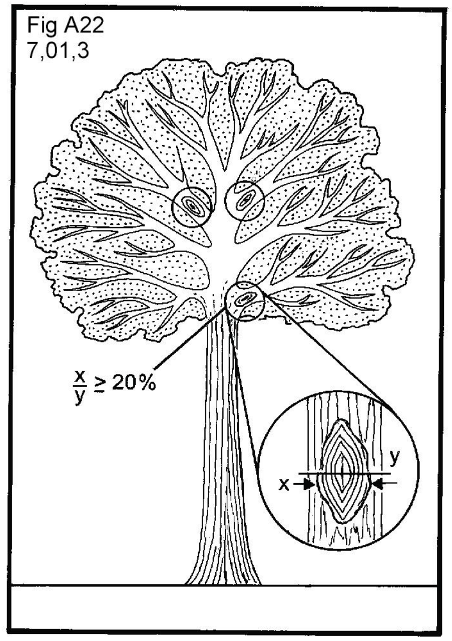


01 - Cankers above the threshold on ≥ 20% of branches

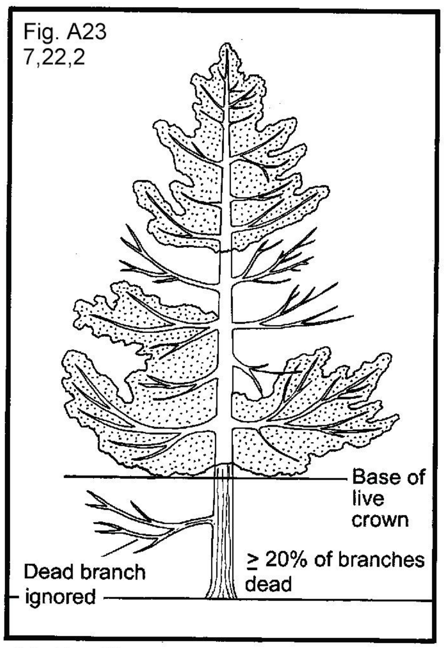
Figure 6-30. Examples of damage coding.



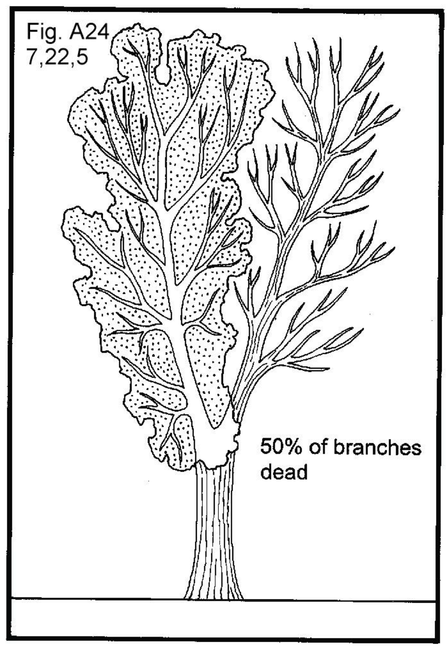
02 - Conks on ≥ 20% of branches



01 - Cankers above threshold on ≥ 20% of branches



22 - Dead branches within the live crown area. If branches cannot easily be counted, estimate % area of live crown affected



22 - Dead branches; only 2 branches present within live crown area, fines present and ≥ 20% of branch dead

Figure 6-31. Examples of damage coding.

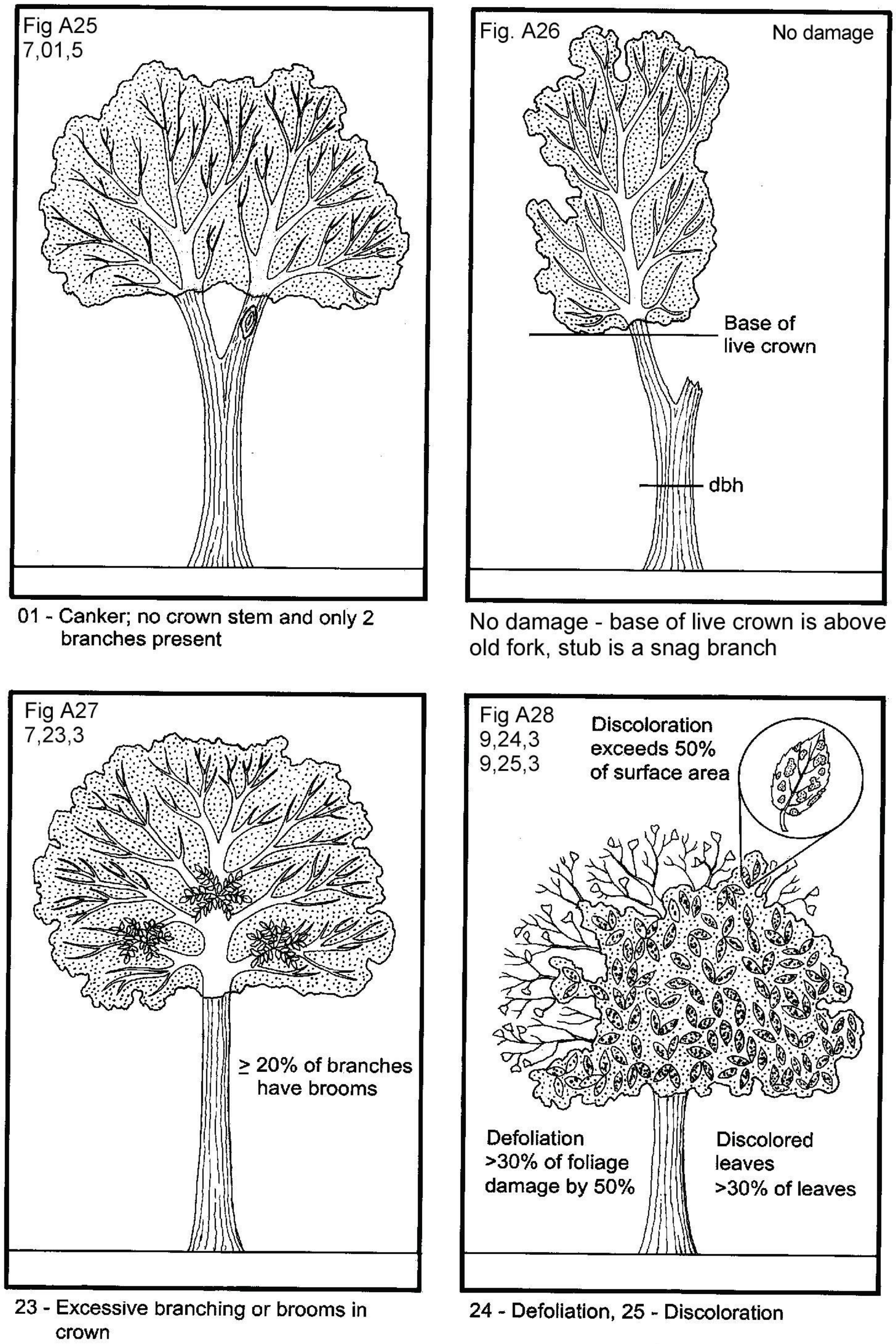


Figure 6-32. Examples of damage coding.

Procedures to Record Multiple Occurrences of the Same Damage

Damage codes 01 (canker), 03 (open wounds), and 04 (resinosis/gummosis) must meet a threshold of 20 percent of the circumference at the point of occurrence, within any 3-ft section. Multiple cankers or open wounds which are directly above one another pose no more threat to long term tree survival than would a single damage incidence of the same width. However, should multiple damages be located horizontally within any 3-ft section, the translocation of water and nutrients would be significantly affected. The widths of each individual damage are added and compared as a percent, to the total circumference at the midpoint of the 3-ft section (Figure 6-26).

Procedures to Measure Circumference Affected

A practical approach is to observe every face of the "stump", bole, or crownstem. About 40% of the circumference of a face can be observed at any one time. The damage is measured horizontally between the margins. If the cumulative area affected within a 3-ft section exceeds 1/2 of any face, then the 20% minimum threshold has been met. The percent of the circumference affected by damage is then estimated in 10% classes. If in doubt, measure the damage and circumference at the widest point of occurrence on the bole with a linear tape, and determine the percent affected.

6.28.4 URBAN DAMAGE AGENT 1

Record appropriate urban damage agent for **DAMAGE TYPE 1**. Agents 5,6,7,8,10,14,15,16,19 must be recorded if damage is present.

Urban Damage Agents:

1. **Stem Girdling Root** (damage type code 01) – Roots that encircle or grow tangential to the stem of a tree and cause bark and wood tissue compression. Must meet the 20% threshold.
2. **Chlorosis** (damage type code 25) – Diffused or patterned subnormal chlorophyll development. Must meet 30% threshold of foliage present affected.
3. **Topped Tree** (damage type code 21) – Crownstem of tree is cut as per the manner of many poorly informed tree miscare companies.
4. **Poor Pruning** (damage type code 03) – Tipping, flush and stub cutting of branches. Must meet 20% threshold of branches affected.
5. **Dutch Elm Disease** (damage type code 25) – Affects only elm species. Includes flagging: discolored, light-colored foliage on single branches appearing obvious against the normal crown; and, more advanced discoloration and wilting of foliage throughout the entire crown. Must be recorded if present.
6. **Verticillium** (damage type code 25) – Affects many tree species, most especially maples and ash. Verticillium has acute and chronic symptoms. Acute symptoms include curling, drying, or abnormal red or yellow leaves between veins; defoliation, wilting, dieback and death. Chronic symptoms include slow growth, sparse foliage, stunted leaves and twigs, scorch, heavy seed crops, and dieback. Must be recorded if present.
7. **Gypsy Moth** (damage type code 24, if defoliation present, or 31) – On many trees, especially oaks. Look for egg masses or pupal cases. Must be recorded if present.
8. **Asian Longhorned Beetle** (damage type code 31) – On several species, especially maples, elms, horse chestnut, and buckeye. Look for tarry spots on light bark, and big, dark holes, ½ inch or more in diameter, with well defined edges resembling precisely drilled holes. Must be recorded if present.

9. **Dogwood Anthracnose** (damage type codes 01, 24, or 25 depending on symptoms present) - Dogwood anthracnose is a disease of flowering and Pacific dogwood. Leaf symptoms develop first in the lower crown and progress up the tree. Symptoms include tan spots that develop purple rims. Leaves may also have necrotic veins and leaf margins, and large necrotic blotches. In some cases shot holes appear. Direct infection of shoots, resulting in tiny cankers, may occur on flowering dogwood during spring and fall. Girdling cankers typically develop at leaf nodes, causing twig dieback. Must meet threshold.
10. **Sudden Oak death** (damage type code 31) – Only in California and southwest Oregon at this time. Red oak group is highly susceptible. Look for bleeding cankers, (discolored gum flow), as differentiated from wetwood, or red oak borer holes. Must be recorded if present.
11. **Bacterial Leaf Scorch** (damage type code 25) – Affects elm, oak, sycamore and mulberry, and maple, mostly in the mid-atlantic and southeastern states. Can be confused with wilt diseases. Mostly manifested as leaf scorch, followed by dieback, decline, and death.
12. **Forest Tent Caterpillar** (damage type code 24) – Defoliator of oaks, aspen and birch primarily. In the spring, look for caterpillars with white keyhole-shaped spots along the back, amidst blue stripes.
13. **Codominant lead with included bark** (damage type code 31) – A fork where any branch comprises at least 20% of the crown volume. The crotch, or fork union, is "V" shaped and results in the formation of a bark ridge at the union forcing the major forks apart as the tree grows.
14. **Oak wilt** (damage type code 25) – Affects the red oak group principally. Can cause chronic dieback in white oaks, especially bur oak. In red oaks, leaves wilt and fall within several weeks in early July in the north. Must be recorded if present.
15. **Confined space** (damage type code 31) – At or below ground. Must be recorded if present.
16. **Object restricting crown growth - anthroprogenic** (damage type code 31)
17. **Girdling from foreign object** (damage type code 31)
18. **Construction activity evident around tree** (damage type code 31)
19. **Absent basal trunk flare** (damage type code 31) – evidence of planting too deeply. Must be recorded if present.
20. **Other human** (damage type code 31) – describe in notes

When Collected: All tally trees where DAMAGE LOCATION 1 > 0
Field width: 2 digits
Tolerance: No errors
MQO: At least 80% of the time
Values:

Urban Damage Agent Codes 1-20.

6.28.5 DAMAGE LOCATION 2

Record the location on the tree where TREE DAMAGE 2 is found. Follow the same procedures as for DAMAGE LOCATION 1.

6.28.6 DAMAGE TYPE 2

RECORD the second damage type observed that meets the damage threshold definition in the lowest location. Follow the same procedures as for DAMAGE TYPE 1.

6.28.7 DAMAGE SEVERITY 2

Record the amount of affected area (above threshold) in DAMAGE LOCATION 2 recorded for DAMAGE TYPE 2. Follow the same procedures as for DAMAGE SEVERITY 1.

6.28.8 URBAN DAMAGE AGENT 2

Record appropriate urban damage agent for DAMAGE TYPE 2. Agents 5,6,7,8,10,14,15,16,19 must be recorded if damage is present.

6.28.9 DAMAGE LOCATION 3

Record the location on the tree where TREE DAMAGE 2 is found. Follow the same procedures as for DAMAGE LOCATION 1.

6.28.10 DAMAGE TYPE 3

RECORD the third damage type observed that meets the damage threshold definition in the lowest location. Follow the same procedures as for DAMAGE TYPE 1.

6.28.11 DAMAGE SEVERITY 3

Record the amount of affected area (above threshold) in DAMAGE LOCATION 3 recorded for DAMAGE TYPE 3. Follow the same procedures as for DAMAGE SEVERITY 1.

6.28.12 URBAN DAMAGE AGENT 3

Record appropriate urban damage agent for DAMAGE TYPE 3. Agents 5,6,7,8,10,14,15,16,19 must be recorded if damage is present.

6.28.13 DAMAGE LOCATION 4

Record the location on the tree where TREE DAMAGE 4 is found. Follow the same procedures as for DAMAGE LOCATION 1.

6.28.14 DAMAGE TYPE 4

RECORD the fourth damage type observed that meets the damage threshold definition in the lowest location. Follow the same procedures as for DAMAGE TYPE 1.

6.28.15 DAMAGE SEVERITY 4

Record the amount of affected area (above threshold) in DAMAGE LOCATION 4 recorded for DAMAGE TYPE 4. Follow the same procedures as for DAMAGE SEVERITY 1.

6.28.16 URBAN DAMAGE AGENT 4

Record appropriate urban damage agent for DAMAGE TYPE 4. Agents 5,6,7,8,10,14,15,16,19 must be recorded if damage is present.

6.29 BUILDING ENERGY DATA

Data is collected for trees>=20 feet in total height within 60 feet of buildings (space conditioned structures) that are 3 (2 stories + attic) in height. Do not count unheated garages, sheds, etc.

6.29.1 BUILDING DISTANCE 1

The shortest distance to the building measured in feet. Measure to closest wall or to corner of building (for tree planted on corner)

When Collected: All trees>=20ft. in height
Field width: 1 digits
Tolerance:
MQO:
Values:

1 less than 20 feet
2 21 to 40 feet
3 41 to 60 feet

6.29.2 BUILDING AZIMUTH 1

Direction **to** building, measured in degrees. Note: some trees may be within 60 feet of more than one building; in this case; add data to BUILDING 2 for second building, BUILDING 3 for third building, etc. The building the tree affects does not have to be on the plot.

When Collected: All trees>=20ft. in height
Field width: 3 digits
Tolerance:
MQO:
Values: 000 to 360

6.29.3 BUILDING DISTANCE 2

Follow same procedures as BUILDING DISTANCE 1

6.29.4 BUILDING AZIMUTH 2

Follow same procedures as BUILDING AZIMUTH 1

6.29.5 BUILDING DISTANCE 3

Follow same procedures as BUILDING DISTANCE 1

6.29.6 BUILDING AZIMUTH 3

Follow same procedures as BUILDING AZIMUTH 1

6.29.7 BUILDING DISTANCE 4

Follow same procedures as BUILDING DISTANCE 1

6.29.8 BUILDING AZIMUTH 4

Follow same procedures as BUILDING AZIMUTH 1