FOREST INVENTORY AND ANALYSIS
NATIONAL CORE FIELD GUIDE

VOLUME I: FIELD DATA COLLECTION PROCEDURES FOR PHASE 2 PLOTS

Version 2.0

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Changes or corrections to the field guide since the first printing in August 2003

Item	Old Page	New page	Explanation
5.20 MORTALITY YEAR	**142**	**142**	**Corrected "when collected" to refer to PREVIOUS not PAST TREE STATUS. Corrected PDR prompt name to be MOYR.**
2.5.4 STAND SIZE CLASS	**56**	**56**	**Corrected < 4.9 in value 1 to be ≤ 4.9 by removing underlining (all values) which was covering up the equal**
5.8 SPECIES	**93**	**92**	**Corrected reference to code number for unknown dead hardwood to be 998**
1.4NC NC SAMPLE KIND	**30**	**31**	**Added "or re-measure annual subplots 1-4" to NCSK value 6**
4.2.3 BOUNDARY CHANGE	**78**	**78**	**Changed prompt (????) to (CHNG)**
5.26.1NC BAVA	**145**	**145**	**Replaced indented items under first sentence of text with:** **Branches in the bottom 7.5 feet of the tree** **At least one branch no larger in diameter than a pencil where clipped** **At least 18 inches in length with live needles**
5.26.3NC GUID	**145**	**145**	**Replaced indented items under first sentence of text with:** **Branches cut were no larger in diameter than a pencil** **Part of the cut branches were left for growth and regeneration** **On smaller trees at least 50% of the trees limbs were left in the upper portion of the tree**
5.27.5-6 UPPER BARK	**149-151**	**149-151**	**Added text to the UPPER BARK data items to include the description of UPPER "8.0 feet – 16.0 feet from the ground"**
7.1 SITETREE SELECTION	**155**	**155**	**Corrected the text in the NC NOTE to reference Appendix 4.**
Appendix 1	**177**	**175**	**Added a "h" to the county name for County #103 in Kansas.**
Appendix 5	**None**	**215**	**Added table 5b**

Changes or corrections to the field guide since the first printing in August 2003

Item	Old Page	New page	Explanation
Appendix 10	**263**	**261**	**Corrected codes for data item LTRU/UTRU to be 0,1,2**
Appendix 2	**189**	**183**	**Added forest type 182- Rocky Mountain juniper**
All Text			**Corrected references to Appendix numbers to be correct for new field guide**
Appendix 2	**195-202**	**195-202**	**Added * for noncomercial species**
0.2.3NC NC Azimuth to PC	**24**	**25**	**Corrected tolerance to none, 99% of the time and inserted the correct values of** 45, 90, 135, 180, 225, 270, 315, 360, added field width 3 digits.
0.2.4NC NC Distance to PC	**25**	**25**	**Added field with of 4 digits, Corrected the tolerance to 33 feet or ½ chain, added the values of 1 – 9999**
8.3.14 CONDITION CLASS STATUS	**169**	**165**	**Changed requirement for field collection on PLOT STATUS = 2 only**
8.3.24NC NC LAND USE	**170-171**	**166**	**Changed requirement for field collection on PLOT STATUS = 2 only**
List of appendices	**173**	**169**	**Updated to include all 12 appendices**
Appendix 4	**203**	**199**	**Corrected the NC figure for Scotch to 95**

Header is not correct for chapters after Chapter 11, from then on all headers say "soils"

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1.2: August 1999
1.3: September 1999 (revised from Bangor, ME Data Acquisition Band meeting, Aug 1999)
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2.0: April 2003 (revised from Atlantic City, NJ, Data Acquisition Band Meeting, Mar 2003)

INTRODUCTION

This document describes the standards, codes, methods, and definitions for Forest Inventory and Analysis (FIA) field data items. The objective is to describe CORE FIA field procedures that are consistent and uniform across all FIA units. **This CORE is the framework for regional FIA programs; individual programs may add variables, but may not change the CORE requirements.** Unless otherwise noted, the items in this field guide are considered CORE, that is, the information will be collected by all FIA Units as specified. Items or codes specified as CORE OPTIONAL are not required by individual units; however, if the item is collected or coded, it will be done as specified in this field guide. It is expected that on average all items in Volume I can be measured by a two-person field crew in less than one day, including travel time to and from the plot.

The FIA program is in transition, changing in response to legislation and new customer demands. One of these demands is for increased consistency, which this field guide begins to address. Another change was the merger of the FIA program with the field plot component of the Forest Health Monitoring (FHM) program's Detection Monitoring. A systematic grid was established that includes some, but not all former FIA plots. This grid contains the Phase 2 plots, the annual survey plots that are designed for measurement on a rotation such that a portion of the plots are measured each year. The rotation length varies by region. The former FHM Detection Monitoring field plots are the Phase 3 plots, a subset of the Phase 2 plots. The same basic plot and sampling designs are used on all the plots.

The focus of Volume I is on data that are collected in the field on all Phase 2 plots in the FIA sample. The methods in Volume I are also used on Phase 3 plots except when specifically noted otherwise in the methods text. Volume II of the series describes an additional, expanded suite of data collected on the Phase 3 subset of plots. Volume II contains methods for the following indicators: ozone bioindicator plants; lichen communities; soils (physical and chemical characteristics); crown condition; vegetation diversity and structure; and down woody debris. Volume III of the series (in preparation) will document the office procedures including data elements measured in the office, data from other sources that are merged into the FIA database, and CORE compilation and analysis algorithms. When complete, the three-volume set will describe the CORE FIA program field data, all of which are measured consistently across the country.

FIELD GUIDE LAYOUT

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

0 General Description
1 Plot
2 Condition
3 Subplot
4 Boundary
5 Tree Measurements
6 Seedling
7 Site Tree
8 Nonforest/Nonsampled Plots

Each section begins with a general overview of the data elements collected at that level and background necessary to prepare field crews for data collection. Descriptions of data elements follow in this format:

DATA ELEMENT NAME -- <brief variable description>

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

Data elements, descriptions of when to collect the data elements, field width, tolerances, MQO's, and values, apply to both Phase 2 plots (formerly called FIA plots) and Phase 3 plots (formerly called FHM Detection Monitoring plots) unless specifically noted. Field width designates the number of columns (or spaces) needed to properly record the data element.

Tolerances may be stated in +/- terms or 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 percent of the value). For some data elements, no errors are tolerated (e.g., PLOT NUMBER).

MQO's 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.

UNITS OF MEASURE

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

Plot Dimensions:

Annular plot - for sample intensification or sampling relatively rare events.

Radius = 58.9 feet
Area = 10,899 square feet or 0.25 acre (ac) or 1/4 acre

Subplot - for selecting trees with diameter $\geq$ 5.0 inch (in)

Radius = 24.0 feet
Area = 1,809.56 square feet or approximately 0.04 acre or approximately 1/24 acre

Microplot - for counting seedlings and selecting saplings

Radius = 6.8 feet
Area = 145.27 square feet or approximately 0.003 acre or approximately 1/300 acre

The distance between subplot centers is 120.0 feet horizontal.
The minimum area needed to qualify as accessible forest land is 1.0 acre.
The minimum width to qualify as accessible forest land is 120.0 ft

Tree Limiting Dimensions:

breast height	4.5 ft
stump height	1.0 ft
merchantable top	4.0 in DOB
merchantable top for woodland	1.5 in DOB
minimum conifer seedling length	0.5 ft
minimum hardwood seedling length	1.0 ft
seedling/sapling DBH/DRC break	1.0 in DOB
sapling/tree DBH/DRC break	5.0 in DOB

0.0 GENERAL DESCRIPTION

The CORE field plot consists of four subplots approximately 1/24 acre in size with a radius of 24.0 feet. The center subplot is subplot 1. Subplots 2, 3, and 4 are located 120.0 feet horizontal (+/- 7 feet) at azimuths of 360, 120, and 240 degrees, respectively, from the center of subplot 1 (see Figure 1). Subplots are used to collect data on trees with a diameter (at breast height "DBH", or at root collar "DRC") of 5.0 inches or greater. Throughout this field guide, use of the word “plot” refers to the entire set of four subplots. “Plot center” is defined as the center of subplot 1.

Each subplot contains a microplot of approximately 1/300 acre in size with a radius of 6.8 feet. The center of the microplot is offset 90 degrees and 12.0 feet horizontal (+/- 1 foot) from each subplot center. Microplots are numbered in the same way as subplots. Microplots are used to select and collect data on saplings (DBH/DRC of 1.0 inch through 4.9 inches) and seedlings [DBH/DRC less than 1.0 inch in diameter and greater than 0.5 foot in length (conifers) or greater than 1.0 foot in length (hardwoods)].

As a **CORE OPTION**, the field plot may also include annular plots that are 1/4 acre in size with a radius of 58.9 feet; each subplot’s annular plot center coincides with the subplot’s center. Annular plots are numbered in the same way as subplots. Annular plots may be used to select and collect additional data for regional enhancements. For example, annular plots may be used to provide a better sample of rare population elements such as very large trees.

Data are collected on field plots at the following levels:

Plot	Data that describe the entire cluster of four subplots.
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 CLASS STATUS, RESERVED STATUS, OWNER GROUP, FOREST TYPE, STAND SIZE CLASS, REGENERATION STATUS, and TREE DENSITY.

Boundary	An approximate description of the demarcation line between two condition classes that occur on a single subplot, microplot, or annular plot. There is no boundary recorded when the demarcation occurs beyond the fixed radius plots.
Tree	Data describing saplings with a diameter 1.0 inch through 4.9 inches, and trees with diameter greater than or equal to 5.0 inches
Seedling	Data describing trees with a diameter less than 1.0 inch and greater than or equal to 0.5 foot in length (conifers) or greater than or equal to 1.0 foot in length (hardwoods).
Site Tree	Data describing site index trees.

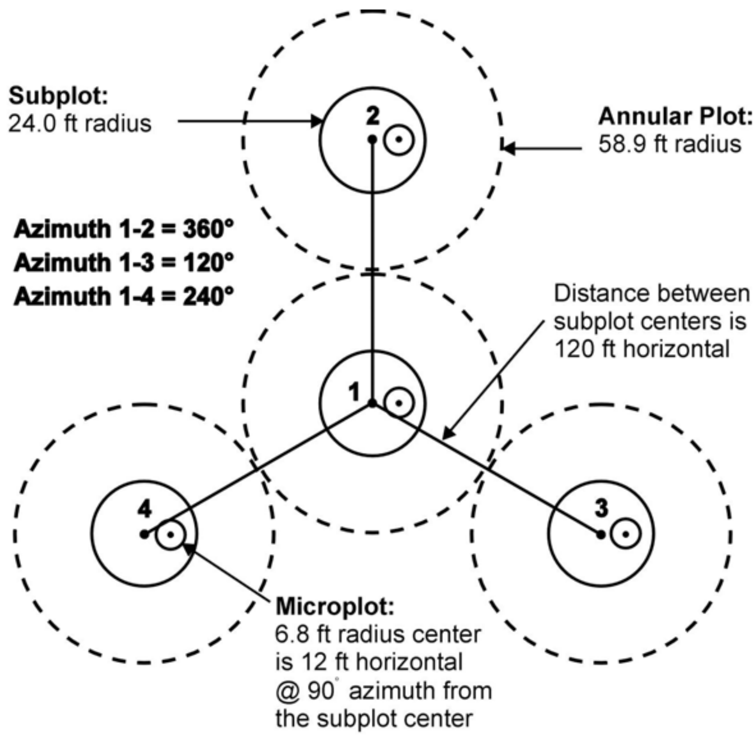


Figure 1. FIA Phase 2 plot diagram. See individual Phase 3 chapters for Phase 3 plot figures.

0.1 PLOT SETUP

Plots will be established according to the regional guidelines of each FIA unit. When the crew cannot occupy the plot center because safety hazards exist, or the plot center is inaccessible or out of the sample, the crew should check the other subplots. If any subplot centers can be occupied and are in the sample, the subplots that can be occupied should be established and sampled following normal procedures. When a subplot center or microplot center cannot be occupied, no data will be collected from that subplot or microplot; instead, the entire subplot or microplot should be classified according to the condition preventing occupancy.

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

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

If a subplot was installed incorrectly at the previous visit, the current crew should remeasure the subplot in its present location. In cases where individual subplots are lost (cannot be relocated), or it is determined that individual subplots are in the wrong location and subplots are moved, use the following procedures:

- assign the appropriate present CONDITION CLASS STATUS Code(s) to the new subplot (usually CONDITION CLASS STATUS = 1 or 2)
- assign TREE STATUS = 0 to all downloaded trees (i.e., incorrectly tallied at the previous survey)
- assign RECONCILE codes 3 or 4 (i.e., missed live or missed dead) to all trees on the new subplot.
- assign the next TREE RECORD NUMBER.

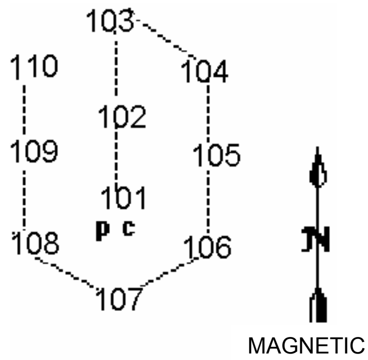
0.1NC NC OLD VARIABLE RADIUS PLOT

The old variable radius plot consists of 10 subplots. The layout of these subplots is shown in figure NC1. Plot center (PC) is the term applied to the point used to locate the plot. It is the ground location that corresponds to the pin prick on the photography. To distinguish subplots on the new standard plots from subplots on the old 10-point plot, the new standard subplots will be given subplot numbers 1-4 and the old 10-point subplots will be numbered 101-110. Subplot center 101 is the same as plot center. All old subplots consisted of a variable radius (37.5 BAF) plot to sample trees 5.0 inches and larger and a fixed radius micro plot (6.8 ft. radius) to sample trees less than 5.0 inches.

In MO, MI, IA and prior to Cycle 6 in MN, when a subplot center was in a different land use than plot center, subplots were rotated so that all ten subplots fell in the same land use as PC. If PC was non-forest, subplots were not established. If PC was forest, all subplots were rotated to be located in forest. Figure NC1 does not apply for these plots. Instead, refer to the plot sheets for subplot location.

Figure NC1. Old variable radius plot layout.

From subplot center	70' to subplot center	Azimuth
101	102	0°
102	103	0°
103	104	120°
104	105	180°
105	106	180°
106	107	240°
107	108	300°
108	109	0°
109	110	0°



0.1.1NC NC LOCATING THE PLOT PROCEEDURE

There is a mix of new and re-measurement plots sent to the field for measurement.

The steps of locating the plot center include the following:

- Review old course to plot information when available
  - Use and re-record old course to plot information if still valid
    - Re-monument Starting Point
    - Record baseline on new image
    - Record starting point information (species, dbh, etc)
    - GPS starting point and record
    - Record and traverse COURSE TO PLOT (distance and azimuth)
- Establish new course to plot information if old information is not available or useable
  - Monument Starting Point
  - BASELINE
  - Select and record STARTING POINT description
  - GPS starting point and record
  - COURSE TO PLOT
    - distance and azimuth computation
    - chaining
    - location correction

0.1.1.1NC NC STARTING POINT TREE MONUMENTATION

In the field, mark the starting point with paint facing the direction of normal approach. Paint "SP" (in letters four-inches tall) just above where the diameter at breast height (DBH) measurement was taken. Paint three-inches tall "SP" near ground level. Use discretion in painting trees on private lands and in well-traveled areas. Make a note when painting deviates from normal procedures on the plot sheet. In reserved areas do not use paint, unless the manager of the reserved area* indicates otherwise. Instead, nail a tag marked with "SP" to the base of the tree. Please make a note on the plot sheet if reserved areas are marked differently than with a nail and tag at the base.

** If the reserved area is a National Park, we have a National agreement to use the nails. Do not paint, in a National Park.*

Describe the starting point on the plot sheet under "Starting Point Description." Include the landmarks you used to locate SP. Specify details of the starting point such as:

- Species, DBH, and the face on which the tree is painted.
- Any nearby road, fence, pasture, etc. and the tree's location in relation to that feature.
- Any noticeable characteristic of the SP tree, such as a fork at 10 feet, multiple stems, deer stand, etc.
- Take a GPS reading at SP tree and record on the plot sheet & in the data recorder. Follow the same directions as getting a GPS reading at plot center. (See Appendix 11.)

0.1.1.2NC NC BASELINE

A baseline is established on a photo image so that it is oriented with the ground as to compass direction.

Locate the baseline by finding two features on the ground that are easily recognized on the new photo or image. The two features should be at least 10 chains apart for scale 1:20,000 and 20 chains apart for scale 1:40,000 to help minimize error. Select such features as straight road sections, drainage ditches, or two distinct trees. Avoid using railroads or power lines since they influence the compass reading.

Pinprick both features on the photo and circle the pinpricks on the back of the photos. Draw a line between these pinpricks on the back of the photo with an arrow at one end of the line to indicate the azimuth direction.

Measure the azimuth with a compass to the nearest half-degree and record it on the back of the photograph.

0.1.1.3NC NC STARTING POINT

A starting point (SP) is established for the purpose of locating a sample plot. It should be as near as possible to the sample location, yet not on the same acre as the sample plot.
When selecting the SP, make sure it is readily identifiable on the ground and on the photograph. Select a prominent tree located at the edge of a field or clearing, at a bend in a stream, or any landmark easy to find on the next survey. A SP tree must provide the next crew a point from which to physically and efficiently chain to PC from during all seasons and water levels. (i.e. without the aid of a GPS)

Using both the new and/or old photograph(s) and/or provided image, locate the SP. For the remainder of this manual photo will refer to any image format. A SP is a point that can be seen on the photo and on the ground. It will help re-locate the plot center at the time the plot is re-measured.

Pinprick the SP on the photo that has the sample location pinpricked. Label and circle the pinprick "SP" on the back of the photo.

Re-establish the original SP if one is available to reuse and still meets the requirements mentioned.

If the SP pinprick is missing from the old photo, refer to "SP Description" on the old plot sheet and determine the SP location according to the azimuth and distance to plot center (PC). Any openings on the photo (such as clearings, roads, woods trails, lakes, and streams) are good locations where the SP might logically be located. Also check the sketch of the area on the original plot sheet.

Once the SP tree is located, inspect to verify that it is suitable. If the SP is suitable, the cruiser re-scribes (not in reserved areas), repaints (not in reserved areas), and re-measures DBH. The tallier checks the "Course to Sample Location" on the plot sheet to see if it seems reasonable. The tallier then transfers the original course to sample location, SP description, and the re-measured DBH to the new plot sheet, and in the data recorder. On the new photo, pinprick the SP and record the course to sample location on the back of the photo.

0.1.1.4NC NC GPS STARTING POINT

Record the latitude and longitude of the “SP” tree on the plot sheet and data recorder using the same method as “Collecting the Plot Center Coordinate” in Appendix 11.

0.1.1.5NC COURSE TO PLOT

AZIMUTH AND DISTANCE COMPUTATION

On the back of the photograph, connect the pinpricks for the SP and plot center (PC) with a straight line. Extend this line to intersect the baseline. Lines should extend well beyond the intersection to allow reading the backsight off the 360-degree protractor to check the accuracy of the angle being measured.

If the baseline and the line to the sample location do not intersect on the photograph, draw a straight line or Reference Line that will intersect the baseline and the course to sample location line. Indicate the directions of the sample location line and the baseline by putting an arrow at the end of each line. Measure the angle between these lines, starting from the baseline.

Be sure to use an inverted 360^0 protractor or flip a standard 360^0 protractor over. Align the 360-degree protractor over the azimuth of the baseline to get the azimuth of the sample location line. The azimuth is read directly off the protractor once the azimuth of the baseline is correctly aligned on the inverted protractor. This is because east-west azimuths are reversed 180 degrees when working on the back of the photo. Repeat this procedure if a reference line is needed to intersect the course to sample location. To minimize error, check the backsights of both base and course to sample location lines. This is a check to see if the protractor is precisely aligned.

Important Note: East-west azimuths are reversed when working on back of photo with standard protractor. Inverted protectors are available.

Refer to Figure NC3. Measure the photo the distance from the SP to the PC, to the nearest quarter chain, with a photo scale. (Photo scales, corresponding to the aerial photography, are supplied.) Hold the photo up to the light and carefully measure, from the center of one pinprick to the center of the other. (Sometimes it helps to use your stereoscope as a magnifier.) Record both distance in feet, and direction on the back of the photo, on the plot sheet under "Course to Sample Location" and in the data recorder.

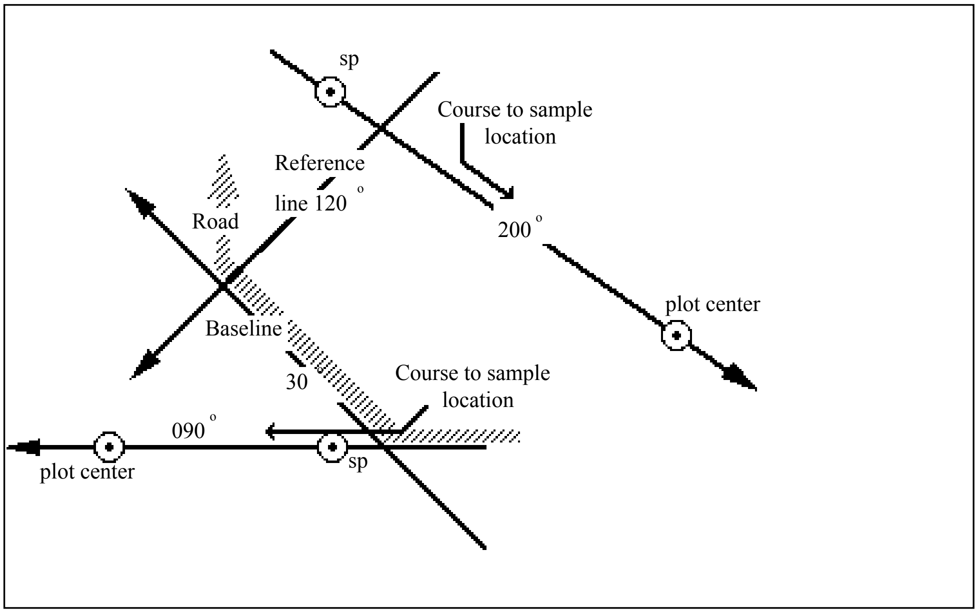


Figure NC3. Azimuth settings (back of photo)

CHAINING

Using compass and tape run a course on the computed azimuth. Distance correction for slope is necessary when slope exceeds 10 percent. Using the Suunto clinometer, slope correction can be quickly determined and added after the line is run out. The appropriate slope correction can then be found in NC Table 1. The correct adjustment should be added at the same percent slope. For example, to chain a horizontal distance of 66.0 feet on a 25 percent slope, chain 68.0 feet (66.0 + 2.0) on the slope.

Once the computed course has been run, place a permanent stake at the end of the computed course. Important: Make sure that photograph location agrees with ground location.

NC Table 1. Slope Correction in feet
(Distance is measured on slope)

	Feet				
Percent	50'	60'	66'	70'	99'
10	.5	.3	.3	.3	.5
15			.7	.8	1.1
20	1.0	1.2	1.3	1.4	2.0
25			2.0	2.2	3.0
30	2.2	2.6	2.9	3.1	4.4
35			3.9	4.2	5.9
40	3.9	4.6	5.1	5.4	7.6
45			6.4	6.8	9.6
50	5.9	7.1	7.8	8.3	11.7
55			9.3	9.9	14.0
60	8.3	10.0	11.0	11.6	16.5
65			12.7	13.5	19.1
70	11.0	13.2	14.6	15.5	21.9
75			16.5	17.5	24.7
80	14.0	16.8	18.5	19.7	27.8
85			20.6	21.9	30.9
90	17.3	20.7	22.8	24.2	34.2
95			25.0	26.6	37.6
100	20.7	24.9	27.3	29.0	41.0

LOCATION CORRECTION

If the ground location is clearly not the point pinpricked on the photograph (more than 2 chains error), and the correct location can be determined on the ground, place a second pin at the correct location. Note the azimuth and distance from the initial pin to the relocated pin and record these items under "Course to Sample Location" on the plot header sheet and remove the first pin. The initial pin is referred to as a turning point. The second pin becomes the location of the plot.

This is only done when on a new plot it is obvious that the location arrived at with the chaining azimuth and distance does not agree with the location on the photo or image provided.
If using original course to plot work, chain the computed azimuth and distance along the approach line and mark the location. If the original PC is found here continue to relocate other subplots and establish any new subplot or microplot locations as needed.

USING ORIGINAL SP AND DISTANCE-AZIMUTH COMPUTATIONS

If the original PC is not found at the end of the chaining, search the area for evidence of the old plot. Items to look for are paint on the tree bases (vertical line) and at breast height (horizontal line). Look for 10-inch wire pins and bits of flagging at each subplot, and witness trees (painted with an "X").

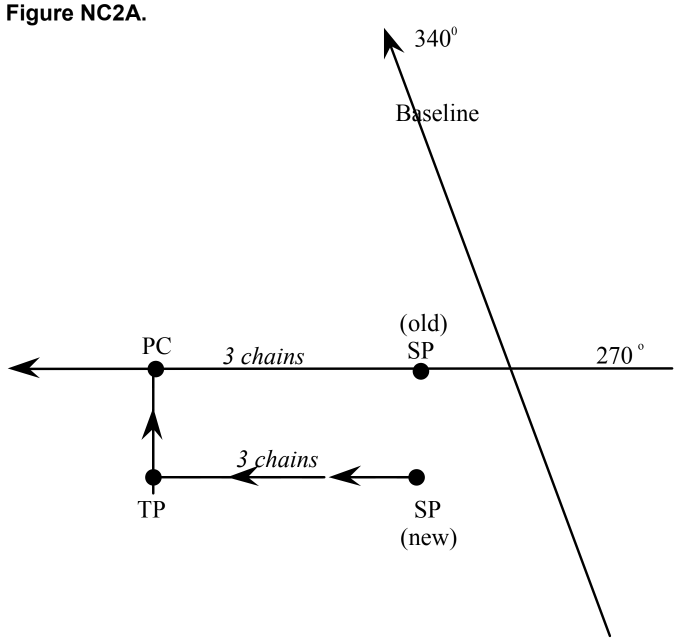
After finding PC, establish a Turning Point (TP) if the distance between PC and the end of the approach line exceeds 3% of the chaining distance.

In the event that, after chaining the prescribed distance, no evidence of the old plot can be found, the following alternatives for locating PC are available.

- Using the original SP, look for landmarks to discern if the plot is in the area. Look especially for mistaken openings, trails, etc.
- Search an area of five chains around the end of the approach line(s).
- Return to the SP, check the photo work, and try re-chaining.
- Check the photo work to see if the original crew chained in the opposite direction.
- Pick a new SP, establish a new approach line, and chain in from there.

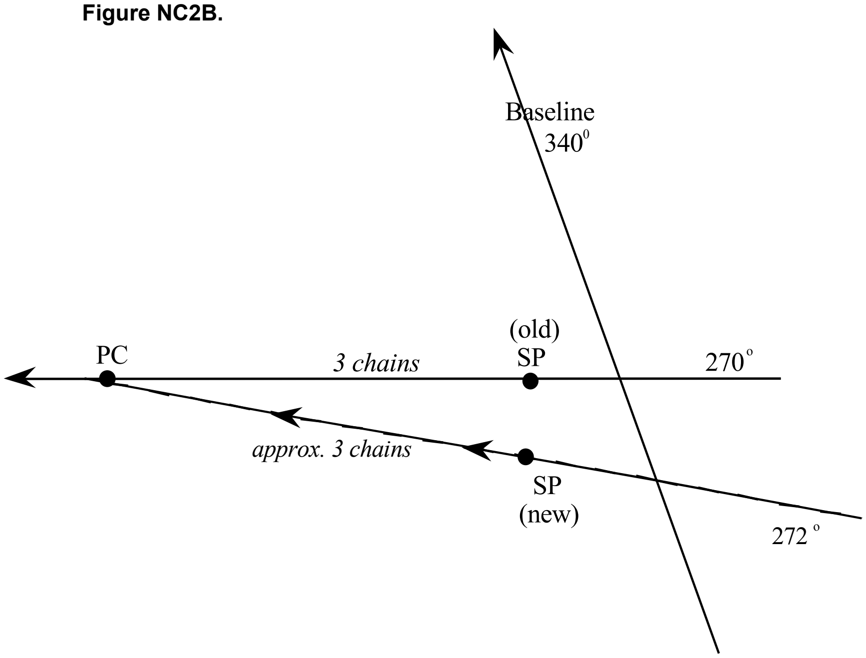
An easy way to establish a new SP, when needed, is to inspect the vicinity of the original SP for a suitable replacement. The following three options are available once you've found a replacement (fig. NC2A, NC2B, NC2C). Note that fig. NC3 shows the plot sketch—east-west azimuths would need to be reversed if drawn on the back of the photo.

Figure NC2A.



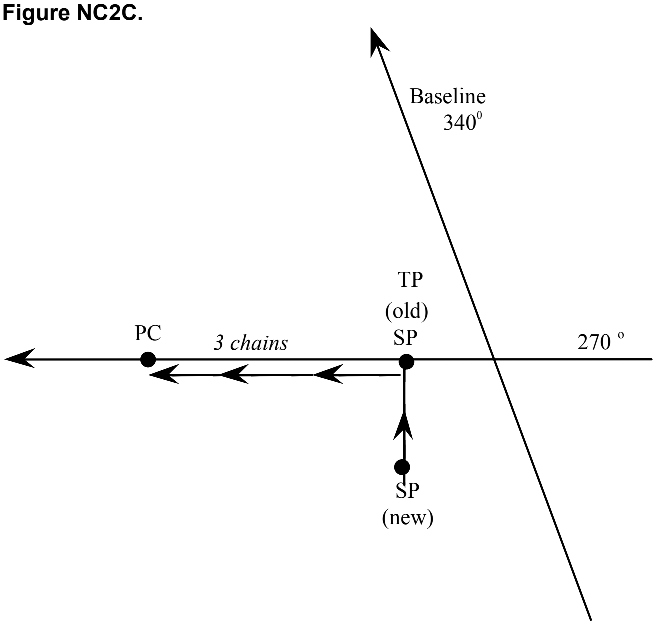
If the new SP is close by, pick the tree on the photo and use the original course to sample location. Leave a marker at your destination and look for plot center. It should be approximately the same distance and azimuth that the old SP is from the new SP. Once PC is found, make a Turning Point (TP) from your marker to PC.

Figure NC2B.



Depending on how far the new SP is from the old SP, you may try adding or subtracting a degree or two (whichever is appropriate) and follow this azimuth into the plot. Adding a few feet onto the old distance may be helpful. Use a marker to show where you ended your chaining. Scan the area for the plot center and then make the necessary turning point to plot center.

Figure NC2C.



Measure the distance and azimuth from the new SP to the original SP. Record this information in "Course to Sample Location". Record the old course to sample location to the right of this new course. At this time, a new SP has been established and the original SP is used as a turning point in the course to sample location. Note: This is the least desirable choice, for it may result in having two turning points--one at the beginning and one at the end.

After finding some evidence of the old plot, look for trees marked at the base and at DBH with paint. When several of these trees are found in close proximity, examine the original plot data and try to match these trees to trees on one of the original subplots.

Match by comparing current tree species, azimuths, distances, and DBH to the data for trees on the tree record sheet. Once it is determined which subplot the trees are on, use triangulation to find the subplot center and mark it with a piece of galvanized or aluminum wire bent into a loop with a piece of blue flagging tied through it. If this is not the plot center, move to the plot center by knowing which subplot you are on and chaining the distance and azimuth to the correct location to plot center.

After finding the old pin at Plot Center, place a new pin next to it. If the old pin cannot be found, triangulate to accurately re-establish the point in the original location.

It is very important to locate each individual subplot that you are required to re-measure as accurately as possible. Finding each subplot is a challenge—most of the flagging disintegrates and the wires rust and look just like twigs or roots. The best method is to run out 120 feet (70 feet if re-measuring a 10-point plot) from the last subplot at the proper azimuth, mark the spot, and search by running your hands through the area.

If several trees identifiable from the paint are available, use the triangulation method to relocate the subplot. If this is not possible, due to lack of trees or other circumstances, locate several adjacent subplots and use these to triangulate to the missing subplot. You can then determine the general location of the missing subplot and reduce the area you will search.

0.1.2NC NC LOCATING NEW PLOT WITH GPS COORDINATES

When establishing a plot for the first time you may use the provided GPS coordinates and the GPS unit to assist you. These coordinates are listed on the printed plot sheet provided to the crew. The true location of the plot is the x on the image. If when you use the GPS to get you to the location on the ground if it is markedly different than the x on the image you will need to adjust to put yourself on the x if possible.

- Enter coordinated of plot from plot sheet into GPS unit
- Establishing a SP.
- Read and record the GPS coordinates of the SP
- Navigate to within 100 – 120 feet of the Plot center coordinates entered
- Let the GPS unit average again at this point and read the distance and azimuth to PC
- Chain the remaining Distance and Azimuth to PC and establish the plot

See Appendix 9 for directions on using the Rockwell Plugger or the Garmin GPS units. Currently these are the only GPS units used in the North Central FIA region.

0.1.3NC NC CHAINING TO OTHER THAN PC

In chaining to PC, you may encounter some condition that makes it impossible or impractical to physically reach PC and put in a pin. PC may be in water, the center of a barn, or on a busy highway. Other subplots on the plot may be in a forest condition and the plot must be installed. In this case you can chain to any one of the subplots and establish it first. This can be done by using the data recorder program to compute the direct distance and azimuth to take from the SP to any subplot center and chaining directly to a given subplot. This method is best when you can see you will have trouble reaching PC before you start chaining.

Note: This program works only if you are farther than 140 ft away from PC.

A turning point can also be used at any point when chaining to reach another subplot center. At any point while chaining, establish a turning point, chain the distance and azimuth from PC to the subplot you wish to chain to, and then continue on your original course. For example, the course from the SP to PC is 200^0, 700 ft. After chaining 600 ft you can see that PC will be in a river and it would be best to chain to subplot 103. At 600 ft, establish a turning point and go 360^0, 140 ft (the distance and azimuth from PC to subplot 103). Establish another turning point and complete the original course (200^0, for the remaining 100 ft) to reach subplot 103.

0.1.4NC NC DISTURBED OR LOST PLOT

If the crew can't find a re-measurement plot, bring it to the attention of the crew leader. After the crew has thoroughly searched for the plot without success, establish the plot using one of the following guidelines.

DISTURBED

When there has been a major disturbance (such as the area has been clearcut and bulldozed) and it is obvious that the plot can't be relocated, establish the plot as near as possible to the old PC.

- This plot does not get a new PLOT NUMBER.
- Account for previous trees before entering any new tree data.

NOT DISTURBED PLOT

When there has been no major disturbance to the plot area and it must be a re-measurement.

- PLOT STATUS of 3 is assigned and directions for Lost plot are followed in Section 8 of the field guide.
- A new plot file will be created with the same number as the nonsampled - lost plot.
- A second new plot file will be created with the new PLOT NUMBER for the plot sampled.
- Both plot data sheets will be returned to St. Paul.

HOW TO START THE PLOT with getting a new download file.

This is the preferred method of completing a non-disturbed plot replacement.

- The lost plot is closed out as a PLOT STATUS of 3 (nonsampled), NONSAMPLED REASON of 6 (Lost):
  - Plot header filled out.
  - See section 8 of the field guide for data items needed.
- Call your location lead, field supervisor or St. Paul for a new plot number.
- Get the new download file one of two ways.
  - When given the new plot number filename use the Field data manager program to retrieve the new download file.
  - Have St. Paul send you the new download file with the new plot number.
- Go to the field and collect all the data for the plot on the new download file.
- Transfer/send both the lost plot file and the new plot file to St. Paul.

HOW TO START THE PLOT without getting a new download file.

- The lost plot is closed out as a PLOT STATUS of 3 (nonsampled), a NONSAMPLED REASON of 6 (Lost:

- Start a new plot on the Husky using the Husky option from Data entry below:

  - >0000000.00 NEW PLOT Enter/Edit
  - Change the default values for STATE, UNIT, COUNTY to the correct ones for the plot location. Leave the PLOT NUMBER as 9999 until you get to the office to get a new number from headquarters. Collect all the data under this plot number of 9999 and return to the office.

- Call your location lead, field supervisor or St. Paul for a new plot number.

  - Change the plot collected under 9999 to the correct new plot number.
  - When you save the new plot with the correct new PLOT NUMBER, you will still have the plot you called 9999 in the plot list and on the Husky. Now you must delete the plot number 9999 from the Husky, using the “Delete a Plot” option.

- Transfer/send both the lost plot file and the new plot file to headquarters.

0.1.5NC NC PLOT IN THE WRONG LOCATION

If a re-measurement plot (NCSK=6 or 8) was established in the wrong location (i.e. not in the same location as the photo pinprick), re-establish the plot in that wrong location. If the error is more than 2 chains or if it needs clarification for next crew, re-pinprick the new photo where the plot is actually located.

NOTE: An example that needs clarification for the next crew is when the current pinprick is on the north side of the road within one chain away but the plot is on the south side of the road. In this case please re-pinprick the new photo.

In the "Notes" section of the plot sheet, indicate that you moved the pin prick to agree with the original location the plot was installed. Record the distance and azimuth (using a photo scale) from the original pinprick on the new photo to where the plot is actually located. Bring such plots to the attention of the crew leader or state coordinator. It is assumed that the plot is located in the correct location unless physical evidence of the plot is found in the wrong place (i.e. pins, paint or flagging).

Occasionally, while chaining in, you may pass near or over PC. To minimize the length of a turning point, or perhaps eliminate the need for a turning point, reduce the chaining distance by backtracking along the line of approach.

0.2NC NC STARTING POINT DATA ELEMENTS

0.2.1NC NC SP LATITUDE (N:)

Record the latitude of the PC in degrees and decimal minutes. Record decimal minutes to the 3rd decimal place and do not round.

When collected:
Field width: 7 digits collected as Degrees and decimal minutes.
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values: : **NC Note:** Vary by State.

0.2.2NC NC SP LONGITUDE (W:)
Record the longitude of the plot degrees and decimal minutes. Record decimal minutes to the 3rd decimal place and do not round.

When collected
Field width: 8 digits collected as Degrees and decimal minutes.
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values: **NC Note:** Vary by State.

0.2.3NC NC Azimuth to PC (Azm1)
Record compass direction from the SP tree to the PC.

When collected: All plots visited in the field
Field width: 3 digits
Tolerance: None
MQO: 99% of the time
Values: 1-360

0.2.4NC NC Distance to PC (DIS1)
Record the slope distance from the SP tree to the PC in feet.
When collected: All plots visited in the field
Field width: 4 digits
Tolerance: +/- 33 feet (1/2 chain)
MQO: 99% of the time
Values: 1 - 9999

Repeat the above two items if needed for tuning points.
0.2.5NC NC Azimuth to PC (Azm2)
0.2.6NC NC Distance to PC (DIS2)
0.2.7NC NC Azimuth to PC (Azm3)
0.2.8NC NC Distance to PC (DIS3)
0.2.9NC NC Azimuth to PC (Azm4)
0.2.10NC NC Distance to PC (DIS4)

0.2 PLOT INTEGRITY

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

- Scribing and nailing tags on witness trees so that subplot centers can be relocated.
- Boring trees for age on subplots and annular plots to determine tree age, site index, stand age, or for other reasons.
- Nailing and tagging trees on microplots, subplots, and annular plots so that these trees can be identified and relocated efficiently and positively at times of remeasurement.
- Nailing, scribing, or painting microplot, subplot, and annular plot trees so that the point of diameter measurement can be accurately relocated and remeasured.

All other potentially damaging procedures that may erode subplot integrity are prohibited. The following practices are specifically prohibited:

- Boring and scribing some specific tree species that are known to be negatively affected (i.e., the initiation of infection or callusing).

NC Note: Aspen may be used as a site tree in the North Central region but the tree must be selected off the subplot. Do not scribe thin barked trees.

- Chopping vines from tally trees. When possible, vines should be pried off trunks to enable accurate measurement. If this is not possible, alternative tools (calipers, biltmore sticks) should be used.

1.0 PLOT LEVEL DATA

All variables listed in Section 1.0 are collected on plots with at least one accessible forested condition (PLOT STATUS = 1). For all NONFOREST/NONSAMPLED plots (PLOT STATUS = 2 or PLOT STATUS = 3), see Section 8. In general, plot level data apply to the entire plot and they are recorded from the center of subplot 1.

1.0.1NC NC SUBPLOT CENTER MONUMENTATION

When subplot center is monumented:
- ✓ All forested subplot centers.
- ✓ All forested microplot centers
- ✓ All nonforested subplot centers where the determination of nonforest was made due to the stocking level of the trees in the area.

Subplot centers are marked with wire, bent into a loop and wrapped with flagging (usually blue). Leave about two inches of the wire projecting above the ground. In reserved areas do not attach flagging to the wire. All subplot centers 1-4 are marked.

1.0.2NC NC SUBPLOT REFERENCE TREES

When subplot center is referenced:
- ✓ Only required on subplots 1-4
- ✓ All forested subplot centers that have no 3.0+ inch diameter trees tallied.
- ✓ All non-forest subplot centers on a plot with any forested conditions.
    - o Where there is a tree or usable object within 60 feet.
    - o No trees are tallied

On many plots, certain subplots within the plot lack information useful in determining their location on future surveys. Examples of this are subplots with a forested condition but without any trees within the subplot area.

All subplots 1-4 on the plot without live trees on the subplot or microplot that could be used to re-established subplot center location (i.e. no azimuth or distances to any tree) must be referenced.

Monument reference trees above DBH and at the base with a scribe mark and paint on the side of the tree facing the subplot center. There is no set rule for painting a reference tree, but it is best to paint the tree with a number corresponding to the subplot being referenced. This method makes it easier for field crews on the next survey to identify which subplot they have located. In reserved areas, follow the same rules as on a subplot tree for monumentation.

Reference trees should have the following characteristics:
- ❖ Located within 60 feet of the subplot center
- ❖ Not likely to die or be cut before the next survey
- ❖ Species easily located in the stand
- ❖ At least 5.0 " DBH (or at least 2.0" DBH if no 5.0+ DBH is available)

In the "Reference Tree" grid of the plot sheet record the subplot number, azimuth, slope distance to the center at the base (nearest tenth of a foot), and DBH.

1.1NC NC CYCLE (CYCL)

This is the number assigned by state for each group of 5 panels which will complete one full state inventory. This number is in all downloaded plot files and on all plot sheets and should never be changed in the field.

When collected: All plots (assigned and set with download data)
Field width: 2 digits
Tolerance: No Errors
MQO: None
Values:

State	Cycle	State	Cycle	State	Cycle
Illinois	5	Michigan	6	North Dakota	4
Indiana	6	Minnesota	13	South Dakota	5
Iowa	5	Missouri	6	Wisconsin	6
Kansas	5	Nebraska	4		

1.2NC NC SUBCYCLE (SUBC)

Each cycle is broken down to 5 sub-cycles and these are the sub-cycles assigned to each state for this year of data collection. . This number is in all downloaded plot files and on all plot sheets and should never be changed in the field.

When collected: All plots (assigned and set with download data)
Field width: 2 digits
Tolerance: No Errors
MQO: None
Values:

State	SubCycle	State	SubCycle	State	SubCycle
Illinois	4	Michigan	5	North Dakota	4
Indiana	1	Minnesota	1	South Dakota	4
Iowa	1	Missouri	1	Wisconsin	5
Kansas	4	Nebraska	4		

1.1 STATE (ST)

Record the unique FIPS (Federal Information Processing Standard) code identifying the State where the plot center is located.

When collected: All plots
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 1

1.3NC NC UNIT (UNIT)

Record the unique one digit North Central code identifying the unit where the plot center is located.

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

1.2 COUNTY (CNTY)

Record the unique FIPS (Federal Information Processing Standard) code identifying the county, parish, or borough (or unit in AK) where the plot center is located.

When collected: All plots
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 1

1.3 PLOT NUMBER (PLT#)

Record the identification number, unique within a county, parish, or borough (survey unit in AK), for each plot. If SAMPLE KIND = 3, the plot number will be assigned by the National Information Management System (NIMS).

When collected: SAMPLE KIND = 1 or SAMPLE KIND = 2
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 0001 to 9999

1.4 PLOT STATUS (STAT)

Record the code that describes the sampling status of the plot.

NC Note: See section 8 for nonsampled plots (nonforest, denied, lost, etc)

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

1 Sampled – at least one accessible forest land condition present on plot or previously had at least one accessible forest land condition on plot

1.5 SAMPLE KIND (SK)

Record the code that describes the kind of plot being installed.

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

1 Initial plot establishment - the initial establishment and sampling of a national design plot (FIA Field Guide versions 1.1 and higher). SAMPLE KIND 1 is assigned under the following circumstances:
- Initial activation of a panel or subpanel
- Reactivation of a panel or subpanel that was previously dropped
- Resampling of established plots that were not sampled at the previous visit

2 Remeasurement – remeasurement of a national design plot that was sampled at the previous inventory.

3 Replacement plot - a replacement plot for a previously established plot. Assign SAMPLE KIND = 3 if a plot is installed at a location other than the previous location (i.e., plots that have been lost, moved, or otherwise replaced). Note that replacement plots require a separate plot file for the previous plot. Replaced plots are assigned PLOT STATUS = 3, SAMPLE KIND = 2, and the appropriate NONSAMPLED REASON code. The plot number for the replacement plot is assigned by NIMS.

1.4NC NC SAMPLE KIND (NCSK)

The NC sample kind indicates the information to be collected on plot types that are unique to North Central Research Station FIA.

When collected: All plots
Field width: 1 digit
MQO: No errors, 100% of the time
Values:

0 **New plot**– This is a first time visit to the location to install a plot. If ground evidence of an old plot could not be found and there has been no major disturbance to the area.

6 **Partial Re-measurement Relocate**. Measure all old trees on subplots 101-105 or saplings on subplots 121-124 or re-measure of annual subplots 1-4.

8 **No Re-measurement Relocate**. Do not measure old plot just use old plot information to locate subplot center to begin installation of new plot design.

1.6 PREVIOUS PLOT NUMBER

Record the identification number for the plot that is being replaced.
NC Note: This is applied after the field in the data processing at North Central.
When collected: When SAMPLE KIND = 3
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 0001 to 9999

1.7 FIELD GUIDE VERSION

Record the version number of the National Core Field Guide that was used to collect the data on this plot. FIELD GUIDE VERSION will be used to match collected data to the proper version of the field guide.

When collected: All plots
Field width: 2 digits (x.y)
Tolerance: No errors
MQO: At least 99% of the time
Values: 2.0

NC Note: The manual version will be applied by St. Paul after the field data is returned.

1.8 CURRENT DATE

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

1.8.1 YEAR (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: $\geq$ 2003

1.8.2 MONTH (MONT)
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

1.8.3 DAY (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

1.9 DECLINATION (CORE OPTIONAL)
(**NC Note:** Not collected in North Central FIA region)
Record the azimuth correction used to adjust magnetic north to true north. All azimuths are assumed to be magnetic azimuths unless otherwise designated. The Portland FIA unit historically has corrected all compass readings for true north. This field is to be used only in cases where units are adjusting azimuths to correspond to true north; for units using magnetic azimuths, this field will always be set = 0 in the office. This field carries a decimal place because the USGS corrections are provided to the nearest half degree. DECLINATION is defined as:

DECLINATION = (TRUE NORTH - MAGNETIC NORTH)

When collected: CORE OPTIONAL: All plots
Field width: 5 digits including sign (+xxx.y)
Tolerance: No errors
MQO: At least 99% of the time
Values: -359.0 to +359.0

1.10 HORIZONTAL DISTANCE TO IMPROVED ROAD (RDIST)

Record the straight-line distance from plot center (subplot 1) to the nearest improved road. An improved road is a road of any width that is maintained as evidenced by pavement, gravel, grading, ditching, and/or other improvements.

NC Note: A private drive is considered a road if it meets the qualifications above. Improved roads should not have advanced rutting, old washouts, old fallen trees, vegetation, etc. inhibiting regular vehicular travel.

When collected: All plots with at least one accessible forest land condition class (PLOT STATUS = 1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

1	100 ft or less
2	101 to 300 ft
3	301 to 500 ft
4	501 to 1000 ft
5	1001 ft to 1/2 mile
6	1/2 to 1 mile
7	1 to 3 miles
8	3 to 5 miles
9	Greater than 5 miles

1.11 WATER ON PLOT (WTPY)

Record the water source that has the greatest impact on the area within the accessible forest land portion of any of the four subplots. The coding hierarchy is listed in order from large permanent water to temporary water. This variable can be used for recreation, wildlife, hydrology, and timber availability studies.

When collected: All plots with at least one accessible forest land condition class (PLOT STATUS = 1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

0	None – no water sources within the accessible forest land CONDITON CLASS
1	Permanent streams or ponds too small to qualify as noncensus water
2	Permanent water in the form of deep swamps, bogs, marshes without standing trees present and less than 1.0 ac in size, or with standing trees
3	Ditch/canal – human-made channels used as a means of moving water, such as irrigation or drainage which are too small to qualify as noncensus water
4	Temporary streams
5	Flood zones – evidence of flooding when bodies of water exceed their natural banks
9	Other temporary water – specify in plot notes

1.12 QA STATUS (QAST)

Record the code to indicate the type of plot data collected, using the following codes:

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

1	Standard production plot
2	Cold check
3	Reference plot (off grid)
4	Training/practice plot (off grid)
5	Botched plot file (disregard during data processing)
6	Blind check
7	Hot check (production plot)

1.13 CREW TYPE (CRTY)

Record the code to specify what type of crew is measuring the plot.

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

1	Standard field crew
2	QA crew (any QA crew member present collecting data)

1.14 GPS Coordinates

Use a global positioning system (GPS) unit to determine the plot coordinates and elevation of all field-visited plot locations.

1.14.1 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. Most will use the NAD 27 Datum (also known as NAS-C or NA 27 CONUS/CLK66), 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; the regions using the UTM coordinate system will collect UTM Easting, Northing, and Zone.

NC Note: North Central FIA collects all GPS coordinates in the field using NAD 83.

1.14.2 Collecting Readings

Collect at least 180 GPS readings at the plot center. These may be collected in a file for post-processing or may be averaged by the GPS unit. Each individual position should have an error of less than 70 feet if possible (the error of all the averaged readings is far less).

Soon after arriving at plot center, use the GPS unit to attempt to collect coordinates. If suitable positions (180 readings at error less than or equal to 70 feet) cannot be obtained, try again before leaving the plot center.

If it is still not possible to get suitable coordinates from plot center, attempt to obtain them from a location within 200 feet of plot center. Obtain the azimuth and horizontal distance from the "offset" location to plot center. If a PLGR unit is used, use the Rng-Calc function in the PLGR to compute the coordinates of the plot center. If another type of GPS unit is used, record the azimuth and horizontal distance as described in Sections 1.14.12 and 1.14.13.

Coordinates may be collected further away than 200 feet from the plot center if a laser measuring device is used to determine the horizontal distance from the "offset" location to plot center. Again, if a PLGR unit is used, use the Rng-Calc function in the PLGR to compute the coordinates of the plot center. If another type of GPS unit is used, record the azimuth and horizontal distance as described in Sections 1.14.12 and 1.14.13.

In all cases try to obtain at least 180 positions before recording the coordinates.

1.14.3 GPS UNIT (UNIT)

Record the kind of GPS unit used to collect coordinates. If suitable coordinates cannot be obtained, record 0.

NC Note: Garmin GPS units used in the NC region are capable of field-averaging.

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

- 0 GPS coordinates not collected
- 1 Rockwell Precision Lightweight GPS Receiver (PLGR)
- 2 Other brand capable of field-averaging
- 3 Other brands capable of producing files that can be post-processed
- 4 Other brands not capable of field-averaging or post-processing

1.14.4 GPS SERIAL NUMBER (GPS#)

Record the last six digits of the serial number on the GPS unit used.

When collected: When GPS UNIT > 0
Field width: 6 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000001 to 999999

1.14.5 COORDINATE SYSTEM

Record a code indicating the type of coordinate system used to obtain readings.

NC Note: North Central FIA region always collects using code 1 : Geographic coordinate system (Latitude and Longitude).

When collected: When GPS UNIT > 0
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time

Values:

1 Geographic coordinate system
2 UTM coordinate system

1.14.6 LATITUDE (N:)
Record the latitude of the plot center ~~to the nearest hundredth second~~, as determined by GPS.

NC Note: Collected in degrees and decimal minutes. Record decimal minutes to the 3rd decimal place and do not round.

When collected: When COORDINATE SYSTEM = 1
Field width: ~~8 digits (DDMMSSSS)~~ **NC Note:** 7 digits collected as Degrees and decimal minutes.
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values: **NC Note:** Vary by State.

1.14.7 LONGITUDE (W:)
Record the longitude of the plot center~~, to the nearest hundredth second~~, as determined by GPS.

NC Note: Collected in degrees and decimal minutes. Record decimal minutes to the 3rd decimal place and do not round.

When collected: When COORDINATE SYSTEM = 1
Field width: ~~9 digits: (DDDMMSSSS)~~ **NC Note:** 8 digits collected as Degrees and decimal minutes.
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values: **NC Note:** Vary by State.

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

NC NOTE: Not collected in North Central FIA region.

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

1.14.9 EASTING (X) UTM
Record the Easting coordinate of the plot center as determined by GPS.

NC NOTE: Not collected in North Central FIA region.

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

1.14.10 NORTHING (Y) UTM

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

NC NOTE: Not collected in North Central FIA region.

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

1.14.11 Correction For "Offset" Location (OFFSET)

As described in Section 1.14.2, coordinates may be collected at a location other than the plot center (an “offset” location). If a PLGR unit is used all offset coordinates will be "corrected" back using the Rng/Calc function. If a GPS unit other than a PLGR is used, then record items 1.14.12 and 1.14.13.

1.14.12 AZIMUTH TO PLOT CENTER (AZM)

Record the azimuth from the location where coordinates were collected to actual plot center. If coordinates are collected at plot center, record 000.

When collected: When GPS UNIT = 2, 3 or 4
Field width: 3 digits
Tolerance +/- 3 degrees
MQO: At least 99% of the time
Values: 000 when coordinates **are** collected at plot center
001 to 360 when coordinates **are not** collected at plot center

1.14.13 DISTANCE TO PLOT CENTER (DIST)

Record the horizontal distance in feet from the location where coordinates were collected to the actual plot center. If coordinates are collected at plot center, record 000. As described in Section 1.14.2, if a laser range finder is used to determine DISTANCE TO PLOT CENTER, offset locations may be up to 999 feet from the plot center. If a range finder is not used, the offset location must be within 200 feet.

When collected: When GPS UNIT = 2, 3 or 4
Field width: 3 digits
Tolerance: +/- 6 ft
MQO: At least 99% of the time
Values: 000 when coordinates **are** collected at plot center
001 to 200 when a Laser range finder **is not** used to determine distance
001 to 999 when a Laser range finder **is** used to determine distance

1.14.14 GPS ELEVATION (ELEV)

Record the elevation above mean sea level of the plot center, in feet, as determined by GPS.

When collected: When GPS UNIT = 1, 2 or 4
Field width: 6 digits
Tolerance:
MQO: At least 99% of the time
Values: -00100 to 20000

1.14.15 GPS ERROR (ERRS)

Record the error as shown on the GPS unit to the nearest foot. As described in Section 1.14.2, make every effort to collect readings only when the error less than or equal to 70 feet. However, if after trying several different times during the day, at several different locations, this is not possible, record readings with an error of up to 999 feet.

When collected: When GPS UNIT =1 or 2
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000 to 070 if possible
071 to 999 if an error of less than 70 cannot be obtained

1.14.16 NUMBER OF READINGS (READ)

Record a 3-digit code indicating how many readings were averaged by the GPS unit to calculate the plot coordinates. Collect at least 180 readings if possible.

When collected: When GPS UNIT = 1 or 2
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 001 to 999

1.14.17 GPS FILENAME (CORE OPTIONAL)

Record the filename containing the GPS positions collected on the plot.

NC Note: Not collected in the North Central FIA region.

When collected: When GPS UNIT = 3
Field width: 8 characters.3 characters (e.g., R0171519.ssf)
Tolerance: No errors
MQO: At least 99% of the time
Values: Letters and numbers

1.15NC NC PIN PRICK LOCATION on image (Moved pin prick)

When the location of the plot on the image is 132 feet or more from the location of the plot on ground move the location on the image to agree with the ground location.

1.15.1NC NC PIN PRICK AZIMUTH (PAZM)

When a location on an image(X or pin prick) is moved to correctly reflect the ground location of the plot, enter the azimuth from the original mark on the image to the correct ground location.

When collected: SK = 1 or 2 plot where ground plot location and location on image differ by 132 feet or more.
Field width: 2 digit
Tolerance: +/- 45 degrees
MQO: at least 95% of the time
Values: 0, 45, 90, 135, 180, 225, 270, 315

1.15.2NC NC PIN PRICK DISTANCE (PDIS)

When a location on an image(X or pin prick) is moved to correctly reflect the ground location of the plot, enter the distance from the original mark on the image to the correct ground location. Record the distance in feet (1 chain = 66 feet)

When collected: SK = 1 or 2 plot where ground plot location and location on image differ by 132 feet or more.
Field width: 3 digits
Tolerance: +/- 33 feet
MQO: at least 95% of the time
Values:

1.15 PLOT-LEVEL NOTES

Use these fields to record notes pertaining to the entire plot. If the notes apply only to a specific subplot or other specific aspect of the plot, then make that clear in the notes.

When collected: All plots
Field width: Unlimited alphanumeric character field
Tolerance: N/A
MQO: N/A
Values: English language words, phrases and numbers

1.16 P3 HEXAGON NUMBER

Record the unique code assigned to each Phase 3 (former FHM) hexagon.

NC Note: This data item will be attached to the data by St. Paul after the data is collected. The information is printed on the North Central Re-measurement tree list portion of the Plot sheet.

When collected: All Phase 3 plots
Field width: 7 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

1.17 P3 PLOT NUMBER

Record the Phase 3 PLOT NUMBERS that are used to identify individual plots within the same Phase 3 (former FHM) hexagon.

NC Note: This data item will be attached to the data by St. Paul after the data is collected. The information is printed on the North Central Re-measurement tree list portion of the Plot sheet.

When collected: All Phase 3 plots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

1.18NC NC 1 OR 2 PERSON PLOT (CRSZ)

Enter a code 1 or 2 which indicates that the plot could be done with one person or should be done with two people.

When collected: All P2 plots that go to the field
Field width: 1 digit
Tolerance: N/A
MQO: N/A
Values:

1	could be done by one person crew
2	should be done by two person crew

1.19NC NC PLOT SEASON (SEAS)

Enter the code reflecting the best time to complete this plot. This should reflect time of year when the plot is accessible. If there are no hindrances for doing this plot at any time of year please enter 3.

When collected: All P2 plots that go to the field
Field width: 1 digit
Tolerance: N/A
MQO: N/A
Values:

1	Winter
2	Summer
3	Does not matter

1.20NC NC ADDRESS

The name, address and phone number for the owner of the plot will be collected in the courthouse or with other available records. Collect this information only once per plot and record the owner of the first forested condition that you assign. This data is collected in the data recorder.

1.20.1NC NC OWNER FIRST NAME (FIRST NAME)

Enter the First name of the owner of the first forested condition defined on a plot.

When collected: All forested plots on first forested condition
Field width: 40 characters
Tolerance: No errors
MQO: 99% of the time
Values:

1.20.2NC NC OWNER LAST NAME (LAST NAME)

Enter the last name of the owner of the first forested condition defined on a plot. When ownership is Public enter the agency name in the Last Name location.

When collected: All forested plots on first forested condition
Field width: 40 characters
Tolerance: No errors
MQO: 99% of the time
Values:

1.20.3NC NC OWNER STREET (STREET)

Record the street address for the owner of the plot. If the land-owner is a government agency or private industry, owner groups less than 40, this item is not needed.

When Collected: First forested condition where owner group = 40.
Field width: 40 characters
Tolerance: No errors
MQO: 99% of the time
Values:

1.20.4NC NC OWNER CITY (CITY)

Record city name for the street address for the owner of the plot. If the land-owner is a government agency or private industry, owner groups less than 40, this item is not needed.

When Collected: First forested condition where owner group = 40.
Field width: 40 characters
Tolerance: No errors
MQO: 99% of the time
Values:

1.20.5NC NC OWNER STATE (STATE)

Record two digit State name for the street address for the owner of the plot. If the land-owner is a government agency or private industry, owner groups less than 40, this item is not needed.

When Collected: First forested condition where owner group = 40.
Field width: 2 digits
Tolerance: No errors
MQO: 99% of the time
Values: all two character state codes

1.20.6NC NC OWNER ZIP (ZIP)

Record city zip code for the street address for the owner of the plot. If the land-owner is a government agency or private industry, owner groups less than 40, this item is not needed.

When Collected: First forested condition where owner group = 40.
Field width: 15 characters
Tolerance: No errors
MQO: 99% of the time
Values:

1.20.7NC NC PHONE (PHONE)

Record phone number of the land-owner of the plot. Record using dashes between area code and the next 3 digits (exchange) and between the exchange and the number (i.e.: nnn-nnn-nnnn). If the owner group is a government agency or private industry, owner groups less than 40, this item is not needed.

When Collected: First forested condition where owner group = 40 when possible.
Field width: 10 digits
Tolerance: None
MQO: When available
Values: nnn-nnn-nnnn

1.20.8NC NC OWNER REQUESTS INFORMATION (SEND INFO ST P)

If the land owner requests more information on the forest inventory data than can be provided in field this data item should be set to “Y”. This item has a default setting of N so if there is a request from the land owner this should be changed to Y.

When collected:
Field width: 1 digit
Tolerance:
MQO:
Values:

Y	Yes
N	No

2.0 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).

2.1 DETERMINATION OF CONDITION CLASS

2.1.1 Step 1: Delineate the plot area by CONDITION CLASS STATUS

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

1. Accessible forest land
2. Nonforest land
3. Noncensus water
4. Census water
5. Nonsampled

Accessible forest land defines the population of interest for FIA purposes. This is the area where most of the data collection is conducted.

At time of re-inventory, one additional attribute, PRESENT NONFOREST LAND USE, is used to define new condition classes if the sampled area on a plot has changed from accessible forest land to nonforest land (NOTE: see Section 2.5.24). This allows tracking of land use changes without requiring mapping of all nonforest condition classes on all plots.

2.1.2 Step 2: Further subdivide Accessible Forest Land by 6 delineation variables

Any condition class sampled as accessible forest land may be further subdivided, in order of listed priority, into smaller condition classes if distinct, contrasting condition classes are present because of variation in any of the following attributes within the sampled area:

1. RESERVED STATUS
2. OWNER GROUP
3. FOREST TYPE
4. STAND SIZE CLASS
5. REGENERATION STATUS
6. TREE DENSITY

No other attribute shall be the basis for recognizing contrasting accessible forest land condition classes. For each condition class recognized, several “ancillary attributes” that help describe the condition will be collected, but will not be used for delineation purposes (see Sections 2.5.7 to 2.5.23).

2.2 CONDITION CLASS STATUS DEFINITIONS

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 (Appendix 3) of any size 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 species (Appendix 3) 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.

NC Note: If the stocking is 10-percent by trees, and there is mowing or intensive grazing the plot is given a Condition Status of 1- Forest Land and the plot is installed as a forested plot.

To qualify as forest land, the prospective condition must be at least 1.0 acre in size and 120.0 feet wide measured stem-to-stem from the outer-most edge. Forested strips must be 120.0 feet wide for a continuous length of at least 363.0 feet 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 percent 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 2).

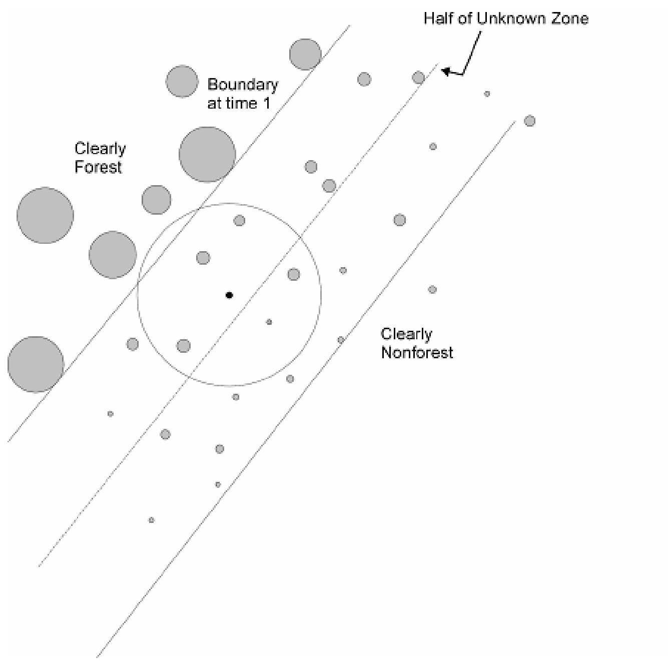


Figure 2. Example of classifying the condition class of the subplot in a transition zone with forest/nonforest encroachment.

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 landowner may help determine the intent of a treatment.

Indistinct boundary due to the condition minimum-width definition – Do not subdivide subplots where a condition class may change due only to the forest vs. nonforest minimum width (120.0 feet) 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 3 and 4. 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.

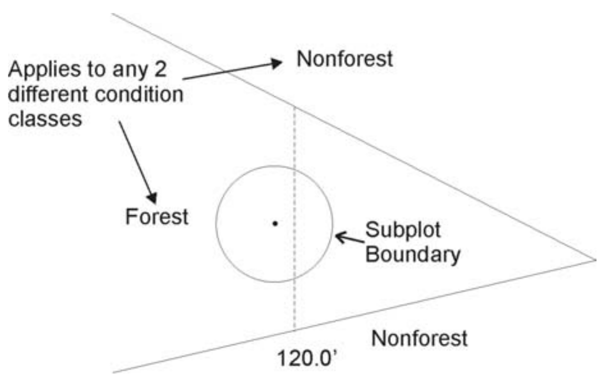


Figure 3. Forest condition narrows within a nonforest condition. Examine the location of the subplot center in reference to the approximate line where the forest narrows to 120.0 ft wide. In this example, the entire subplot is classified as forest.

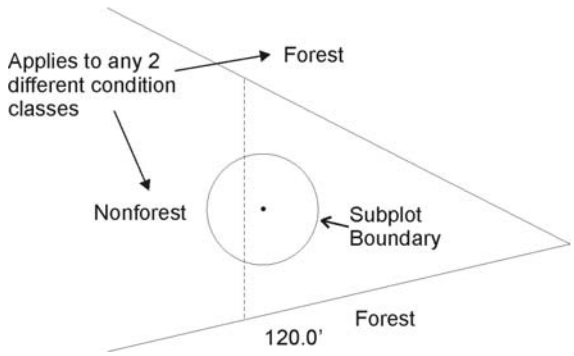


Figure 4. Nonforest condition narrows within a forest condition. Examine the location of the subplot center in reference to the approximate line where the nonforest narrows to 120.0 ft wide. In this example, the entire subplot is classified as forest.

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 CLASS STATUS values defined in #'s 3 and 4 in Section 2.2. To qualify, the area must be at least 1.0 acre in size and 120.0 feet wide; five exceptions are discussed at the beginning of Section 2.4. Do not consider evidence of "possible" or future development or conversion. A nonforest land condition will remain in the sample and will be examined at the next plot visit to see if it has become forest land.

3. Noncensus Water
Lakes, reservoirs, ponds, and similar bodies of water 1.0 acre to 4.5 acres in size. Rivers, streams, canals, etc., 30.0 feet to 200 feet wide.

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

2.3 CONDITION CLASS ATTRIBUTES

A CONDITION CLASS NUMBER and a classification for CONDITION CLASS STATUS are required for every condition class sampled on a plot. For each condition class classified as accessible forest land, a classification is required for each of the following attributes:

2.5.1	RESERVED STATUS	Attributes where a change causes a separate condition class
2.5.2	OWNER GROUP	
2.5.3	FOREST TYPE	
2.5.4	STAND SIZE CLASS	
2.5.5	REGENERATION STATUS	
2.5.6	TREE DENSITY	
2.5.7	OWNER CLASS	Ancillary - changes do not delineate a new condition class
2.5.7NC	NC PRIVATE ACRES	
2.5.8	PRIVATE OWNER INDUSTRIAL STATUS	
2.5.9	ARTIFICIAL REGENERATION SPECIES	
2.5.10	STAND AGE	
2.5.11	DISTURBANCE (up to 3 coded)	
2.5.12	DISTURBANCE YEAR (1 per disturbance)	
2.5.17	TREATMENT (up to 3 coded)	
2.5.18	TREATMENT YEAR (1 per treatment)	
2.5.23	PHYSIOGRAPHIC CLASS	

2.5.24 PRESENT NONFOREST LAND USE (for area converted from accessible forest land condition class to nonforest land since last inventory).
2.4.23NC NC LAND USE

When classifying CONDITION CLASS STATUS, OWNER GROUP, RESERVED STATUS, and PRESENT NONFOREST USE, base the classification on what is present within the area defined by the fixed radius plot (annular, subplot, or microplot). When classifying all other condition class variables, base the classification on the annular plot.

2.4 DELINEATING CONDITION CLASSES DIFFERING IN CONDITION STATUS:

The first step in delineating condition classes is to recognize differences in CONDITION CLASS 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 acre in size, and each is at least 120.0 feet 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 acre in size and less than 120.0 feet 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 acre in size and less than 120.0 feet in width are considered part of the nonforest condition class.

Five exceptions to these size and width requirements apply:

Figure 6. To be added later

1. Developed nonforest condition: human-caused nonforest land condition classes such as homes or cabins that are less than 1.0 acre in size and 120.0 feet in width and are surrounded by forest land. There are three kinds of developed nonforest conditions that do not have to meet area or width requirements (Figures 5).

    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 acre 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 acre in size and less than 120.0 feet 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. This exception applies only to nonforest conditions that are not listed under #1, e.g., improved roads, maintained rights-of-way, and developments.

    For many small intermingled strips, determine the total area that the alternating strips occupy, and classify according to the CONDITION CLASS 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 7. Figure 7 delineates the boundary between the forest and nonforest condition classes for four different examples. The plot center defines the plot condition for all strips covered by the arrow. Any subplot that falls in the alternating strips uses the rule. Any subplot that falls in assigned nonforest / forest is assigned that type.

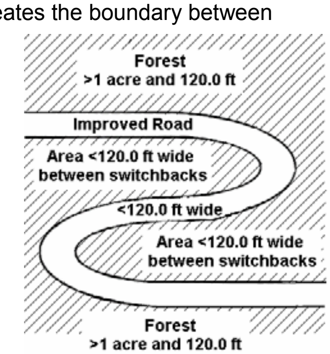


Figure 5. Example of a switchback road.

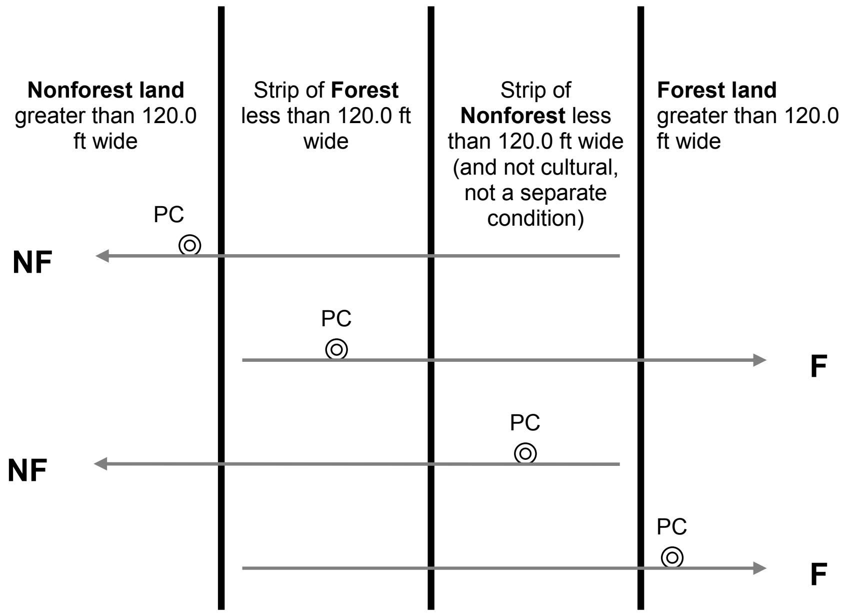


Figure 7. Example of alternating strips of forested and nonforested conditions. PC is the plot center (center of subplot 1).

3. The 120.0-foot minimum width for delineation does not apply when a corner angle is 90 degrees or greater (Figure 8).

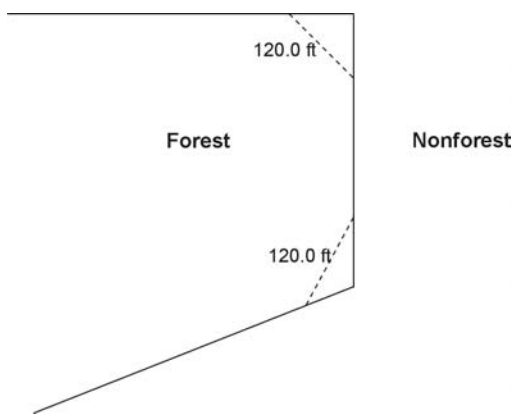


Figure 8. Illustration of the 90 degree corner rule. The dotted lines do not create nonforest conditions.

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 feet wide and cover at least 1.0 acre. 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 that 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 acre requirement; use professional judgment and common sense on any linear water feature.

5. Nonsampled conditions within accessible forest land are delineated, regardless of size, as a separate condition.

2.4.1 CONDITION CLASS NUMBER (CON#)

On a plot, assign and record a number for each condition class. 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.

When collected: All condition classes
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

2.4.2 CONDITION CLASS STATUS (CDST)

Record the code that describes the sampling status of the condition class. The instructions in Sections 2.3 and 2.4 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	Nonsampled

NC Note: On any North Central plot sent to the field with re-measurement trees that has changed condition class status to anything other than Accessible Forest Land, the trees must be accounted for in the returned data file. See Tree section (Section 5) in the manual for how to deal with these.

2.4.3 CONDITION NONSAMPLED REASON (REAS)

For portions of plots that cannot be sampled (CONDITION CLASS STATUS = 5), record one of the following reasons.

When collected: When CONDITION CLASS STATUS = 5
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

01 Outside U.S. boundary – Assign this code to condition classes beyond the U.S. border.

02 Denied access area – Any area within the sampled area of a plot to which access is denied by the legal owner, or to which an owner of the only reasonable route to the plot denies access. 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. In some regions denied access plots may be replaced; check with the field supervisor regarding regional protocols for plot replacement.

03 Hazardous situation – 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 substance 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. In some regions hazardous plots may be replaced; check with the field supervisor regarding regional protocols for plot replacement.

10 Other – This code is used whenever a plot or condition class is not sampled due to a reason other than one of the specific reasons listed. A field note is required to describe the situation.

2.5 DELINEATING CONDITION CLASSES WITHIN ACCESSIBLE FOREST LAND:

Accessible forest land is subdivided into condition classes that are based on differences in RESERVED STATUS, OWNER GROUP, FOREST TYPE, STAND SIZE CLASS, REGENERATION STATUS, and TREE DENSITY. Section 2.1 applies when delineating contrasting forest condition classes. Specific criteria apply for each of the six attributes and are documented by attribute in 2.5.1 to 2.5.6. "Stands" are defined by plurality of stocking for all live trees that are not overtopped.

Additionally, each separate forest condition class recognized within accessible forest land must be at least 1.0 acre in size and at least 120.0 feet in width. If prospective contrasting forest land condition classes do not each meet these minimum size and width requirements, the most similar prospective conditions should be combined until these minimums are attained.

No other attribute shall be the basis for recognizing contrasting condition classes within accessible forest land. For each condition class recognized, many "ancillary attributes" that help describe the condition will be collected, but will not be used for delineation purposes (see Sections 2.5.7 to 2.5.23).

General instructions for delineating condition classes within accessible forest lands:

1. <u>Distinct boundary within an annular plot (if applicable), subplot, or microplot</u> – Separate condition classes ARE recognized if, within a subplot, two (or more) distinctly different condition classes are present and delineated by a distinct, abrupt boundary. The boundary is referenced; see Section 4.0.

2. <u>Indistinct boundary within a subplot</u> – Separate condition classes are NOT recognized if the prospective condition classes abut along an indistinct transition zone, rather than on an abrupt, obvious boundary. Only one condition is recognized, and the subplot is classified entirely as the condition it most resembles.

   Example: The four subplots all sample only accessible forest land. Subplots 1, 3, and 4 sample what is clearly a stand of large diameter trees. Subplot 2 falls in the middle of a stand size transition zone. In the zone, the large diameter stand phases into a sapling stand.

   Subplot 2 must not be divided into two condition classes on the basis of stand size. Instead, it is treated entirely as part of the large diameter condition class or is assigned entirely to a new condition class that is classified as a seedling-sapling stand. The latter occurs only if the crew thinks the entire subplot is more like a stand of seedlings-saplings than a stand of large diameter trees; then the boundary between the large and small diameter stands is assumed to occur between and not on the subplots.

3. <u>A boundary or transition zone between fixed radii plots that sample distinctly different condition classes</u> – Separate condition classes are recognized and recorded when a valid attribute obviously differs between two fixed radius plots, but a distinct boundary or indistinct transition zone exists outside the sampled (fixed-radius) area of the subplots. In such cases, a boundary, if present, is not referenced.

   Example: The northernmost subplot (2) samples entirely accessible forest land. The other three subplots, 1, 3, and 4, fall clearly in a nonforest meadow. Between subplot 1 and 2 is a transition zone; the number of trees present goes from none to what clearly represents at least 10-percent tree stocking. Two condition classes are sampled: accessible forest land sampled on subplot 2, and nonforest land sampled on the other subplots.

4. Riparian forest area – A riparian forest area is defined as a forest area between 30.0 and 120.0 feet wide, and 1.0 acre or more in size, cumulative, and adjacent to but not necessarily present on both sides of a naturally occurring or artificially created body of water or watercourse with continuous or intermittent flow. Riparian forest areas may be associated with but not limited to streams, rivers, lakes, sloughs, seeps, springs, marsh, beaver ponds, sink holes, cypress domes and ponds, man-made ditches and canals. A riparian forest area must be associated "within forest" and contain at least one distinct and obvious change in a condition class delineation attribute from its adjacent accessible forest land condition class. Figures 9-14 provide examples of when to delineate riparian forest area as a separate condition class.

   Note: When the width of forest adjacent to a stream is between 120.0 feet and 150.0 feet and the width of the riparian forest is at least 30.0 feet wide, the rules for identifying the non-riparian forest (at least 30.0 feet but less than 120.0 feet) need to be modified. The non-riparian forest can be between 30.0 feet and 120.0 feet and mapped as a separate condition as long as it meets the criteria for delineating a separate condition class, otherwise it will be an inclusion in the riparian forest condition class.

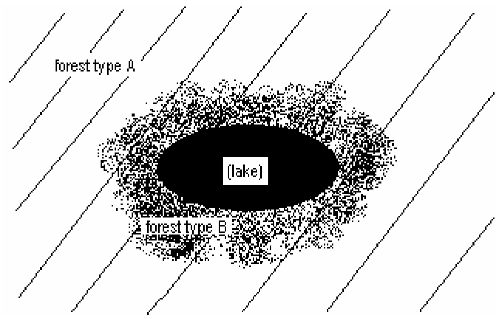


Figure 9. Forest type B is a separate condition class (riparian) if the band of it is between 30.0 feet and 120.0 feet wide, and is ≥ 1.0 acre in size.

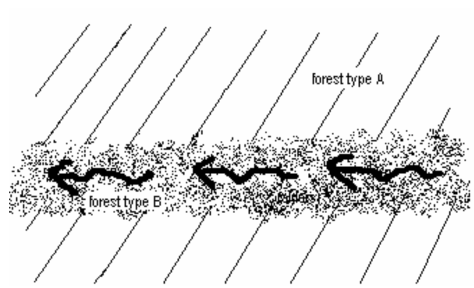


Figure 10. Forest type B is a separate condition class (riparian) if the band of it is between 30.0 feet and 120.0 feet wide, and is ≥ 1.0 acre in size.

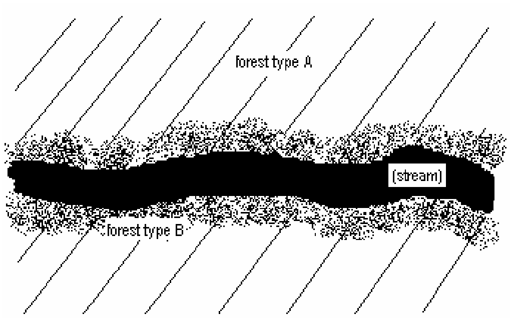


Figure 11. If the stream is < 30.0 feet wide, forest type B is a separate condition class (riparian) if the sum of the two widths of the bands falls between 30.0 feet and 120.0 feet wide, and is ≥ 1.0 acre in size.

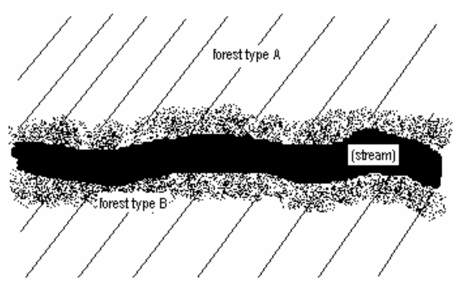


Figure 12. If the stream is > 30.0 feet wide, forest type B is a separate condition class (riparian) if either of the two widths of the bands falls between 30.0 feet and 120.0 feet wide and is ≥ 1.0 acre in size.

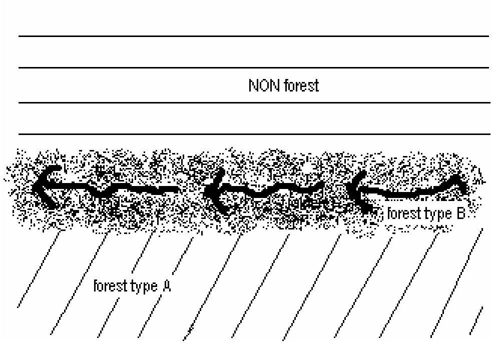


Figure 13. Forest type B is a separate condition class (riparian) if the band of it is between 30.0 feet and 120.0 feet wide, and is ≥ 1.0 acre in size.

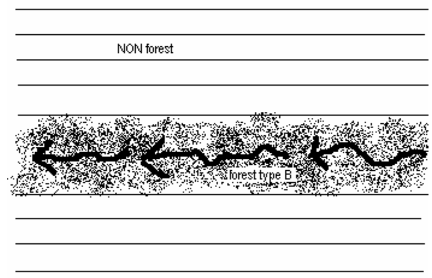


Figure 14. In a non-forested area, a band of forest type B that is < 120.0 feet wide is NOT considered a riparian area. It is not a separate condition class at all.

2.5.1 RESERVED STATUS (RESV)

Record the code that identifies the reserved designation for the condition. Reserved land is withdrawn by law(s) prohibiting the management of land for the production of wood products (not merely controlling or prohibiting wood-harvesting methods). Such authority is vested in a public agency or department, and supersedes rights of ownership. The prohibition against management for wood products cannot be changed through decision of the land manager (management agency) or through a change in land management personnel, but rather is permanent in nature.

When collected: All accessible forestland condition classes (CONDITION CLASS STATUS = 1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0	Not reserved
1	Reserved

2.5.2 OWNER GROUP (OWNG)

Record the OWNER GROUP 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 OWNER GROUP only; separate conditions due to changes in OWNER GROUP are recognized only where differences can be clearly identified on the ground when visiting the plot.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)
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

2.5.3 FOREST TYPE (FTYP)

Record the code corresponding to the FOREST TYPE (from Appendix 2) that best describes the species with the plurality of stocking for all live trees in the condition class that are not overtopped.

NC Note: First try to match the trees present with the bold face type names of each type. If this does not match your stand try to match your stand with the trees listed as associates under each type even if the bold faced species is not in your stand.

If STAND SIZE CLASS is nonstocked, then FOREST TYPE is determined by the following hierarchy:

- For SAMPLE KIND = 2 plots, record the FOREST TYPE of the condition at the previous inventory.
- For all other plots:
  1. Evaluate any seedlings available to determine the FOREST TYPE.
  2. If no seedlings exist, use adjacent stands and your best professional judgment to determine FOREST TYPE.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)
Field width: 3 digits
Tolerance: No errors in group or type
MQO: At least 99% of the time in group; at least 95% of the time in type. No MQO when STAND SIZE CLASS = 0.
Values: See Appendix 2

The instructions in Sections 2.1 and 2.4 apply when delineating, within accessible forest land, contrasting conditions based on differences in FOREST TYPE.

2.5.4 STAND SIZE CLASS (STSZ)

Record the code that best describes the predominant size class of all live trees in the condition class.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0 Nonstocked:
Meeting the definition of accessible forest land, and one of the following applies:

(a) less than 10 percent stocked by trees of any size, and not classified as cover trees (see code 6), or

(b) for several western woodland species where stocking standards are not available, less than 5 percent **crown cover** of trees of any size.

1 ≤ 4.9 inches (seedlings / saplings)

At least 10 percent stocking (or 5 percent crown cover if stocking standards are not available) in trees of any size; and at least 2/3 of the crown cover is in trees less than 5.0 inches DBH/DRC.

2 5.0 – 8.9 inches (softwoods) / 5.0 – 10.9 inches (hardwoods)
At least 10 percent stocking (or 5 percent crown cover if stocking standards are not available) in trees of any size; and at least 1/3 of the crown cover is in trees greater than 5.0 inches DBH/DRC **and** the plurality of the crown cover is in softwoods between 5.0 – 8.9 inches diameter and/or hardwoods between 5.0 – 10.9 inches DBH, and/or western woodland trees 5.0 – 8.9 inches DRC.

3 9.0 – 19.9 inches (softwoods) / 11.0 – 19.9 inches (hardwoods)
At least 10 percent stocking (or 5 percent crown cover if stocking standards are not available) in trees of any size; and at least 1/3 of the crown cover is in trees greater than 5.0 inches DBH/DRC **and** the plurality of the crown cover is in softwoods between 9.0 – 19.9 inches diameter and/or hardwoods between 11.0 – 19.9 inches DBH, and for western woodland trees 9.0 – 19.9 inches DRC.

4 20.0 – 39.9 inches
At least 10 percent stocking (or 5 percent crown cover if stocking standards are not available) in trees of any size; and at least 1/3 of the crown cover is in trees greater than 5.0 inches DBH/DRC **and** the plurality of the crown cover is in trees between 20.0 – 39.9 inches DBH.

5 40.0 + inches
At least 10 percent stocking (or 5 percent crown cover if stocking standards are not available) in trees of any size; and at least 1/3 of the crown cover is in trees greater than 5.0 inches DBH/DRC **and** the plurality of the crown cover is in trees $\geq$ 40.0 inches DBH.

6 Cover trees (trees not on species list, used for plots classified as nonforest):
Less than 10 percent stocking by trees of any size, and greater than 5 percent **crown cover** of species that comprise cover trees.

The instructions in Sections 2.1 and 2.4 apply when delineating, on accessible forest land, contrasting conditions based on differences in STAND SIZE CLASS.

Within the sampled area on microplot, subplot, or annular plot, recognize only very obvious contrasting stands of different mean diameter with an abrupt boundary. Example: an obvious abrupt boundary exists within the sampled (fixed-radius) area of a subplot and demarcates a STAND SIZE CLASS change. Use tree stocking of all live trees that are not overtopped to differentiate between stand-size classes; for most western woodland forest types (e.g., pinyon, juniper, gambel oak) where stocking standards are not readily available, use percent tree cover to represent stocking.

Use crown cover as the surrogate for stocking to determine STAND SIZE CLASS. View the plot from the top down and examine crown cover. The stand must have at least 5 percent of the crown cover in STAND SIZE CLASSES of 1, 2, 3, 4, or 5 or any combination of these STAND SIZE CLASSES; otherwise the STAND SIZE CLASS is 0. If 2/3 of the crown cover is STAND SIZE CLASS = 1, classify the condition as STAND SIZE CLASS = 1. If less than 2/3 of the crown cover is STAND SIZE CLASS = 1, classify the condition as STAND SIZE CLASS = 2, 3, 4, or 5, based on which of these STAND SIZE CLASSES has the most crown cover.

2.5.5 REGENERATION STATUS (SORI)

Record the code that best describes the artificial regeneration that occurred in the condition.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0	Natural – present stand shows no clear evidence of artificial regeneration. Includes unplanted, recently cut lands
1	Artificial – present stand shows clear evidence of artificial regeneration

The instructions in section 2.1 and 2.4 apply when delineating, within accessible forest land, contrasting conditions based on differences in REGENERATION STATUS.

For a forest land condition to be delineated and/or classified as artificially regenerated, the condition must show distinct evidence of planting or seeding. If it is difficult to determine whether or not a stand has been planted or seeded, then use code 0. If no distinct boundary exists within the sampled (fixed-radius) area on any subplot, then do not recognize separate conditions. In many regions of the West, trees are not planted in rows, and planted stands do not differ in physical appearance from natural conditions. In these cases, there is no need to differentiate conditions based on stand origin.

NOTE: Plot records or verbal evidence from landowner is acceptable for determining regeneration status.

2.5.6 TREE DENSITY (DENS)

Record a code to indicate the relative tree density classification. Base the classification on the number of stems/unit area, basal area, tree cover, or stocking of all live trees in the condition that are not overtopped, compared to any previously defined condition class TREE DENSITY.

The instructions in Sections 2.1 and 2.4 apply when delineating, within accessible forest land, contrasting conditions based on differences in TREE DENSITY.

Codes 2 and higher are used ONLY when all other attributes used to delineate separate condition classes are homogenous, i.e., when a change in density is the ONLY difference within what would otherwise be treated as only one forest condition. Otherwise, code 1 for all condition classes. Codes 2 and higher are usually, but not always, used to demarcate areas that differ from an adjacent area due to forest disturbance, e.g., a partial harvest or heavy, but not total tree mortality due to a ground fire. Delineation by density should only be done when the less-dense condition is 50 percent or less as dense as the more dense condition.

Do not distinguish between low-stocked stands or stands of sparse and patchy forest.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1	Initial density class
2	Density class 2 - density different than 1
3	Density class 3 - density different than 1 and 2

In order to qualify as a separate condition based on density, there MUST be a distinct, easily observed change in the density of an area's tree cover or basal area.

Examples of valid contrasting conditions defined by differences in tree density are:

- the eastern half of an otherwise homogeneous, 20-acre stand has many trees killed by a bark beetle outbreak,
- one portion of a stand is partially cut over (with 40 square feet basal area per acre) while the other portion is undisturbed (with 100 square feet basal area per acre).

NOTE: In these examples, RESERVED STATUS, OWNER GROUP, FOREST TYPE, STAND SIZE CLASS, and REGENERATION STATUS are the same.

ANCILLARY (NON-DELINEATING) VARIABLES

2.5.7 OWNER CLASS (OWNC)

Record the OWNER CLASS code that best corresponds to the ownership (or the managing Agency for public lands) of the land in the condition class. Conditions will **NOT** be delineated based on changes in owner class. If multiple owner classes within a group occur on a single condition class, record the owner class closest to the plot center.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

Owner Classes within Forest Service Lands (Owner Group 10):

11 National Forest
12 National Grassland
13 Other Forest Service

Owner Classes within Other Federal Lands (Owner Group 20)

21 National Park Service
22 Bureau of Land Management
23 Fish and Wildlife Service
24 Departments of Defense/Energy
25 Other Federal

Owner Classes within State and Local Government lands (Owner Group 30)

31 State
32 Local (County, Municipality, etc.)
33 Other Non Federal Public

Owner Classes within Private lands (Owner Group 40)

41 Corporate
42 Non Governmental Conservation / Natural Resources Organization
- examples: Nature Conservancy, National Trust for Private Lands, Pacific Forest Trust, Boy Scouts of America, etc.
43 Unincorporated Partnerships / Associations / Clubs – examples: Hunting Clubs that **own, not lease** property, recreation associations, 4H, etc.

44 Native American (Indian) – within reservation boundaries
45 Individual

2.5.7NC NC PRIVATE ACRES (NCPA)

For Ownership Group code 40, record the acres of forest land owned using the code that indicates ownership size (Condition Status=1) in the United States.

When collected: Only when owner group=40
Field width: 1 digit
MQO: +/- 1 code
Values:

Code	Acres forest land
1	1-4
2	5-9
3	10-19
4	20-49
5	50-99
6	100-499
7	500-2499
8	2500-4999
9	5000+

2.5.8 PRIVATE OWNER INDUSTRIAL STATUS (INDU)
Record the code identifying the status of the owner with regard to being considered industrial as determined by whether or not they own and operate a primary wood processing plant. A primary wood processing plant is any commercial operation which originates the primary processing of wood on a regular and continuing basis. Examples include: pulp or paper mill, sawmill, panel board mill, post or pole mill, etc. Cabinet shops, "mom & pop" home-operated businesses, etc., should not be considered as industrial plants. If any doubt exists with the determination by the field crew about the owner's industrial status due to name, commercial plant size, type plant, etc., choose code 0.

NOTE: FIA unit or State headquarters may have to maintain a list of recognized industrial owners within a State for crews to use when making these determinations.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1) when the owner group is private (OWNER GROUP 40)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0 Land **is not** owned by industrial owner with a wood processing plant
1 Land **is** owned by industrial owner with wood processing plant

2.5.9 ARTIFICIAL REGENERATION SPECIES (SOSP)
Record the species code of the predominant tree species for which evidence exists of artificial regeneration in the stand. This attribute is ancillary; that is, contrasting condition classes are never delineated based on variation in this attribute.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1) with evidence of artificial regeneration (REGENERATION STATUS = 1)
Field width: 4 digits

Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 3

2.5.10 STAND AGE (SAGE)

Record the average total age, to the nearest year, of the trees (plurality of all live trees not overtopped) in the predominant STAND SIZE CLASS of the condition, determined using local procedures. Record 000 for non-stocked stands.

An estimate of STAND AGE is required for every forest land condition class defined on a plot. Stand age is usually highly correlated with stand size and should reflect the average age of all trees that are not overtopped. Unlike the procedure for site tree age (TREE AGE AT DIAMETER), estimates of STAND AGE should estimate the time of tree establishment (e.g., not age at the point of diameter measurement). Note: For planted stands, estimate age based on the year the stand was planted (e.g., do not add in the age of the planting stock).

To estimate STAND AGE, select two or three dominant or codominant trees from the overstory. If the overstory covers a wide range of tree sizes and species, try to select the trees accordingly, but it is not necessary to core additional trees in such stands. The variance associated with mean stand age increases with stand heterogeneity, and additional cores are not likely to improve the estimate. Core each tree at the point of diameter measurement and count the rings between the outside edge and the core to the pith. Add in the number of years that passed from germination until the tree reached the point of core extraction to determine the total age of the tree. Unless more specific information is provided at training or by the unit, add 5 years to all eastern species, 5 years to western hardwoods, and 10 years to western softwoods. Assign a weight to each core by visually estimating the percentage of total overstory trees it represents. Make sure the weights from all cores add up to 1.0, compute the weighted average age, and record. For example, if three trees aged 34, 62, and 59 years represent 25 percent, 60 percent, and 15 percent of the overstory, respectively, the weighted stand age should be:

(34 x 0.25) + (62 x 0.60) + (59 x 0.15) = 55 years.

In some cases, it may be possible to avoid coring trees to determine age. If a stand has not been seriously disturbed since the previous survey, simply add the number of years since the previous inventory to the previous STAND AGE. In other situations, cores collected from site trees can be used to estimate STAND AGE.

If a condition class is nonstocked, assign a STAND AGE of 000.

If all of the trees in a condition class are of a species which, by regional standards, cannot be bored for age (e.g., mountain mahogany, tupelo) record 998. This code should be used in these cases only.

If tree cores are not counted in the field, but are collected and sent to the office for the counting of rings, record 999. Note on the core the % of stand that type of core represents so that STAND AGE can be calculated later.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)
Field width: 3 digits
Tolerance: +/- 10%
MQO: At least 95% of the time
Values: 000 to 997, 998, 999

2.5.11 DISTURBANCE 1 (DIS1)

Record the code corresponding to the presence of the following disturbances. Disturbance can connote positive or negative effects. The area affected by any natural or human-caused disturbance must be at least 1.0 acre in size. Record up to three different disturbances per condition class from most important to least important as best as can be determined. This attribute is ancillary; that is, contrasting conditions are never delineated based on variation in this attribute.

For initial forest plot establishment (initial grid activation or newly forested plots), the disturbance must be within the last 5 years. For remeasured plots recognize only those disturbances that have occurred since the previous inventory.

The following disturbance codes require "significant threshold" damage, which implies mortality and/or damage to 25 percent of all trees in a stand or 50 percent of an individual species' count. Additionally, some disturbances affect forests but initially may not affect tree growth or health (e.g., grazing, browsing, flooding, etc.). In these cases, a disturbance should be coded when at least 25 percent of the soil surface or understory vegetation has been affected.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

Code	Definition
00	None - no observable disturbance
10	Insect damage
11	insect damage to understory vegetation
12	insect damage to trees, including seedlings and saplings
20	Disease damage
21	disease damage to understory vegetation
22	disease damage to trees, including seedlings and saplings
30	Fire (from crown and ground fire, either prescribed or natural)
31	ground fire
32	crown fire
40	Animal damage
41	beaver (includes flooding caused by beaver)
42	porcupine
43	deer/ungulate
~~44~~	~~bear~~ (CORE OPTIONAL) **NC Note:** Not used
~~45~~	~~rabbit~~ (CORE OPTIONAL) **NC Note:** Not used
46	domestic animal/livestock (includes grazing):
50	Weather damage
51	ice
52	wind (includes hurricane, tornado)
53	flooding (weather induced)
54	drought
55	earth movement/avalanches
60	Vegetation (suppression, competition, vines):
70	Unknown/not sure/other (include in NOTES)
80	Human-caused damage – any significant threshold of human-caused damage not described in the DISTURBANCE codes listed or in the TREATMENT codes listed. Must include a plot-level note to describe further.

2.5.12 DISTURBANCE YEAR 1 (DYR1)

Record the year in which DISTURBANCE 1 occurred. If the disturbance occurs continuously over a period of time, record 9999.

When collected: When DISTURBANCE 1 > 00
Field width: 4 digits
Tolerance: +/- 1 year for measurement cycles of 5 years
+/- 2 years for measurement cycles of > 5 years
MQO: At least 99% of the time
Values: Since the previous plot visit, or the past 5 years for plots visited for the first time
NC Note: Or 9999 if continuous

2.5.13 DISTURBANCE 2 (DIS2)

If a stand has experienced more than one disturbance, record the second disturbance here. See DISTURBANCE 1 for coding instructions.

2.5.14 DISTURBANCE YEAR 2 (DYR2)

Record the year in which DISTURBANCE 2 occurred. See DISTURBANCE YEAR 1 for coding instructions.

2.5.15 DISTURBANCE 3 (DIS3)

If a stand has experienced more than two disturbances, record the third disturbance here. See DISTURBANCE 1 for coding instructions.

2.5.16 DISTURBANCE YEAR 3 (DYR3)

Record the year in which DISTURBANCE 3 occurred. See DISTURBANCE YEAR 1 for coding instructions.

2.5.17 TREATMENT 1 (TRE1)

Forestry treatments are a form of disturbance. These human disturbances are recorded separately here for ease of coding and analysis. The term treatment further implies that a silvicultural application has been prescribed. This does not include occasional stumps of unknown origin or sparse removals for firewood, Christmas trees, or other miscellaneous purposes. The area affected by any treatment must be at least 1.0 acre in size. Record up to three different treatments per condition class from most important to least important as best as can be determined. This attribute is ancillary; that is, contrasting conditions are never delineated based on variation in this attribute.

For initial forest plot establishment (initial grid activation or newly forested plots), the treatment must be within the last 5 years. For remeasured plots recognize only those treatments that have occurred since the previous inventory.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

Code	Definition
00	None - No observable treatment.

10 Cutting - The removal of one or more trees from a stand.

20 Site preparation - Clearing, slash burning, chopping, disking, bedding, or other practices clearly intended to prepare a site for either natural or artificial regeneration.

30 Artificial regeneration - Following a disturbance or treatment (usually cutting), a new stand where at least 50% of the live trees present resulted from planting or direct seeding.

40 Natural regeneration - Following a disturbance or treatment (usually cutting), a new stand where at least 50% of the live trees present (of any size) were established through the growth of existing trees and/or natural seeding or sprouting.

50 Other silvicultural treatment - The use of fertilizers, herbicides, girdling, pruning, or other activities (not covered by codes 11-40) designed to improve the commercial value of the residual stand, or chaining, which is a practice used on western woodlands to encourage wildlife forage.

2.5.18 TREATMENT YEAR 1 (TYR1)
Record the year in which TREATMENT 1 occurred.

When collected: When TREATMENT 1 > 00
Field width: 4 digits
Tolerance: +/- 1 year for measurement cycles of 5 years
+/- 2 years for measurement cycles of > 5 years
MQO: At least 99% of the time
Values: Since the previous plot visit, or the past 5 years for plots visited for the first time

2.5.19 TREATMENT 2 (TRE2)
If a stand has experienced more than one treatment, record the second treatment here. See TREATMENT 1 for coding instructions; code 00 if none.

2.5.20 TREATMENT YEAR 2 (TYR2)
Record the year in which TREATMENT 2 occurred. See TREATMENT YEAR 1 for coding instructions.

2.5.21 TREATMENT 3 (TRE3)
If a stand has experienced more than two treatments, record the third treatment here. See TREATMENT 1 for coding instructions; code 00 if none.

2.5.22 TREATMENT YEAR 3 (TYR3)
Record the year in which TREATMENT 3 occurred. See TREATMENT YEAR 1 for coding instructions.

2.5.23 PHYSIOGRAPHIC CLASS (PHYS)
Record the code that best describes the PHYSIOGRAPHIC CLASS of the condition within the plot area; land form, topographic position, and soil generally determine physiographic class.

When collected: All accessible forest land condition classes (CONDITION CLASS STATUS = 1)

Field width: 2 digits
Tolerance: No errors
MQO: At least 80% of the time
Values:

Xeric Sites that are normally low or deficient in moisture available to support vigorous tree growth. These areas may receive adequate precipitation, but experience a rapid loss of available moisture due to runoff, percolation, evaporation, etc.

11 Dry Tops - Ridge tops with thin rock outcrops and considerable exposure to sun and wind.

12 Dry Slopes - Slopes with thin rock outcrops and considerable exposure to sun and wind. Includes most steep slopes with a southern or western exposure.

13 Deep Sands - Sites with a deep, sandy surface subject to rapid loss of moisture following precipitation. Typical examples include sand hills, sites along the beach and shores of lakes and streams, and many deserts.

19 Other Xeric - All dry physiographic sites not already described.

Mesic Sites that have moderate but adequate moisture available to support vigorous tree growth except for periods of extended drought. These sites may be subjected to occasional flooding during periods of heavy or extended precipitation.

21 Flatwoods - Flat or fairly level sites outside flood plains. Excludes deep sands and wet, swampy sites.

22 Rolling Uplands - Hills and gently rolling, undulating terrain and associated small streams. Excludes deep sands, all hydric sites, and streams with associated flood plains.

23 Moist Slopes and Coves - Moist slopes and coves with relatively deep, fertile soils. Often these sites have a northern or eastern exposure and are partially shielded from wind and sun. Includes moist mountain tops and saddles.

24 Narrow Flood plains/Bottomlands - Flood plains and bottomlands less than 1/4-mile in width along rivers and streams. These sites are normally well drained but are subjected to occasional flooding during periods of heavy or extended precipitation. Includes associated levees, benches, and terraces within a 1/4 mile limit. Excludes swamps, sloughs, and bogs.

25 Broad Flood plains/Bottomlands - Flood plains and bottomlands 1/4 mile or wider in width along rivers and streams. These sites are normally well drained but are subjected to occasional flooding during periods of heavy or extended precipitation. Includes associated levees, benches, and terraces. Excludes swamps, sloughs, and bogs with year-round water problems.

29 Other Mesic - All moderately moist physiographic sites not already described.

Hydric Sites that generally have a year-round abundance or over-abundance of moisture. Hydric sites are very wet sites where excess water seriously limits both growth and species occurrence.

31 Swamps / Bogs - Low, wet, flat forested areas usually quite extensive that are flooded for long periods of time except during periods of extreme drought. Excludes cypress ponds and small drains.

32 Small Drains - Narrow, stream-like, wet strands of forest land often without a well-defined stream channel. These areas are poorly drained or flooded throughout most of the year and drain the adjacent higher ground.

33 Bays and wet pocosins - Low, wet, boggy sites characterized by peaty or organic soils. May be somewhat dry during periods of extended drought. Examples include sites in the Lake States with lowland swamp conifers or the Carolina bays in the southeast US.

34 Beaver ponds

35 Cypress ponds

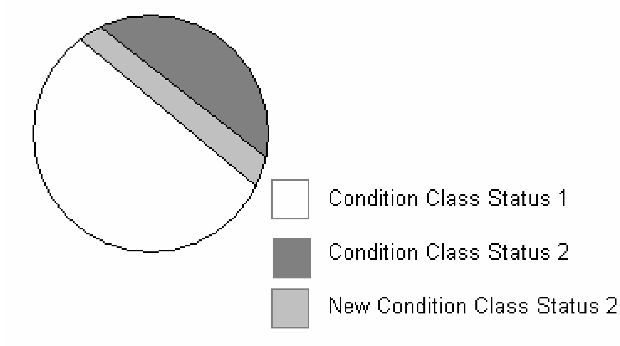
39 Other hydric - All other hydric physiographic sites.

2.5.24 PRESENT NONFOREST LAND USE (NFLU)

Record this attribute when area sampled and classified at last inventory as accessible forest land is now nonforest land. The area that has changed is a new, separate condition class. It should not be considered part of any nonforest land condition class(es) sampled during the previous inventory that may still be present. Instructions in Sections 2.1 and 2.4 apply. When classifying these cases, select the classification that, within sampled area, indicates what the majority of this changed area is now if more than one nonforest classes are present.

NC Note: North Central crews will not be defining a separate condition class for areas of nonforest that changed from forest if the changed portion is attached to a nonforest that was defined in the previous visit. The boundary information from the last visit and the new boundary information from this current visit will be used in the office to assign and area to this changed portion. **NC crews will assign the PRESENT NONFOREST LAND USE code that applies to this changed portion.** The NC LAND USE code for the condition will reflect the nonforest land use closest to PC as always.

In this case you would assign the New portion to condition 2 and assign the PRESENT NONFOREST LAND USE (NFLU) which best described the new portion to condition 2 data. (The new portion may be the same or different land use as the original Condition 2.)



NC Figure 2.1 How to treat a change between time 1 CONDITION STATUS = 1 to time 2 CONDITION STATUS = 2 when connected to a previous CONDITION STATUS = 2.

(CORE OPTIONAL) - Record the PRESENT NONFOREST LAND USE for all nonforest conditions (CONDITION CLASS STATUS = 2), regardless of past condition.

When collected: CORE: SAMPLE KIND = 2, previous CONDITION CLASS STATUS = 1, current CONDITION CLASS STATUS = 2
CORE OPTIONAL: current CONDITION CLASS STATUS = 2

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

10 Agricultural land - Land managed for crops, pasture, or other agricultural use. The area must be at least 1.0 acre in size and 120.0 feet wide. Use the 10 code only for cases not better described by one of the following:

- 11 Cropland
- 12 Pasture (improved through cultural practices)
- 13 Idle farmland
- 14 Orchard

15 Christmas tree plantation

20 Rangeland - Land primarily composed of grasses, forbs, or shrubs. This includes lands vegetated naturally or artificially to provide a plant cover managed like native vegetation and does not meet the definition of pasture. The area must be at least 1.0 acre in size and 120.0 feet wide.

30 Developed - Land used primarily by humans for purposes other than forestry or agriculture. Use the 30 code only for land not better described by one of the following:

31 Cultural: business, residential, and other places of intense human activity.
32 Rights-of-way: improved roads, railway, power lines, maintained canal
33 Recreation: parks, skiing, golf courses

40 Other - Land parcels greater than 1.0 acre in size and greater than 120.0 feet wide, that do not fall into one of the uses described above. Examples include undeveloped beaches, barren land (rock, sand), noncensus water, marshes, bogs, ice, and snow.

2.4.23NC NC LAND USE (NCLU)

All conditions defined will receive an NC LAND USE. This item is not a condition class defining variable and will only be added to the ancillary data collected on a condition.

When a condition is assigned a CONDITION STATUS = 2 for nonforest, assign the NC LAND USE to that condition that represents the land use closest to PC.

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

Accessible forest land (CONDITION CLASS STATUS = 1)

20 **Timberland** Forest land that is capable of producing in excess of 20 cubic feet per acre per year of roundwood products, excluding fuelwood, and is not withdrawn from timber utilization by statute, administrative designation, or exclusive use for Christmas tree production. (If land is used for grazing, see codes 21 and 59.)

21 **Pastured Timberland** Forest land used for wood production and grazing. (If land has a stocking value of less than 10 in trees over 1.0" DBH or less than 25 in growing-stock trees of any size, see codes 52 and 59.)

22 **Plantations** An artificially reforested area, sufficiently productive to qualify as commercial forest land, established by planting or by direct seeding. Planted species is not necessarily predominant. The forest type, stand age, and stand size class should reflect the planted species. If the plantation has failed, give the plot a GLU code 20. (If land is used for Christmas tree production, see code 46.) Unless the land is used primarily for grazing, code 22 is preferred over codes 21 and 59.

40 **Unproductive forest land** Forest land incapable of producing 20 cubic feet per acre per year of roundwood products, excluding fuelwood, because of adverse site conditions. Adverse conditions include sterile soils, dry climate, poor drainage, high elevation, steepness, and rockiness. Vegetation, if present, is widely spaced and scrubby, or tree growth cannot be established. Based on site index under 15 for Northern White-cedar, under 20 for Tamarack & Black Spruce, under 25 for Eastern Redcedar & Rocky Mt. Juniper, under 21 for Ponderosa Pine and under 35 for all other species. All commercial species must be unproductive. In cases where compaction or other negative impact by grazing is the cause for the low productivity use code 52 or 59.

Note: All species found within the portion of the plot where the condition extends should be considered and determined unproductive (code 40) before classifying the condition as unproductive forest land. Do not include species that are only growing in small inclusions in the condition such as a small high or low spot in the topography. The tallier judges whether the unproductive area is over one acre in size; if it is, the condition is classified as unproductive. Refer to Site Index, items 51-59, for more information.

41 **Reserved forest land - unproductive** Forest land that is withdrawn from timber utilization, by a public agency or by law, and is incapable of producing 20 cubic feet per acre per year of roundwood products .

45 **Reserved forest land - productive** Forest land withdrawn from timber utilization by a public agency or by law and is sufficiently productive to produce at least 20 cubic feet per acre per year of roundwood products.

57 **Wide windbreaks** A group of trees, greater than 120 feet wide and one acre in size, protecting buildings in use. Area would qualify as timberland except that the primary land use is protection of buildings. As a guideline, consider using code 22 if there are more than 12 rows of trees or the area is larger than 5 acres.

59 **Wooded pasture** Grazed land with a stocking value of more than 10.0 in all live trees 1" DBH or larger, but less than 25.0 in growing stock (20 class) trees of any size. Two situations are possible. The first is that the land could qualify as pastured timberland except that the low stocking in growing stock trees indicates that the land is not being used for wood production. The second is that the land is unproductive for timber, due to livestock or intrinsic site factors, and is being used for forage. If evidence indicates that the primary use is wood production or the protection of buildings see code 21 and 57. The stocking value 25.0 rule applies when determining primary land use in fairly homogeneous areas. In clumps, openings, and other inclusions, use your best judgment.

71 **Urban forest land** Land that normally would meet the criteria for timberland, but is in an urban-suburban area surrounded by commercial, industrial, or residential development. It is extremely unlikely that such land is used for timber products on a continuing basis. Example: wooded creek bottom surrounded by houses.

Other sampled condition class status NC LAND USE codes

When any of the following NC LAND USE codes occur where they both have the same CONDITION CLASS STATUS code, record the land use that is closest to plot center (PC):

CONDITION CLASS STATUS	Closest NC LAND USE to PC
2 - Nonforest land	46, 72, 50- 56,58, 60 - 69
3 - Noncensus water	80, 89
4 - Census water	90

46 **Christmas Tree Plantations** Forest land sufficiently productive to qualify as timberland but withdrawn from timber utilization for exclusive use in Christmas tree production. There must be evidence of annual shearing, or other management practices that indicate the exclusive use for Christmas trees.

The following NC landuse codes of 50-58 must have one or more trees, 5.0 inches DBH or larger, within the visual acre surrounding the subplot center.

50 **Reserved, Nonforest with trees** Nonforest-land with trees that is withdrawn from timber utilization, by a public agency or by law.

51 **Cropland with trees** Cropland with scattered inclusions of single trees or small groups of trees. Orchards are also included in this class.

52 **Pasture and rangeland with trees** Land used for grazing with a stocking value of less than 10.0 in all live trees 1" DBH or larger. Examples of grazing evidence include:
- cattle trails
- cow pies
- water tanks
- bush hogged periodically
- evidence of being bush hogged (maximum height of seedlings three to four feet and basal scars present on trees)
- area periodically treated with herbicides.

53 **Wooded strip** An acre or more of continuous forest land that meets the definition of forest land (code 20, 21, 22, 40, 41, 45) except that it is less than 120 feet wide.

54 **Idle farmland with trees** Farmland that has not been tended within the last two years and has a stocking value of less than 10.0 in all live trees. **Caution:** Do not confuse this with non-stocked forest land which is GLU 20 and should have a stand-size class code 0.

55 **Marsh with trees** Land that has a stocking value of less than 10.0 in all live trees; characteristically supports low, generally herbaceous or shrubby vegetation and is intermittently covered with water.

56 **Narrow windbreaks** A group of trees, less than 120 feet wide, used for the protection of buildings in use.

58 **Shelterbelt** A group of trees, less than 120 feet wide, used for the protection of soil and crop fields. Do not confuse this land use with an old fence line between two fields that contains a few trees.

72 **Urban and other with trees** Area with trees that is developed for residential, industrial, recreational, or other urban use. For example City Park, cemetery, golf course, maintained backyard, farmsteads with trees. The 120 feet/one acre rule does not apply in the case of a maintained yard.

The following NC Land Uses must have no tree species present 5.0 inch DBH or larger, within the visual acre surrounding the subplot center.

61 **Cropland without trees** Presently cropped or fallow up to two years.

62 **Pasture and rangeland without trees**

64 **Idle farmland without trees** Farmland that has not been tended within the last two years and has no trees. Do not confuse with non-stocked forest land.

65 **Marsh without trees**

66 **Other farmland** Including farmsteads and farm buildings.

67 **Urban and other areas without trees** Areas without trees that are developed for residential, industrial, recreational, or other use than those covered in other land use codes. The 120 feet/one acre rule does not apply in the case of a maintained yard.

68 **Rights-of-way** Transportation, utility, and communication rights-of-way. This includes railroads, power lines, pipelines, and maintained roads. A right-of-way of any width qualifies as non-forest land--this is an exception to the one acre, 120 feet rule.

69 **Nonforest without trees** (reserved)

80 **Noncensus Water** A body of water 30 feet wide but less than 200 feet, and one acre in size but less than 4.5 acres in size (normal water level)

89 **Noncensus Water** (reserved)

90 **Census Water** A body of water greater than 200 feet wide and greater than 4.5 acres (normal water level).

Other nonsampled condition class status NC land use codes

When any of the following NC LAND USE codes occur where they both have the same CONDITION CLASS STATUS code, record the land use that is closest to plot center (PC):

CONDITION CLASS STATUS	Closest NC LAND USE to PC
5 - Nonsampled	79, 96, 99

79 **In another country.**

96 **Inaccessible** When any portion of a forest condition cannot be reached or measured because permanent physical conditions prohibit **safe** access (e.g. steep slopes) no field measurements are required. Explain in notes why the condition is inaccessible. Includes forested areas on military bases, depots, or proving grounds where access and use are restricted because of certain activities.

99 **Denied access**

3.0 SUBPLOT INFORMATION

Each subplot is described by a series of area parameters relating to topographic features and existing cover type. These data also relate to the microplot, since the microplot is contained within the subplot perimeter.

***NC Note:** Subplot data **will not** be collected on subplots 101-105 or 121-124.
Subplot data **will** be collected on subplots 1-4.

NC Note: Monumentation of NC plots with PLOT STATUS = 1 and SUBPLOT/ANNULAR PLOT STATUS = 1:

- ✓ subplot centers - Metal pin with flagging
- ✓ microplot centers - Metal pin with flagging

Monumentation of NC plots with PLOT STATUS = 1 and SUBPLOT/ANNULAR PLOT STATUS = 2 or 3:

- ✓ subplot centers - Metal pin with flagging, or REFERENCE TREE

3.1 SUBPLOT NUMBER

Record the code corresponding to the number of the subplot.

NC Note: This item is given to you on the data recorder screen, be sure you are recording the Subplot data on the correct subplot number.

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

3.2 SUBPLOT/ANNULAR PLOT STATUS (STAT)

Indicate whether or not this subplot currently has at least one accessible forested condition class. In regions measuring the CORE OPTIONAL annular plot, indicate whether or not this annular plot currently has at least one forested condition class.

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

1 Sampled – at least one accessible forest land condition present on subplot
2 Sampled – no accessible forest land condition present on subplot
3 Nonsampled

3.3 SUBPLOT NONSAMPLED REASON (REAS)

For entire subplots that cannot be sampled, record one of the following reasons.

When collected: When SUBPLOT/ANNULAR PLOT STATUS = 3
Field width: 2 digits

Tolerance: No errors
MQO: At least 99% of the time
Values:

01 Outside U.S. boundary – Assign this code to condition classes beyond the U.S. border.

02 Denied access area – Any area within the sampled area of a plot to which access is denied by the legal owner, or to which an owner of the only reasonable route to the plot denies access. 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. In some regions denied access plots may be replaced; check with the field supervisor regarding regional protocols for plot replacement.

03 Hazardous situation – 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 substance 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. In some regions hazardous plots may be replaced; check with the field supervisor regarding regional protocols for plot replacement.

04 Time limitation – This code applies to full subplots that cannot be sampled due to a time restriction. This code is reserved for areas with limited access, and in situations where it is imperative for the crew to leave before the plot can be completed (e.g., scheduled helicopter rendezvous). Use of this code requires notification to the field supervisor. This code should not be used for an entire plot (use code 8 (skipped visit) when an entire plot is skipped; see Section 8.3.5).

05 Lost data – The plot data file was discovered to be corrupt after a panel was completed and submitted for processing. This code is assigned to entire plots or full subplots that could not be processed, and is applied at the time of processing after notification to the region. Note: This code is for office use only.

10 Other – This code is used whenever a plot or condition class is not sampled due to a reason other than one of the specific reasons already listed. A field note is required to describe the situation.

3.4 SUBPLOT CENTER CONDITION (SCEN)

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 9

3.5 MICROPLOT CENTER CONDITION (MCEN)

Record the CONDITION CLASS NUMBER of the condition class at the microplot center.

When collected: All microplots where subplot center is CONDITION CLASS STATUS = 1, 2, 3
NC Note: Also collected on CONDITION STATUS 4
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

3.6 SUBPLOT SLOPE (SLOP)

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 predominantly of one direction, code the predominant slope percentage rather than the average.
- If the subplot falls directly on or straddles a canyon bottom or narrow ridge top, 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 where most of the area lies.

When collected: All subplots* with at least one accessible forest land condition present on subplot (SUBPLOT/ANNULAR PLOT STATUS = 1)
Field width: 3 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 000 to 155

3.7 SUBPLOT ASPECT (ASP)

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 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 at least one accessible forest land condition present on subplot (SUBPLOT/ANNULAR PLOT STATUS = 1)
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

3.8 SNOW/WATER DEPTH (SWD)

Record to the nearest 0.1 foot the average approximate depth of water or snow covering the subplot at the time of data collection. This variable is used to indicate subplots where some variables (e.g., seedling count, total lengths) may be measured with less certainty due to conditions at the time of measurement.

When collected: All subplots* with at least one accessible forest land condition present on subplot (SUBPLOT/ANNUALR PLOT STATUS = 1)
Field width: 2 digits (x.y)
Tolerance: +/- 0.5 ft
MQO: At the time of measurement (no MQO after initial date of visit)
Values: 0.0 to 9.9

3.9 SUBPLOT/ANNULAR PLOT CONDITION LIST (CORE OPTIONAL)

This is a listing of all condition classes located within the 24.0-foot radius around the subplot center. In regions measuring the CORE OPTIONAL annular plot, this is a listing of all condition classes located within the 58.9-foot radius around the annular plot center. A maximum of four conditions is permitted at any individual subplot / annular plot. If a condition class has already been defined at a previously completed subplot / annular plot, use the same condition class number whenever that condition is encountered. Define new condition classes as they are encountered. If more than one condition class is listed here, boundary data are required. If only one condition class is listed, this condition is automatically assigned to the subplot center and microplot center. If less than four condition classes occur on this subplot, complete the remainder of this field with zeros. For example, if condition 1 is the only condition class on a subplot, record 1000.

NC Note: Not collected in North Central Region.

When collected: All forested Phase 3 plots
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 1000 to 9876

4.0 BOUNDARY REFERENCES

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

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

NC Note: No mapping of condition boundaries will be done on the old NC variable radius plot (subplots 101-105).
Boundary's will be mapped on microplots 121-124 and subplots and microplots 1-4.

NC Note: In Indiana and Illinois the 4 –point plot will be re-measured so there are some specific examples on how to handle these in Appendix 8.

4.1 REFERENCE PROCEDURE

Reference, within the sampled area on each microplot, subplot, and annular plot, the approximate boundary of each condition class that differs from the condition classes 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 delineated.

Boundary referencing is done by recording azimuths and distances from subplot center to the reference points and/or from microplot center to the reference points (Figures 15 and 16). Each boundary is marked by a maximum of three points - two where the boundary intersects the subplot circumference or microplot 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.

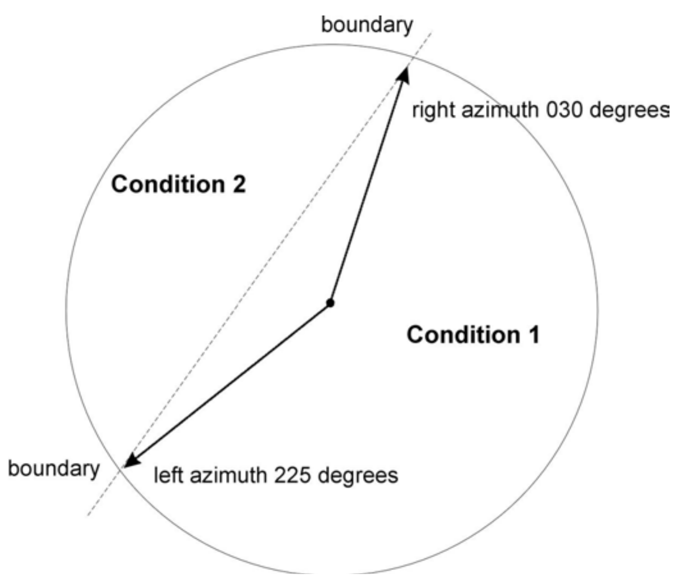


Figure 15. How to measure a straight boundary on a microplot, subplot, or annular plot.

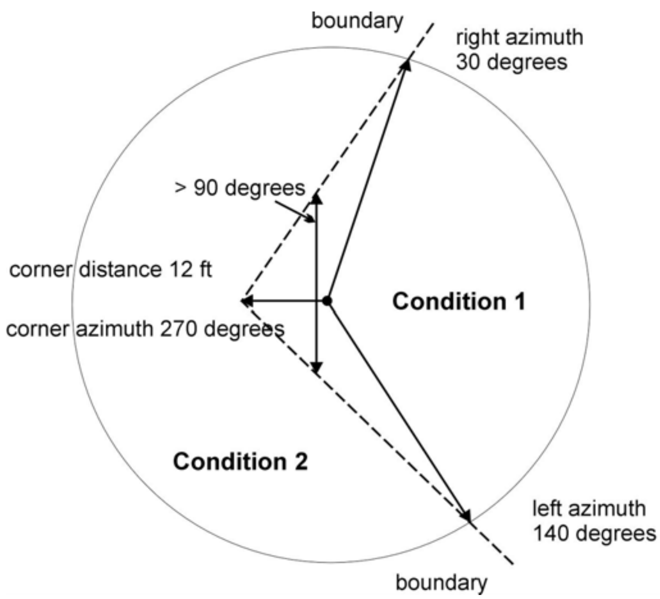


Figure 16. How to measure a boundary with a corner on a subplot or annular plot.

Microplot boundaries are referenced to the microplot center, and annular plot boundaries are referenced to the subplot center in the same manner described for subplots. Note that the larger the plot, the greater likelihood of a need for a boundary corner to record boundaries that are not straight lines.

Refer to Sections 2.1 and 2.4 for general condition class delineation guidelines. The following additional rules apply when referencing a boundary within a subplot, microplot, or annular plot:

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 MQO's 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 percent of the subplot or microplot area. This allows for slight variations in azimuths or distances due to the approximate nature of mapping procedures.

4.2 BOUNDARY DATA

Record the appropriate values for each boundary mapped on the subplot, microplot, or annular plot as follows:

NC Note: When BOUNDARY CHANGE (CHNG) = 0 then copy the information on the new plotsheet to the data recorder. If the boundary has changed then new data must be collected for all boundary items.

4.2.1 SUBPLOT NUMBER

Record the code corresponding to the number of the subplot.

NC Note: This item is given to you on the data recorder screen, just be sure you are recording the boundary data on the correct subplot number.

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

4.2.2 PLOT TYPE (TYPE)

Record the code to specify whether the boundary data are for a subplot, microplot, or annular plot.

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

1 Subplot boundary
2 Microplot boundary
3 Annular plot boundary (coded only when annular plots are taken)

4.2.3 BOUNDARY CHANGE (CHNG)

Remeasurement (SAMPLE KIND = 2) locations only. Record the appropriate code to indicate the relationship between previously recorded and current boundary information.

When collected: SAMPLE KIND = 2, All boundaries
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0 No change - boundary is the same as indicated on plot map and/or data collected by a previous crew.
1 New boundary, or boundary data has been changed to reflect an actual on-the-ground physical change resulting in a difference from the boundaries recorded.
2 Boundary has been changed to correct an error from previous crew.
3 Boundary has been changed to reflect a change in variable definition.

4.2.4 CONTRASTING CONDITION (CCON)

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 or annular plot) or at the microplot center (for boundaries on the microplot), e.g., the condition class present on the other side of the boundary line. See section 3.0 for subplot data.

When collected: All boundaries
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

4.2.5 LEFT AZIMUTH (LAZM)

Record the azimuth from the subplot, microplot, or annular plot center to the farthest left point (facing the contrasting condition class) where the boundary intersects the subplot, microplot, or annular plot circumference.

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

4.2.6 CORNER AZIMUTH (CAZM)

Record the azimuth from the subplot, microplot, or annular plot center 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

4.2.7 CORNER DISTANCE (CDIS)

Record the horizontal distance, to the nearest 1 foot, from the subplot, microplot, or annular plot center 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	01 to 07 ft (actual limiting distance is 6.8 ft)
subplot	01 to 24 ft
annular plot	01 to 59 ft (actual limiting distance is 58.9 ft)

4.2.8 RIGHT AZIMUTH (RAZM)

Record the azimuth from subplot, microplot, or annular plot center to the farthest right point (facing the contrasting condition) where the boundary intersects the subplot, microplot, or annular plot circumference.

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

4.2.9NC NC PERCENT AREA (%ARE)

The percent area of the subplot that is in the condition listed as the Contrasting Condition (CCON). This is calculated by the data recorder after entry of all data and moving on to the next screen of data.

When collected: All boundaries
Field width: 3 digits
Tolerance: N/A
MQO: N/A
Values: 1 - 100

5.0 TREE AND SAPLING DATA

Trees at least 5.0 inches in diameter are sampled within the subplot. ‘Tally trees’ are defined as all live and standing dead trees in accessible forest land condition classes encountered on the subplot the first time a subplot is established, and all trees that grow into a subplot thereafter. These data yield information on tree volume, growth, mortality, and removals; wildlife habitats; forest structure and composition; biomass; and carbon sequestration.

Trees with a diameter at least 1.0 inch but less than 5.0 inches, termed saplings, are sampled within the microplot. ‘Tally saplings’ are defined as all live saplings in accessible forest land condition classes encountered the first time a microplot is established, and all saplings that grow into each microplot thereafter are included until they grow to 5.0 inches or larger, at which time they are tallied on the 24.0-foot subplot and referenced (new AZIMUTH and HORIZONTAL DISTANCE taken) to the subplot center.

For multi-stemmed western woodland species, a cumulative DRC is used to compute diameter as described in Sections 5.9 and 5.9.4.

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 5.0 inches in diameter are tracked until they no longer qualify as standing dead. **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 at least 5.0 inches in diameter, have a bole which has an unbroken ACTUAL LENGTH of at least 4.5 feet, and lean less than 45 degrees from vertical.

“Unbroken” is defined as at least 50 percent attached to the original source of growth. The degree of lean on dead trees with partially separated (i.e., 1 to 50 percent) boles is measured from the base of the tree to the top of ACTUAL LENGTH.

Portions of boles on dead trees that are separated greater than 50 percent (either above or below 4.5 feet), are considered severed and are included in Down Woody Debris (DWD) if they otherwise meet DWD tally criteria.

For western woodland species (Appendix 3) with multiple stems, a tree is considered down if more than 2/3 of the volume is no longer attached or upright; do not consider cut and removed volume. For western woodland species with single stems to qualify as a standing dead tally tree, dead trees must be at least 5.0 inches in diameter, be at least 1.0 foot in unbroken ACTUAL LENGTH, and lean less than 45 degrees from vertical.

Live and dead standing tally trees, and partially separated boles of dead tally trees, do not have to be self-supported. They may be supported by other trees, branches, or their crown.

Trees that have been cut above DBH qualify as tally trees, provided they meet the size requirement.

The following apply at remeasurement:

- If at the previous visit a forked tree was recorded as two separate trees but should have been recorded as one tree, delete one tree and correct the diameter for the remaining tree. Record an explanation in TREE NOTES.
- If at the previous visit a forked tree was recorded as one tree but should have been recorded as two separate trees, correct the diameter for the remeasured

tree to represent one tree, and add the other fork as a new tree. Record an explanation in TREE NOTES.

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.

5.0.2NC NC RE-MEASUREMENT TREES

Re-measure all trees listed on the plot tree sheet that are listed “for re-measurement.” All old trees measured on the plot will be located on the tree sheet of the plot sheet packet for use to determine subplot center location.

SK=1 and NCSK=6:
Tally all old trees on the download data (sheets or data recorder file). Trees 5.0” and greater on subplots 101-105 and trees less than 5.0” on microplots 101-103.
Install and measure new subplots (1-4)

SK=2 and NCSK=6:
Tally all old trees on the download data (sheets or data recorder file) and **enter any new trees**. Trees that are 5.0” and greater diameter on subplots 1-4 and trees 1.0” – 4.9” diameter on microplots 121-124.

Install and measure new microplots (1-4) at 90 degrees and 12 feet from each subplot center. All trees will be treated as new tally trees for TREE RECORD NUMBER and will require RECONCILE codes as they will have not been tallied in the previous measuement.

SK=1 and NCS=8
The old ten point PC (subplot 101) will be the location of subplot 1. Follow the old SP map and directions to the plot center. If plot center is not found, place a pin where the starting point directions took you and start installing the new subplots (1-4). **OLD TREES WILL NOT BE MEASURED.** Old tree information may be provided only for your use to locate plot center.
Install and measure new subplots (1-4)

SK=1 and NCSK=0:
No old plot to be remeasured.
Install and measure four point plot design.

5.0.3NC NC RE-MEASUREMENT TREES ON LAND USE CONVERSIONS

When a condition changes from CONDITION CLASS STATUS of forested (1) to a non forested CONDITION CLASS STATUS (2,3,4,5):

- If the tree was cut as a part of the land use change it would get a PRESENT TREE STATUS that reflects the cutting of the tree (3).
- If the tree is still alive, died or was cut after the land use change and unrelated to the land use change, it should get a PRESENT TREE STATUS of no status (0).
- If the tree is still standing dead it should get a PRESENT TREE STATUS also of no status (0).

5.0.4NC NC RE-MEASUREMENT TREES THAT SHOULD NOT HAVE BEEN

A tree was tallied on the old NC plot design, but should not have been and should not be tallied now is given a PRESENT TREE STATUS of no status (0). Put a reason on data recorder in the TREE NOTE.

5.0.5NC NC RE-MEASUREMENT TREES OF DISPLACED TREES

Trees tallied on the old NC plot design that are now displaced off the plot due to natural reasons, are given a PRESENT TREE STATUS of no status (0) and a RECONCILE of missing (6).

5.0.6NC NC TREES ON SUBPLOTS 1-4 OF A **P3** PLOT

Some of the Phase 3 (P3) plots are old Forest Health Management (FHM) plot installations with previously measured trees by the FHM program. The FIA National Managers agreed to keep the tree numbers that the FHM program had assigned to these trees. They did not agree to re-measure the trees for change though. This means that any tree that no longer meets the qualifications for a measurement tree on a new plot (first annual visit) needs to be deleted from the data on the downloaded data file in the data recorder.

If the plot was measured by a North Central FIA crew as a 4-point plot design (IN & IL) the trees are not deleted as mentioned in the above paragraph. Also if this is the second annual measurement or a SK=2 then section 5.0.6NC does not apply.

5.0.7NC NC RE-MEASUREMENT TREES ON NOW DENIED ACCESS CONDITIONS

Trees on an old plot what is now denied access need to have their tree status changed to zero (0). See Manual Section 8 for further data collected on denied access conditions.

NC Table 3

	Microplots 1-4 DBH < 5.0”	Subplots 1-4 DBH ≥ 5.0”												Microplots 121-124 DBH < 5.0”											
TRST	**1**	**0**			**1**			**2**			**3**			**0**			**1**			**2**			**3**		
PAST*		**1**	**2**		**1**	**2**	**NT**	**1**	**2**	**NT**	**1**	**2**	**NT**	**1**	**2**	**NT**	**1**	**2**	**NT**	**1**	**2**	**NT**	**1**	**2**	**NT**
Sub#	X	D	D		D	D	X	D	D	X	D	D		D	D		D		**X**	D			D		
TR#	X	D	D	**N**	D	D	X	D	D	X	D	D	**N**	D	D	**N**	D	**N**	**X**	D	**N**	**N**	D	**N**	**N**
TYPE	X			**O**	X	X	X	X	X	X	X	X	**O**	D	D	**O**	X	**O**	**X**	X	**O**	**O**		**O**	**O**
DIST	X	D	D	**T**	D	D	X	D	D	X	D	D	**T**	D	D	**T**	D	**T**	X	D	**T**	**T**	D	**T**	**T**
DBHO*		D	D		D	D		D	D		D	D		D	D		D			D			D		
DBH	X				X	X	X	X	X	X							X		**X**	X					
DIAH*	X			**V**	X	X	X	X	X	X			**V**			**V**	X	**V**	**X**	X	**V**	**V**		**V**	**V**
DCHE	X			**A**	X	X	X	X	X	X			**A**			**A**	X	**A**	**X**	X	**A**	**A**		**A**	**A**
SPP	X	D	D	**L**	D	D	X	D	D	X	D	D	**L**	D	D	**L**	D	**L**	**X**	D	**L**	**L**	D	**L**	**L**
RECO	2nd Annual	X	X	**I**			X			X			**I**	X	X	**I**		**I**	**X**		**I**	**I**		**I**	**I**
DEAD				**D**				X	X	X			**D**			**D**		**D**		X	**D**	**D**		**D**	**D**
TCC/DEC	X				X	X	X	X	X	X							X		X	X					
DECA*								X	X	X															
MOYR								X		W	X									X			X		
CCR	X				X	X	X										X		X						
CCC	X				X	X	X										X		X						
AZM	X	D	D		D	D	X	D	D	X	D	D		D	D		D		X	D			D		
CON#	X	X	X		X	X	X	X	X	X	X	X		X	X		X		X	X			X		
THGT	P				X	X	X										P								
ACTU*	P				X	X	X	X	X	X							P								
METH	P				X	X	X										P								
TRGD*					X	X	X																		
ROTT					X	X	X																		
CAUS*								X			X									X			X		
LOC12					X	X	X																		
DAM12					X	X	X																		
SEV12					X	X	X																		
NCD12					X	X	X																		
UCRC	P				P	P	P																		
CRPO	P				P	P	P																		
CRLE	P				P	P	P																		
CRVC	P																P								
CRDN					P	P	P																		
CRDB					P	P	P																		
CRTR					P	P	P																		
LTRU					B	B			B	B															
LHAR					B	B			B	B															
LSUR					B*	B*			B*	B*															
LCHA					B*	B*			B*	B*															
UTRU					B*	B*			B*	B*															
UHAR					B*	B*			B*	B*															
USUR					B*	B*			B*	B*															
UCHA					B*	B*			B*	B*															
BAVA	C				C																				
BHAR	C				C																				
GUID	C				C																				

X – Data required
P – Phase 3 only
C – Only when species = 0012
* – Data required when applicable

D – Downloaded

2nd Annual – Only in States (MN, MO, IN, IA) second annual measuement

W – When reconcile code = 1, 2 or 3
B – Only when species = 0375
NT – No Tree tallied last visit

	Microplot trees 101-103 DBH < 5.0”				Subplot trees 101-105 DBH≥ 5.0”							
TRST	1	2	3	0	1		2		3		0	
PAST	1	1	1	1	1	2	1	2	1	2	1	2
Sub#	D	D	D	D	D	D	D	D	D	D	D	D
TR#	D	D	D	D	D	D	D	D	D	D	D	D
TYPE	X	X			X	X	X	X				
DIST	D	D	D	D	D	D	D	D	D	D	D	D
PDBH	D	D	D	D	D	D	D	D	D	D	D	D
DBH	X	X			X	X	X	X				
DIAH*	X	X			X	X	X	X				
DCHE	X	X			X	X	X	X				
SPP	D	D	D	D	D	D	D	D	D	D	D	D
RECO				X							X	X
DEAD		X					X	X				
TCC/DEC	X	X			X	X	X	X				
DECA*												
MOYR												
CCR					X	X						
CCC					X	X						
AZM	D	D	D	D	D	D	D	D	D	D	D	D
CON#												
THGT												
ACTU												
METH												
TRGD												
ROTT												
CAUS*		X					X	X				
LOC12												
DAM12												
SEV12												
NCD12												
UCRC												
CRPO												
CRLE												
CRVC												
CRDN												
CRDB												
CRTR												

X – Data required
* – Data required when applicable (see data item “when collected”
P – Phase 3 only
D – Downloaded

OLD SUBPLOTS and microplots Illinois only See Appendix 8

5.1 SUBPLOT NUMBER

Record the subplot number where the tree occurs.

NC Note: This item is given to you on the data recorder screen, just be sure you are recording the tree data on the correct subplot number.

When Collected: All live tally trees ≥ 1.0 in DBH/DRC and standing dead tally trees ≥ 5.0 in DBH/DRC
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 TREE RECORD NUMBER (TR#)

Record a code to uniquely and permanently identify each tree on a given subplot. The TREE RECORD 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 perimeter. On remeasured plots, use the previously assigned tree number. Saplings tallied on microplots will retain their initially assigned tree number if they grow to tree size. 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.

If TREE RECORD NUMBERs are not assigned in the field, record 000.

NOTE: If this is a Phase 3 plot, match the trees on this point to the hard copy list provided. Record the three-digit FHM tree number assigned to each standing tree.

NC Note: On all subplots 1 – 4 and 121 - 124 use next available tree number to assign new tree numbers to any trees not in the download data file. The next available tree number is on the printed plot sheets and an option on the data recorder. On subplots 121-124 all trees that were less than 5 inches and are now greater than or equal to 5 inches will receive a new TREE RECORD NUMBER and be treated as a new tree on a re-measurement plot.

On P3 plots which are on their first annual P3 measurement. Re-measure any old trees on subplot 101and then use the "copy tree" option on the data recorder to move the trees to subplot 1. This will assure we keep the P3 tree numbers. For the P3 plots, the tree numbers in the download data file and on the printed plot sheet reflect their old FHM tree number. Use the "next available tree number" option on the data recorder to assign tree numbers to new trees on the subplot.

When Collected: All live tally trees ≥ 1.0 in DBH/DRC and standing dead tally trees ≥ 5.0 in DBH/DRC
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000 or 001 to 999

5.2NC NCPLOT TYPE (TYPE)

Record whether the tree is on the subplot (≥ 5.0”dbh) or microplot (< 5.0” dbh). Do not change on re-measurement tree unless the tree is live and still live and on the microplot

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

1 subplot tree
2 microplot tree

5.3 CONDITION CLASS NUMBER (CON#)

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 17).

When Collected: All trees **NC Note:** Not collected on subplots 101 - 105
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

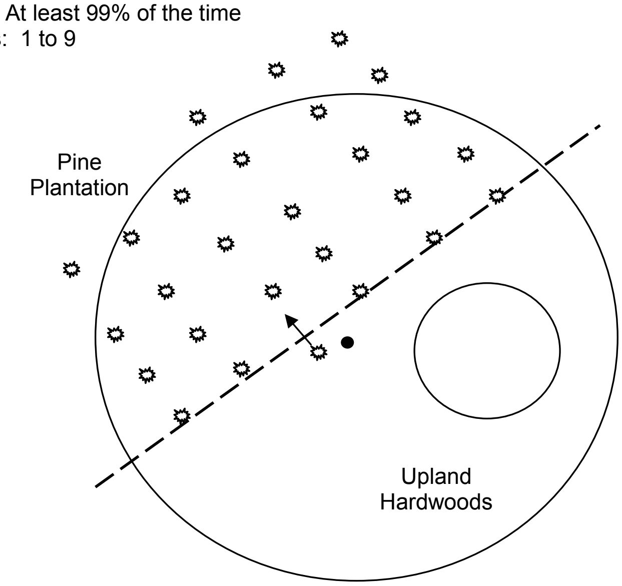


Figure 17. Ragged CONDITION CLASS boundary and tree condition class designation.

NCNote: This Figure 17 applies to trees that lie across approximate boundaries between two conditions of any CONDITION CLASS STATUS. So when the trees do not land on the boundary which must be a straight line, enter the CONDITION CLASS NUMBER for the condition that those trees should be tallied with. Remembering that trees located within condition other than CONDITION CLASS STATUS 1 are never tallied.

5.4 AZIMUTH (AZM)

Record the AZIMUTH from the subplot center (for trees greater than or equal to 5.0 inches DBH/DRC) or the microplot center (for trees greater than or equal to 1.0 inch and less than 5.0 inches DBH/DRC), sight the center of the base of each tree with a compass. Sight to the geographic center for multi-stemmed western woodland species (Appendix 3). The geographic center is a point of equal distance between all tallied stems for a given woodland tree. Record AZIMUTH to the nearest degree. Use 360 for north.

NC Note: Do not repeat azimuths on a subplot, if needed separate by one degree.

When Collected: All live tally trees $\geq$ 1.0 in DBH/DRC and standing dead tally trees $\geq$ 5.0 in DBH/DRC
Field width: 3 digits
Tolerance: +/- 10 degrees
MQO: At least 90% of the time
Values: 001 to 360

5.5 HORIZONTAL DISTANCE (DIST)

Record the measured HORIZONTAL DISTANCE, to the nearest 0.1 foot, from the subplot center (for trees greater than or equal to 5.0 inches DBH/DRC) or microplot center (for trees greater than or equal to 1.0 inch and less than 5.0 inches DBH/DRC) to the pith of the tree at the base. For all multi-stemmed western woodland trees (woodland species indicated in Appendix 3), the HORIZONTAL DISTANCE is measured from subplot or microplot center to the "geographic center" of the tree. The geographic center is a point of equal distance between all tallied stems for a given woodland tree.

When Collected: All live tally trees $\geq$ 1.0 in DBH/DRC and standing dead tally trees $\geq$ 5.0 in DBH/DRC
Field width: 3 digits (xx.y)
Tolerance: Microplot: +/- 0.2 ft
Subplot: +/- 1.0 ft
Annular plot: +/- 3.0 ft
MQO: At least 90% of the time
Values: Microplot: 00.1 to 06.8
Subplot: 00.1 to 24.0
Annular plot: 00.1 to 58.9

5.6 PREVIOUS TREE STATUS (PAST)

If not downloaded from the previous inventory, record PREVIOUS TREE STATUS for each remeasured tally 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: On remeasurement plots (SAMPLE KIND = 2), all previously tallied trees
Field width: 1 digit
Tolerance: No errors
MQO: At least 95% of the time
Values:

1 Live Tree – alive at the previous inventory
2 Dead tree – standing dead tree at the previous inventory

5.7 PRESENT TREE STATUS (TRST)

Record a current PRESENT TREE STATUS for each tallied tree; this code is used to track the status of sample trees over time: as they first appear, as ingrowth, as they survive, and when they die or are removed. 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/DRC
All new dead tally trees ≥ 5.0 in
On remeasurement plots, all previously tallied trees
Field width: 1 digit
Tolerance: No errors
MQO: At least 95% of the time
Values:

0 No status –- tree is not presently in the sample (remeasurement plots only). Tree was incorrectly tallied at the previous inventory, currently is not tallied due to definition or procedural change, or is not tallied due to natural causes. Requires RECONCILE code = 5-8.

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

2 Dead tree -- any dead tree (new, remeasured, or ingrowth), regardless of cause of death. Includes all previously standing dead trees that no longer qualify as standing dead, as well as trees killed by silvicultural or land clearing activity, and are assumed not to have been utilized.

3 Removed - a tree that has been cut and removed by direct human activity related to harvesting, silviculture or land clearing (remeasurement plots only). The tree is assumed to have been utilized.

Note: On remeasured plots, crews must collect new AZIMUTH and HORIZONTAL DISTANCE information from the subplot center for microplot saplings that grow to become subplot trees. For live subplot trees that shrink to become live saplings on the microplot, crews must collect new AZIMUTH and HORIZONTAL DISTANCE information from the microplot center.

5.7.1 RECONCILE (RECO)

For remeasurement locations only, record a RECONCILE code for any new tally tree that was not tallied in the previous inventory, and for all no status remeasurement trees (PRESENT TREE STATUS = 0). This code is used to identify the reason a new tree appeared in the inventory, and identify the reason a remeasurement tree no longer qualifies as a tally tree. This information is needed to correctly assign volume information to the proper component of volume change.

When Collected: On SAMPLE KIND = 2; all new live tally trees ≥ 1.0 in DBH/DRC (PRESENT TREE STATUS = 1 and no PREVIOUS TREE STATUS), all new dead tally trees ≥ 5.0 in (PRESENT TREE STATUS = 2 and no PREVIOUS TREE STATUS), all no status trees (PRESENT TREE STATUS = 0)
Field width: 1 digit
Tolerance: No errors
MQO: At least 95% of the time
Values:

Codes 1-4 are valid for new trees on the plot:

1 Ingrowth – new tally tree not qualifying as through growth (includes reversions).
2 Through growth – new tally tree 5.0 inches DBH/DRC and larger, within the microplot, which was not missed at the previous inventory.
3 Missed live – a live tree missed at previous inventory and that is live or dead now.
4 Missed dead – a dead tree missed at previous inventory that is dead now.

Codes 5-8 are valid for remeasured trees that no longer qualify as tally:

5 Shrank – live tree that shrank below threshold diameter on microplot/subplot/ annular plot
6 Missing – tree was tallied in previous inventory, but is now missing due to natural causes such as landslide, fire, etc.
7 Cruiser error – erroneously tallied at previous inventory
8 Procedural change – tree was tallied at the previous inventory, but is no longer tallied due to a definition or procedural change

Code 5 is used to indicate live trees that shrink below the diameter threshold on the microplot/subplot/annular plot. For example, if a live remeasurement tree shrinks below the 5.0 inch DBH/DRC, then record the following combination of codes: PREVIOUS TREE STATUS = 1, PRESENT TREE STATUS = 0, RECONCILE = 5. If a live measured tree shrinks below the 5.0 inch threshold on the subplot and is currently greater than or equal to 1.0 inch on the microplot, then record PREVIOUS TREE STATUS = 1, PRESENT TREE STATUS = 1. Record all required items for a tally sapling.

5.7.2 STANDING DEAD (DEAD)

Record the code that describes whether the tree qualifies as standing dead or not. To qualify as a standing dead tally tree, dead trees must be at least 5.0 inches in diameter, have a bole which has an unbroken ACTUAL LENGTH of at least 4.5 feet, and lean less than 45 degrees from vertical. See Figures 18-20 for examples.

"Unbroken" is defined as at least 50 percent attached to the original source of growth. The degree of lean on dead trees with partially separated (i.e., 1 to 50 percent) boles is measured from the base of the tree to the top of ACTUAL LENGTH.

Portions of boles on dead trees that are separated greater than 50 percent (either above or below 4.5 feet), are considered severed and are included in Down Woody Debris (DWD) if they otherwise meet DWD tally criteria.

For western woodland species (Appendix 3) with multiple stems, a tree is considered down if more than 2/3 of the volume is no longer attached or upright; do not consider cut and removed volume. For western woodland species with single stems to qualify as a standing dead tally tree, dead trees must be at least 5.0 inches in diameter, be at least 1.0 foot in unbroken ACTUAL LENGTH, and lean less than 45 degrees from vertical.

Live and dead standing tally trees, and partially separated boles of dead tally trees, do not have to be self-supported. They may be supported by other trees, branches, or their crown.

When collected: SAMPLE KIND = 2 only: All dead tally trees (PRESENT TREE STATUS = 2)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0 No – tree does not qualify as standing dead
1 Yes – tree does qualify as standing dead

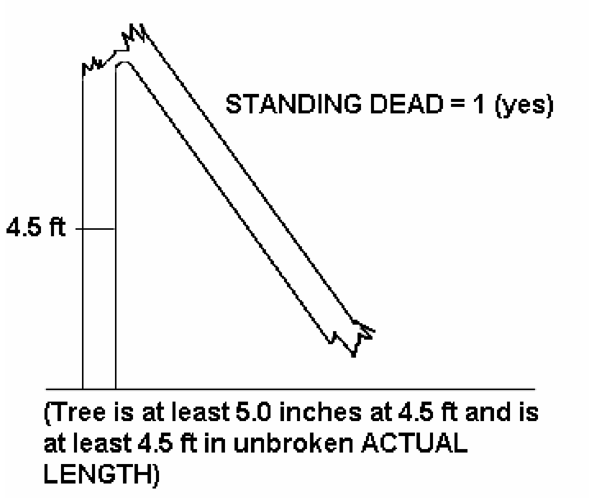


Figure 18. Example of an unbroken bole to 4.5 feet.

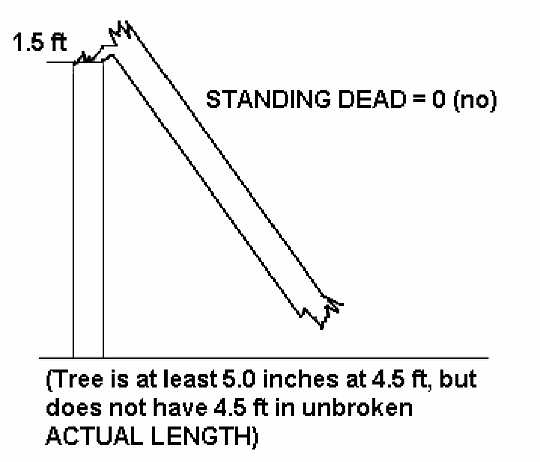


Figure 19. Example of an unboken length of < 1.5 feet.

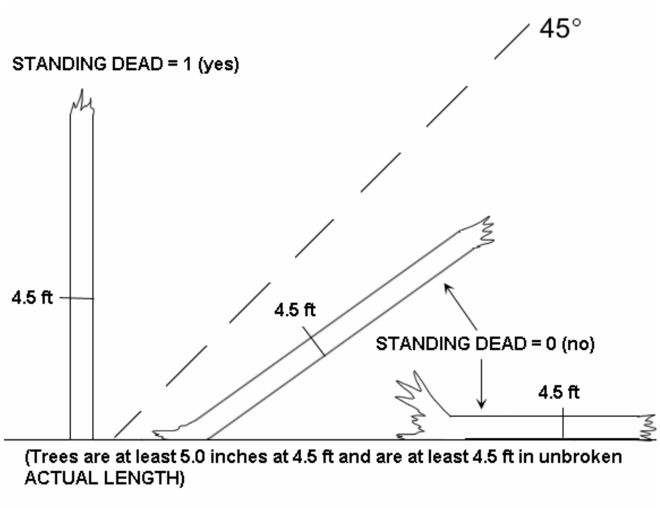


Figure 20. Other examples of dead trees.

5.7.3 MORTALITY (CORE OPTIONAL)

NC Note: Not collected in North Central FIA Unit

Record a mortality code for any tree that was live within the past five years but has died, regardless of cause of death. This information is needed to correctly assign volume information to the proper component of volume change.

When Collected: All standing dead trees 5.0 in DBH/DRC and larger that were live within the past 5 years if no previous inventory (PRESENT TREE STATUS = 2 on SAMPLE KIND = 1 or 3 plots).
Field width: 1 digit
Tolerance: No errors
MQO: At least 85% of the time
Values:

0	No - tree does not qualify as mortality.
1	Yes – tree does qualify as mortality

5.8 SPECIES (SPP)

Record the appropriate SPECIES code from the list in Appendix 3. If you encounter a species not listed in Appendix 3 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 0299 for unknown dead conifer and 0998 for unknown dead hardwood when the genus or species codes cannot be used. 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. This is often the case with standing dead trees on newly established plots. In this case use the sample collections procedures described earlier in this paragraph.

When Collected: All live tally trees $\geq$ 1.0 in DBH/DRC and standing dead tally trees $\geq$ 5.0 in DBH/DRC
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time for genus, at least 95% of the time for species
Values: See Appendix 3

5.9 DIAMETER (DBH)

Diameters are measured at either breast height (DBH) or at the root collar (DRC). Species requiring DRC, referred to as woodland species, are denoted with a “w” in Appendix 3. Trees with diameters between 1.0- and 4.9-inches are measured on the 6.8-foot radius microplot, those with diameters of 5.0-inches and larger are measured on the 24-foot radius subplots.

In order to accurately remeasure diameter (DBH or DRC) at the same point on the tree bole at successive visits, regions have the option of measuring and recording the distance from the ground to the point of diameter measurement, or marking the point of measurement with a scribe, crayon, paint, or aluminum nail. When marking trees for the first time, measure the diameter after the mark is in place. Use caution to avoid damaging trees with scribes and nails. Do not scribe or nail trees less than 3.0-inches in diameter, or species vulnerable to introduction of pathogens (e.g., aspen). Do not penetrate the cambium when using a bark scribe.

<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), there is an abnormality at the previous DIAMETER measurement point, 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.

NC Note: On subplot 101 and higher or subplot 1-4 of a P3 plot with old trees: treat the DBH location as mentioned above in Re-measurement trees. So if the previous location is more than 12 inches beyond where the diameter should be measured according to current protocols move the old mark. Do not assign Diameter Check code of 2. Do assign a Diameter Check code of 0.

When Collected: All live tally trees ≥ 1.0 in DBH/DRC and standing dead tally trees ≥ 5.0 in DBH/DRC
Field width: 4 digits (xxx.y)
Tolerance: +/- 0.1 in per 20.0 in increment of measured diameter on all live trees and dead trees with DECAY CLASS = 1, 2
+/- 1.0 in per 20.0 in increment of measured diameter on dead trees with DECAY CLASS = 3, 4, 5
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

5.9.1 PREVIOUS DIAMETER AT BREAST HEIGHT (DBHO)
This is the DBH assigned at the previous survey. It has been downloaded from the previous inventory. Any change made to this field signifies an error at the time of the previous inventory. DIAMETER CHECK should be set to 2 and an explanation is required in the notes if previous DBH is changed.

NC Note: In the North Central region do not enter a 2 in "DIAMETER CHECK" to signify an error at the time of pervious inventory on subplots 101-105 or 121-124. For these subplots re-measure the diameter where it is and never move it.

5.9.2 DIAMETER AT BREAST HEIGHT (DBH)
Unless one of the following special situations is encountered, measure DBH at 4.5 feet above the ground line 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.

Special DBH situations:

1. Forked tree: In order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem and must branch out from the main stem at an angle of 45 degrees or less. Forks originate at the point on the bole where the piths intersect. Forked trees are handled differently depending on whether the fork originates below 1.0 foot, between 1.0 and 4.5 feet, or above 4.5 feet.

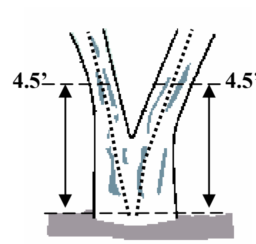


Figure 21. Forked below 1.0 ft.

   - Trees forked below 1.0 foot. Trees forked in this region are treated as distinctly separate trees (Figure 21). Distances and azimuths are measured individually to the center of each stem where it splits from the stump (Figure 24 A-C). DBH is measured for each stem at 4.5 feet above the ground. When stems originate from pith intersections below 1 foot, it is possible for some stems to be within the limiting distance of the microplot or subplot, and others to be beyond the limiting distance. If stems originating from forks that occur below 1.0 foot fork again between 1.0 and 4.5 feet (Figure 24-E), the rules in the next paragraph apply.

- Trees forked between 1.0 foot and 4.5 feet. Trees forked in this region are also counted as separate trees (Figure 22), but only one distance and azimuth (to the central stump) is used for all (Figure 24 D-F). Although a single azimuth and distance applies to all, multiple stems should be recorded as they occur in clockwise order (from front to back when one stem is directly in front of another). The DBH of each fork is measured at a point 3.5 feet above the pith intersection. When forks originate from pith intersections between 1.0 and 4.5 feet, the limiting distance is the same for all forks--they are either all on, or all off the plot.

  NC Note: Azimuths must be recorded with at least one degree difference.

  Multiple forks are possible if they all originate from approximately the same point on the main stem. In such cases, measure DBH on all stems at 3.5 feet above the common pith intersection (Figure 24-F).

  Once a stem is tallied as a fork that originated from a pith intersection between 1.0 and 4.5 feet, do not recognize any additional forks that may occur on that stem. Measure the diameter of such stems just below the base of stem separation as shown in Figure 24-E (i.e., do not move the point of diameter the entire 3.5 feet above the first fork).

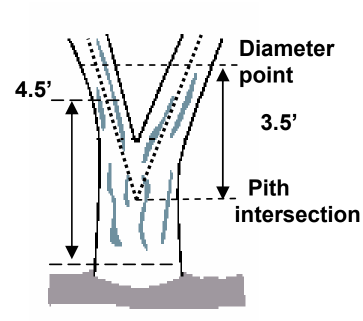


Figure 22. Forked between 1.0-4.5 ft.

- Trees forked at or above 4.5 feet. Trees forked in this region count as one single tree (Figure 23). If a fork occurs at or immediately above 4.5 feet, measure diameter below the fork just beneath any swelling that would inflate DBH.

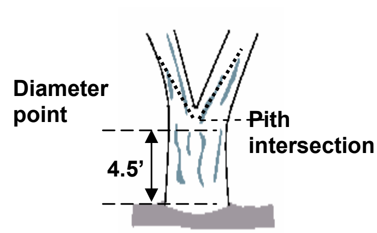


Figure 23. One tree.

2. Stump Sprouts. Stump sprouts originate between ground level and 4.5 feet on the boles of trees that have died or been cut. Stump sprouts are handled the same as forked trees, with the exception that stump sprouts are not required to be 1/3 the diameter of the dead bole. Stump sprouts originating below 1.0 foot are measured at 4.5 feet from ground line. Stump sprouts originating between 1.0 foot and 4.5 feet are measured at 3.5 feet above their point of occurrence. As with forks, rules for measuring distance and azimuth depend on whether the sprouts originate above or below 1.0 foot. For multi-stemmed woodland species, treat all new sprouts as part of the same new tree.

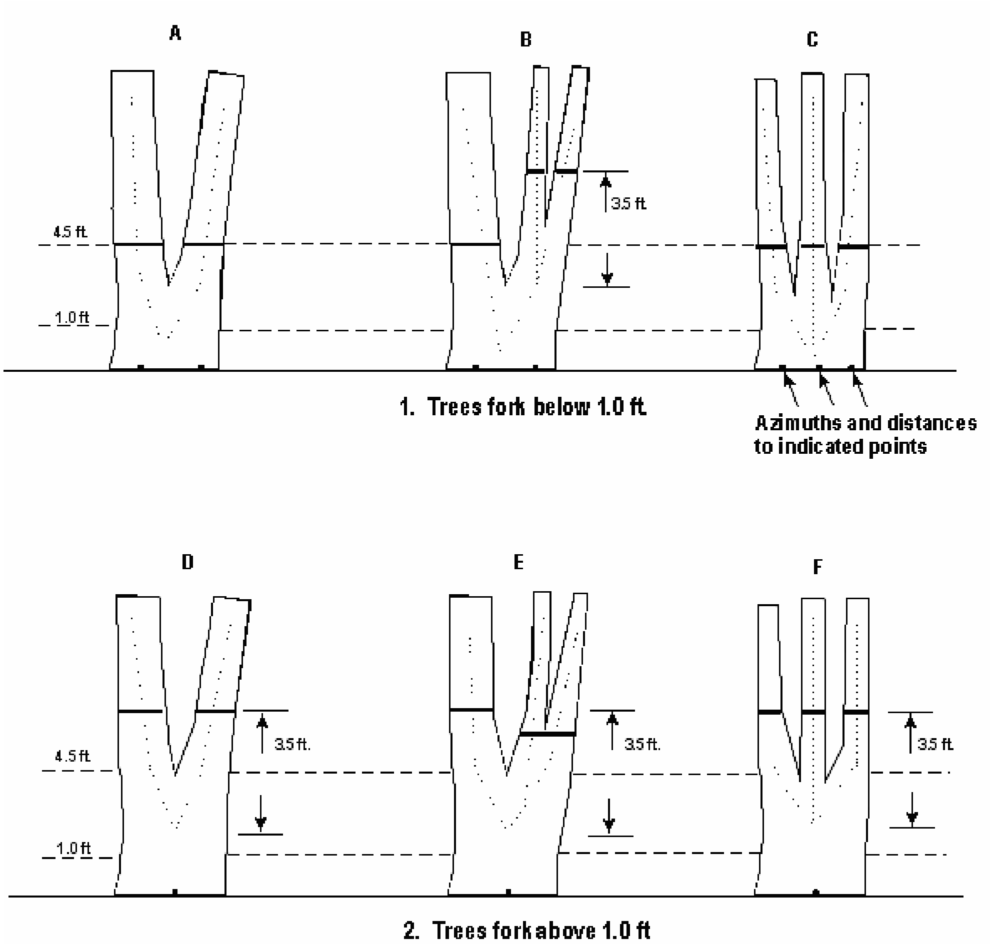


Figure 24. Summary of where to measure DBH, distance, and azimuth on forked trees.

NC Note: Figure 24 is only used for examples of forked trees and how to divide up forks. In the North Central region we do not repeat azimuths on a subplot or microplot, so always record a difference in azimuth by at least one degree.

3. <u>Tree with butt-swell or bottleneck:</u> Measure these trees 1.5 feet above the end of the swell or bottleneck if the swell or bottleneck extends 3.0 feet or more above the ground (Figure 25).

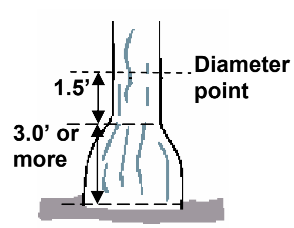


Figure 25. Bottleneck tree.

4. Tree with irregularities at DBH: On trees with swellings (Figure 26), bumps, depressions, and branches (Figure 27) at DBH, diameter will be measured immediately above the irregularity at the place it ceases to affect normal stem form.

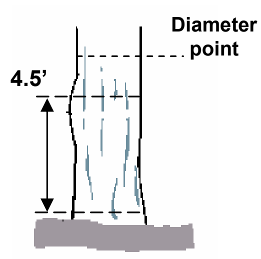


Figure 26. Tree with swelling.

Formatted

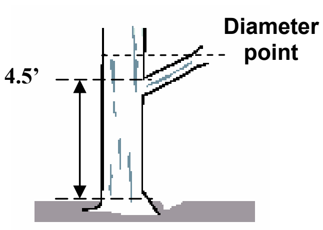


Figure 27. Tree with branch.

5. Tree on slope: Measure diameter at 4.5 feet from the ground along the bole on the uphill side of the tree (Figure 28).

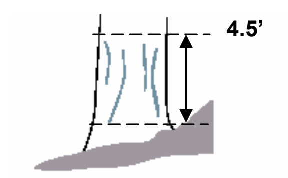


Figure 28. Tree on a slope.

6. Leaning tree: Measure diameter at 4.5 feet from the ground along the bole. The 4.5-foot distance is measured along the underside face of the bole (Figure 29).

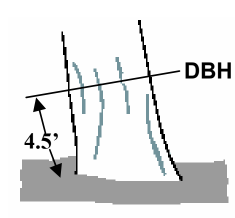


Figure 29. Leaning tree.

7. <u>Turpentine tree:</u> On trees with turpentine face extending above 4.5 feet, estimate the diameter at 10.0 feet above the ground and multiply by 1.1 to estimate DBH outside bark.

8. <u>Independent trees that grow together</u>: 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, and explain the situation in the notes.

9. <u>Missing wood or bark.</u> 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 inch, of the wood and bark that is still attached to the tree (Figure 30). If a tree has a localized abnormality (gouge, depression, etc.) at the point of point of DBH, apply the procedure described for trees with irregularities at DBH (Figure 26 and 27).

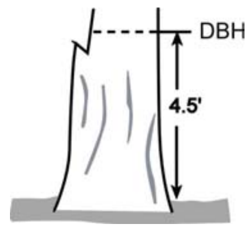


Figure 30. Tree with part of stem missing.

10. <u>Live windthrown tree</u>: Measure from the top of the root collar along the length to 4.5 feet (Figure 31).

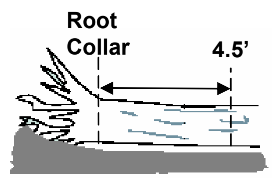


Figure 31. Tree on the ground.

11. <u>Down live tree with tree-form branches growing vertical from main bole</u>. When a down live tree, touching the ground, has vertical (less than 45 degrees 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 32).

    - If the pith intersection of the main down bole and vertical tree-like branch occurs below 4.5 feet from the stump along the main bole, treat that branch as a separate tree, and measure DBH 3.5 feet above the pith intersection for both the main bole and the tree-like branch.

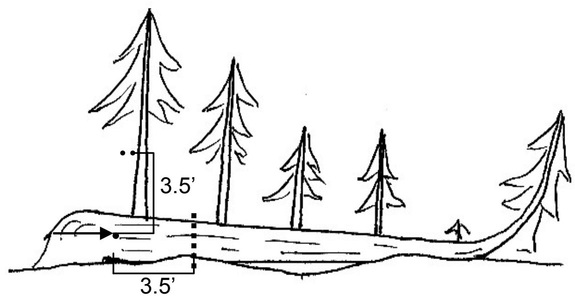


Figure 32. Down tree above duff.

- If the intersection between the main down bole and the tree-like branch occurs beyond the 4.5 feet 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 33). 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.

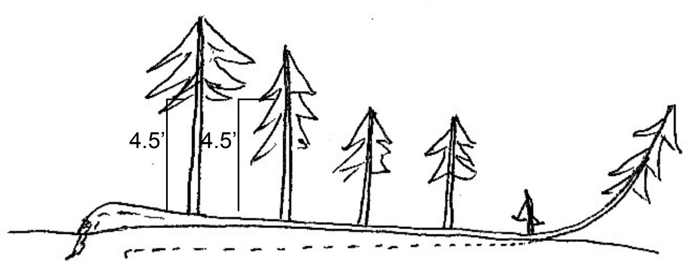


Figure 33. Down tree below duff.

12. Tree with curved bole (pistol butt tree): Measure along the bole on the uphill side (upper surface) of the tree (Figure 34).

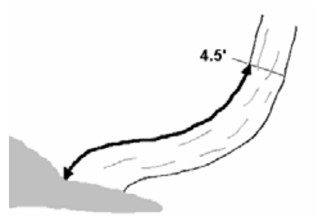


Figure 34. Tree with curved bole (pistol butt tree).

5.9.3 PREVIOUS DIAMETER AT ROOT COLLAR

This is the DRC assigned at the previous survey. It has been downloaded from the previous inventory. Any change made to this field signifies a misclassification at the time of the previous inventory. "DIAMETER CHECK" should be set to 2 and an explanation is required in the notes if previous DRC is changed.

5.9.4 DIAMETER AT ROOT COLLAR (DRC)

For species requiring diameter at the root collar (refer to Appendix 3), measure the diameter at the ground line or at the stem root collar, whichever is higher. For these trees, treat clumps of stems having a unified crown and common root stock as a single tree; examples include mesquite, juniper, and mountain mahogany. Treat stems of woodland species such as Gambel oak and Rocky Mountain maple as individual trees if they originate below the ground. For multi-stemmed trees, compute and record a cumulative DRC; record individual stem diameters and a stem status (live or dead) on a separate form or menu as required.

NC NOTE (everything shaded is NC addition): Within the North Central Research Station (NCRS), DRC is only collected on Rocky Mountain Juniper (*Juniperis scopulorum*) [SPP = 0066] in the states of North Dakota, South Dakota, Kansas, and Nebraska. Rocky Mountain Juniper is generally found in the western half of these states. Rocky Mountain Juniper can be generally differentiated from Eastern Redcedar (*Juniperus virginiana*) [SPP =0068] in that Eastern Redcedar has tighter, less-shaggy bark than and generally is more tree-form than the shrubby, shaggy-barked Rocky Mountain Juniper. Crews should note that the ranges of these two species overlap in the previously mentioned states and that the two species hybridize.

In most cases (see figure 35, example no. 3), if one measurement of DRC at the root collar can be accomplished, then take one measurement, mark the DRC measurement point with paint. In situations where due to growth habits and/or soil level, one measurement is impossible (figure 35, example no. 6), then measure the qualifying stems, mark each measurement location with paint. If the crew has a calculator, calculate the DRC with the formula in section 5.9.4 and record this value. The value should be recorded in the DBH field on the data recorder. If the crew does not have a calculator, then record the individual diameters on the plot sheet, calculate the DRC when the crew returns to the office with the formula and then replace the DRC with the calculated DRC value. [NOTE: HORIZONTAL DISTANCE (DIST) and AZIMUTH (AZM) recorded is to "the geographic center of the tree".]

1 Measuring DRC: Before measuring DRC, remove the loose material on the ground (e.g., litter) but not mineral soil. Measure just above any swells present, and in a location so that the diameter measurements are reflective of the volume above the stems (especially when trees are extremely deformed at the base).

Stems must be at least 1.0 foot in length and 1.0 inch in diameter to qualify for measurement; stems that are missing due to cutting or damage must have previously been at least 1.0 foot in length.

Whenever DRC is impossible or extremely difficult to measure with a diameter tape (e.g., due to thorns, extreme number of limbs), stems may be estimated and recorded to the nearest 1.0-inch class.

Additional instructions for DRC measurements are illustrated in Figure 35.

2 Computing and Recording DRC: For all tally trees requiring DRC, with at least one stem 1.0 inch in diameter or larger at the root collar, DRC is computed as the square root of the sum of the squared stem diameters. For a single-stemmed DRC tree, the computed DRC is equal to the single diameter measured.

Use the following formula to compute DRC:

$$\text{DRC} = \text{SQRT [SUM (stem diameter}^2)]$$

Round the result to the nearest 0.1 inch. For example, a multi-stemmed woodland tree with stems of 12.2, 13.2, 3.8, and 22.1 would be calculated as:

$$\begin{aligned}\text{DRC} &= \text{SQRT } (12.2^2 + 13.2^2 + 3.8^2 + 22.1^2)\\ &= \text{SQRT } (825.93)\\ &= 28.74\\ &= 28.7\end{aligned}$$

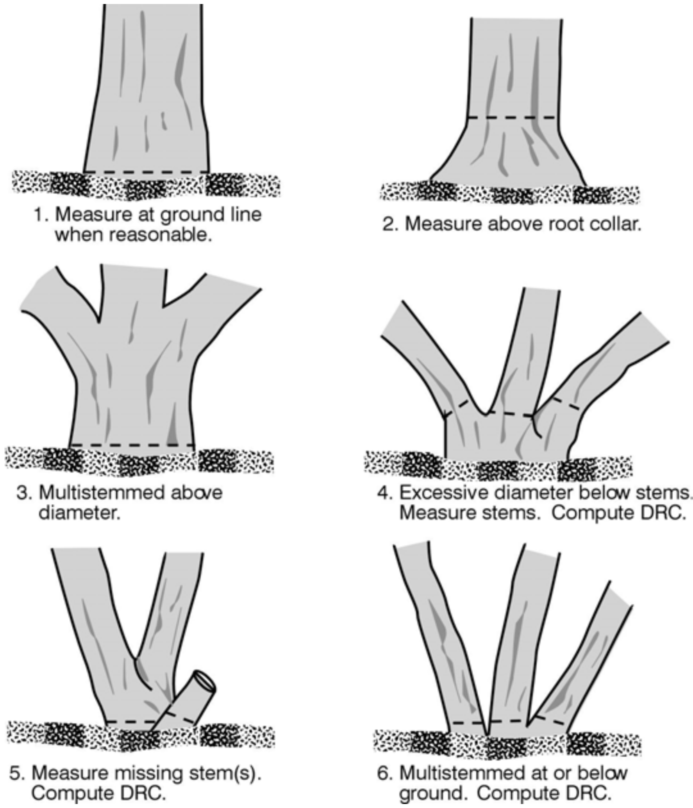


Figure 35. How to measure DRC in a variety of situations.

5.10 DIAMETER CHECK (DCHE)

Record this code to identify any irregularities in diameter measurement positions (e.g., abnormal swellings, diseases, damage, new measurement positions, etc.) that may affect use of this tree in diameter growth/change analyses.

When Collected: All live tally trees ≥ 1.0 in DBH/DRC and standing dead tally trees ≥ 5.0 in DBH/DRC **NC Note:** Also collected on re-measurement trees (subplots 101 - 105).
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0	Diameter measured accurately
1	Diameter estimated
2	Diameter measured at different location than previous measurement (remeasurement trees only)

Note: If both codes 1 and 2 apply, use code 2.

5.10NC NC TREE CLASS/DECAY CLASS CURRENT (TCC)

Tree class/decay class reflects tree suitability for timber products or the extent of decay in the butt section of down-dead trees. Tree class is basically a check for the straightness and soundness of the sawlog portion on a sawtimber tree or the potential sawlog portion on a poletimber tree or sapling. Not considered in determining tree class are: tree vigor, predicted death, and plot site index.

When evaluating log length for determining tree class, there are many things that stop you from obtaining eight and twelve foot logs. The following is a list of "stoppers" to consider when assessing the trees log length.

- **ALL FORKS** (See definition on 5.9.2 for forks) In addition limbs in question must be competing with the other limb for sunlight and length.
- **FULL DIAMETER STOPPER**: Limbs equal to or greater than the diameter of the bole at point of occurrence. Consider this stopper only when the log in question grades out to 1, 2, or 3. Add all limbs 2 inches or greater within a one foot section to determine if limbs are equal to or greater than diameter of the bole.
- **1/3 DIAMETER STOPPER**: Limbs 1/3 the diameter or greater than the diameter of the bole at point of occurrence. Consider this stopper only when the log in question grades out to 4. Add all limbs 2 inches or greater within a one foot section to determine if limbs are 1/3 the diameter or greater than diameter of the bole.
- **ROT /MISSING WOOD STOPPER**: Log is stopped when there is 50% or more of the cross section affected by rot or missing wood. Consider a *Phellinus* spp. conk on aspen and pine a stopper. Also an *Inonotus obliquus* fungal wedge would be considered a stopper.
- **CANKERS:** Consider all cankers a stopper when the damage severity is coded 5 or more.
- **EXCESSIVE CROOK OR SWEEP:** To determine if crook or sweep exceeds the maximum allowed, refer to the crook or sweep deduction tables. (Tables are attached at the end of this section)

The extent of decay in the **butt section** of down-dead trees determines the decay class. A metal pin is useful in assessing the amount of decay, but be sure to minimize damage to the tree. If the pin penetrates to the center of the log the tree is in decay class 44 or 45. Record decay class in the tree class field.

When collected: All live and dead trees $\geq$ 1.0 in DBH on all subplots will be given a NC Tree Class/Decay Class.
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: All subplots: 20,30,31,40
Re-measurement trees: 20,30,31,40 and 41, 42, 43, 44, 45.

Code	Description
20	Growing Stock
30	Rough Cull, Salvable, and Salvable-down
31	Short-log Cull
40	Rotten Cull
Remeasurement trees only	
41	Solid
42	Solid-punky
43	Punky
44	Disintegrating
45	Gone

Use one of the following codes for tree/decay class of live standing, standing-dead, and down-dead trees.

20--Growing Stock

Any live tree of commercial species that is saw-timber size and has at least one merchantable 12-foot saw-log or two merchantable 8-foot saw-logs meeting minimum log-grade requirements. At least one-third of the gross board-foot volume of the saw-log portion must be merchantable material. (Saw-log portion is the length between the one-foot stump and the 9.0" top diameter of outside bark, DOB, for hardwoods, or the 7.0" top DOB for softwoods.) A merchantable saw-log must be at least 50 percent sound at any point.

Any pole timber size tree that has the potential to meet the above specifications. Assume that pole-size trees will eventually attain saw-log size at DBH. In evaluating potential saw-log portion of pole-size trees, only rot/missing/dead wood, forks, excessive sweep/crook, & potential grade may disqualify the tree as a growing stock. Predict what grade the future log will have, this will determine the appropriate size limb stopper needed to stop the log length. When estimating potential saw-log height for pole-timber trees, apply the two-inch rule as a guide. The two-inch rule assumes that a tree's diameter increases uniformly along its bole. For example, a hardwood pole-timber tree with an 8.0" DBH needs 3" of diameter growth to become saw-timber size. If diameter growth is uniform, then the DBH minus two inches (eight minus two), or six inches, identifies the potential saw-log top. This method works for both hardwoods and softwoods.

Consider a seedling or sapling as growing stock unless a specific damage is observed. A seedling or small sapling (< 3.0" DBH) may not be culled on the basis of excessive sweep or crook. Assume that seedlings and saplings will eventually attain saw-log size at DBH.

30--Rough Cull, Salvable, and Salvable-down

Any tree of noncommercial species is a rough cull

Any tree that is saw-timber size and has no merchantable saw-log. Over one-half of the volume in the saw-log portion does not meet minimum log-grade specifications because of roughness, excessive sweep or crook, splits, cracks, limb stoppers, or forks the tree is considered rough cull. The saw-log portion is the length between the one-foot stump and the 9.0" top DOB for hardwoods, or the 7.0" top DOB for softwoods.

Rough cull pole-size trees do not have the potential to meet the specifications for growing stock because of forks, limb stoppers, or excessive sweep or crook. Assume that all live trees not currently saw-log size will eventually attain saw-log size at DBH. Predicted death, tree vigor, and plot site index are not considered in determining tree class. When estimating the potential saw-log height for pole-timber trees, the two-inch rule can be applied as a guide. The two-inch rule assumes that a trees diameter will increase uniformly along its bole. For example; a hardwood pole-timber tree with a DBH of 8.0 inches need three inches of diameter growth to become saw-timber size. If diameter growth is uniform then the DBH minus 2 inches, 8-2 or 6 inches, identifies the potential saw-log top.

A standing-dead tree that contains at least one 8-foot section that is at least 50 percent sound has a tree/decay class of 30. A down-dead tree ≥ 5.0" DBH that meets these standards is given a tree/decay code of 30.

31--Short-log Cull

Any live saw-timber-size tree of commercial species that has at least one 8-foot saw-log, but less than a 12-foot saw-log, meeting minimum log-grade specifications.

Any live saw-timber-size tree of commercial species that has less than one-third of the volume of the saw-log portion in merchantable logs, but has at least one 8-foot or longer saw-log meeting minimum log-grade specifications. A short saw-log must be 50 percent sound at any point. (The saw-log portion is the length between the one-foot stump and the 9.0" top DOB for hardwoods and the 7.0" top DOB for softwoods.)

Note: Pole-size trees never receive a tree class code 31.

40--Rotten Cull
Any live tree of commercial species that is saw-timber size and has no merchantable saw-log. Over one-half of the volume in the saw-log portion does not meet minimum log-grade specifications primarily because of rot, missing sections, or deadwood. (The saw-log portion is the length between the one-foot stump and the 9.0" top DOB for hardwoods, or the 7.0" top DOB for softwoods.)

Classify any pole-size tree that does not have the potential to meet the specifications for growing stock because of rot as rotten cull. Assume that all live trees will eventually attain saw-log size at DBH. Predicted death, tree vigor, and plot site index are not considered in determining tree class.

A standing-dead tree without an 8-foot or longer section that is at least 50 percent sound has a tree class of 40.

On re-measurement of a sapling, if it has died and is still standing it is given a tree class of 40.

Summary: If any of the requirements for growing stock (tree class 20) are not met, the tree is considered cull. If a short saw-log is present, the tree class is 31. If no saw-log is present, the tree class is either 30 or 40. If a pole-size tree does not have the potential to meet saw-log standards, it is either tree class 30 or 40.

Note: Tree class codes 41 and higher are only valid on trees that have a TREE STATUS (TRST) = 2 and a STANDING DEAD = 0. This means that codes 41-45 are only valid on re-measured trees.

41--Solid
The butt section of a down-dead tree with this decay class has intact bark and is structurally sound enough that it cannot be penetrated with a pin. Any rotten portions are also intact. Also use this class for trees $\geq$ 5" DBH that are not salvable due to breakage or form.

42--Solid-punky
Bark may or may not still be attached and the structural integrity of the butt section is sound to somewhat rotten. Branch stubs are still firmly attached. Any rotten portions are partly soft.

43—Punky
Decay has progressed substantially in the butt section. Although bark may still be attached, most is sloughing or detached and a pin easily penetrates the wood. Branch stubs pull out and rotten portions are soft and perhaps even squishy if moist.

44--Disintegrating
Little structural integrity remains. Bark is detached or absent (for some species it may still be intact). A pin penetrates to the center of the log and branch stubs have rotted. Rotten portions are "doughy" when wet and fluffy when dry.

45--Gone
Little to no evidence of the butt section remains.

The following table summarizes valid tree/decay class for the various tree histories.

The following table summarizes valid tree/decay class for the various tree histories.

	Tree Status (TRST)	Standing Dead (DEAD)	Tree/Decay Class (TCC)								
			Subplots 1 - 4				Re-measurement trees				
			20	30	31	40	41	42	43	44	45
	1	-	Yes	Yes	Yes	Yes	No	No	No	No	No
	2	1	No	Yes	No	Yes*	No	No	No	No	No
	2	0	No	Yes**	No	No	Yes	Yes	Yes	Yes	Yes

* Use this class for standing-dead trees <5.0” DBH
** Trees ≥ 5.0” DBH only

See Appendix 8 for diagrams of trees to assist in assigning tree class.

5.11 ROTTEN/MISSING CULL (ROTT)

Record the percent rotten or missing cubic-foot cull for all live tally trees greater than or equal to 5.0 inches DBH/DRC (CORE) and all standing dead tally trees greater than or equal to 5.0 inches DBH/DRC (CORE OPTIONAL).

Record the percentage of rotten and missing cubic-foot volume, to the nearest 1 percent. When estimating volume loss (tree cull), only consider the cull on the merchantable bole/portion of the tree, from a 1-foot stump to a 4-inch top. Do not include any cull estimate above ACTUAL LENGTH. For western woodland species, the merchantable portion is between the point of DRC measurement to a 1.5-inch DOB top.

Rotten and missing volume loss is often difficult to estimate. Refer to supplemental disease and insect pests field guides and local defect guidelines as an aid in identifying damaging agents and their impact on volume loss. Use your best judgment and be alert to such defect indicators as the following:

- Cankers or fruiting bodies.
- Swollen or punky knots.
- Dull, hollow sound of bole (use regional standards).
- Large dead limbs, especially those with frayed ends.
- Sawdust around the base of the tree.

When Collected: CORE: All live tally trees ≥ 5.0 in DBH/DRC
CORE OPTIONAL: All live and standing dead tally trees ≥ 5.0 in DBH/DRC
NC Note: Not collected on re-measurement trees (subplots 101 -105).
Field width: 2 digits
Tolerance: +/- 10 %
MQO: At least 90% of the time
Values: 00 to 99

5.12 TOTAL LENGTH (THGT)

Record the TOTAL LENGTH of the tree, to the nearest 1.0 foot from ground level to the top of the tree. For trees growing on a slope, measure on the uphill side of the tree. If the tree has a missing top (top is broken and completely detached from the tree), estimate what the total length would be if there were no missing top. Forked trees should be treated the same as unforked trees.

When Collected: Phase 2 CORE - All live tally trees ≥ 5.0 in DBH/DRC
Phase 2 CORE OPTIONAL - All live tally trees ≥ 1.0 in DBH/DRC and all standing dead tally trees ≥ 5.0 in DBH/DRC
Phase 3 CORE - All live tally trees ≥ 1.0 in DBH/DRC
NC Note: Not collected on re-measurement trees on subplots 101-105.
Field width: 3 digits
Tolerance: +/- 10 % of true length
MQO: At least 90% of the time
Values: 005 to 400

5.13 ACTUAL LENGTH (ACTU)

For trees with missing tops (top on live trees is completely detached; top on dead trees is greater than 50 percent detached from the tree). If the top is intact, this item may be omitted. Record the ACTUAL LENGTH of the tree to the nearest 1.0 foot from ground level to the break. Use the length to the break for ACTUAL LENGTH until a new leader qualifies as the new top for TOTAL LENGTH; until that occurs, continue to record ACTUAL LENGTH to the break. Trees with previously broken tops are considered recovered (i.e., ACTUAL LENGTH = TOTAL LENGTH) when a new leader (dead or alive) is 1/3 the diameter of the broken top at the point where the top was broken (not where the new leader originates from the trunk). Forked trees should be treated the same as unforked trees.

When Collected: Phase 2 CORE - All live and standing dead tally trees (with broken or missing tops) ≥ 5.0 in DBH/DRC
Phase 2 CORE OPTIONAL - All live tally trees (with broken or missing tops) 1.0 – 4.9 in DBH/DRC
Phase 3 CORE - All live tally trees (with broken or missing tops) ≥1.0 in DBH/DRC
NC Note: Not collected on re-measurement trees on subplots 101-105
Field width: 3 digits
Tolerance: +/- 10 % of true length
MQO: At least 90% of the time
Values: 005 to 400

5.14 LENGTH METHOD (METH)

Record the code that indicates the method used to determine tree lengths.

When Collected: Phase 2 CORE - All live tally trees ≥ 5.0 in DBH/DRC
Phase 2 CORE OPTIONAL - All live tally trees ≥ 1.0 in DBH/DRC and all standing dead tally trees ≥ 5.0 in DBH/DRC
Phase 3 CORE - All live tally trees ≥ 1.0 in DBH/DRC
NC Note: Not collected on re-measurement trees on subplots 101-105
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1	Total and actual lengths are field measured with a measurement instrument (e.g., clinometer, relascope, tape)
2	Total length is visually estimated, actual length is measured with an instrument
3	Total and actual lengths are visually estimated

5.14NC NC TREE GRADE (TRGD)

Grade all live trees that are saw-log size and have a tree class of 20 or 31 on subplots 1-4. See Appendix 10 for help using tree grade flow charts.

When collected: All live trees with a tree class of 20 or 31
Hardwoods ≥ 11" DBH
Softwoods ≥ 9" DBH
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

000	hardwoods/ softwoods	370	hardwoods
100	hardwoods/ softwoods	380	hardwoods
200	softwoods	400	softwoods - White Pine only
210	hardwoods	430	hardwoods
230	hardwoods	520	hardwoods
240	hardwoods	560	hardwoods
250	hardwoods	570	hardwoods
270	hardwoods		
280	hardwoods		
300	softwoods		
310	hardwoods		
330	hardwoods		
340	hardwoods		
350	hardwoods		

First digit

For a **hardwood** saw-timber tree (tree class 20), grade the saw-log portion of the tree using "Hardwood Tree Grades for Factory Lumber" (USDA Forest Service Research Paper NE-333). The table on a following page contains the specifications for hardwood tree grades. Use the table and the following steps to determine tree grade.

- Measure DBH to the nearest inch.
- Establish the location of all defect indicators on the surface of the butt 16-foot log, and then locate the best 12-foot section.
- Within the best 12-foot section, select the third best face of the log. Use this face to determine length of clear cuttings.
- Estimate inside bark diameter (DIB) at the top of the 12-foot section to the nearest inch.
- Estimate scalable defect in the 12-foot section selected previously.
- The grade of the 12-foot section becomes the tree's grade, unless the grade can be improved by using a 14- or 16-foot section

For a hardwood saw-timber tree that does not qualify as tree grade 3, but has a 12-foot log within the butt 16-foot log and meets specifications for hardwood construction lumber logs (tie and timber) assign a grade 4. For a hardwood saw-timber tree that does not qualify as a tree grade 3 or log grade 4, but has a 12-foot log above the butt log or two 8-foot logs that meets log-grade requirements (therefore a 20 or 31 class tree), assign a log grade of 5.

A hardwood construction log grade table (grade 4) and a hardwood lumber log grade table (upper logs or grade 5) are included on the following pages.

For a **softwood** saw-timber (tree class 20) tree, grade the portion of the log that gives the best grade. Use the grading rules in the Tatum Guides for determining log grade.
For a softwood 31-class tree, grade the log that is present.

Minimum saw-log length for tree grades is 12 feet and for log grades is 8 feet. Saw-log lengths should not extend above large forks, have excessive limbs or other defects, or have a section of the tree bole that does not meet minimum log grade specification. Limitations or "stoppers" for all softwoods and for hardwood grades 1, 2 and 3 include: any limb (live or dead) having a collar diameter exceeding the stem DOB at that point; or any group of 2.0" collar diameter or larger limbs (live or dead), within a 1 foot span, having a combined sum of diameters greater than the stem DOB of that section. Limitations for grade 4 hardwoods include: any limb or group of limbs, within a 1 foot span, with a collar diameter or sum of collar diameters greater than 1/3 of the stem DOB of that section.

Code 1st Digit	**Valid Species**
1	hardwoods & softwoods
2	hardwoods & softwoods
3	hardwoods & softwoods
4	hardwoods only & White Pine
5	hardwoods only

Second and third digit

For **hardwoods** given a grade 2, 3, 4, or 5, record the limiting quality factor that is keeping the log from moving into a better quality grade. When a grade 5 is given to a hardwood log, the second digit is a 2 or 7 when an 8' log is present. If a 12' upper log is present, assign a second digit of 6.

For **softwoods**, the second and third digits are always "00".

Code 2nd & 3rd	**Limiting Factor**
00	Not applicable, already a grade 1, all softwoods
10	Diameter
20	Length
30	Clear cuttings
40	Sweep and crook
50	Cull
60	Position in tree
70	Multiple factors
80	Diameter and clear cutting

TABLE OF HARDWOOD TREE GRADES FOR FACTORY LUMBER

Grade factor	Grade 1			Grade 2		Grade 3
Length of grading zone (feet)	Butt 16			Butt 16		Butt 16
Length of grading section [a] (feet)	Best 12			Best 12		Best 12
DBH, minimum (inches)	16[b]			13		11
Diameter, minimum inside bark at top of grading section (inches)	13[b]	16	20	11[c]	12	8
Clear cuttings (on the 3 best faces)[d]						
Length, minimum (feet)	7	5	3	3	3	2
Number on face (maximum)		2		2	3	[e]
Yield in face length (minimum)	5/6			4/6		3/6
Cull deduction (including crook and sweep, but excluding shake) maximum within grading section (percent)	9			9[f]		50

a Whenever a 14- or 16-foot section of the butt 16-foot log is better than the best 12-foot section, the grade of the longer section will become the grade of the tree. This longer section, when used, is the basis for determining the grading factors such as diameter and cull deduction.

b In basswood and ash, DIB at top of grading section must be 12 inches and DBH must be 15 inches.

c Grade 2 trees can be 10 inches DIB at top of grading section if otherwise meeting surface requirements for small grade 1s.

d A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth of the surface of the grading section as divided lengthwise.

e Unlimited.

f Fifteen percent crook and sweep or 40 percent total cull deduction are permitted in grade 2, if size and surface of grading section qualify as grade 1. If rot shortens the required clear cuttings to the extent of dropping the butt log to grade 2, do not drop the tree grade to 3 unless the cull deduction for rot is greater than 40 %.

NOTE: The tree grading in this table is based on measuring DBH to the nearest inch, since FIA measures to the last 10th of a inch, use diameter classes (i.e. for grade 1, DBH can be 15.5" and for grade 2, DBH can be 12.5") for this table. Also FIA uses 11 inch, as the minimum DBH to record tree grades so only grade 1 and 2 are affected by diameter classes.

FOREST SERVICE STANDARD SPECIFICATIONS FOR HARDWOOD CONSTRUCTION (GRADE 4) LOGS

Position in tree		Butt & Upper.
Min. diameter, small end		8 inches +.
Min. length, without trim		8 feet +.
Clear cuttings		No requirements.
Sweep allowance, absolute		1/4 d.i.b. of small end for half logs, 1/2 d.i.b. for logs 16 feet long.
Sound surface defects permitted	Single knots	Any number, if no one knot has an average collar diameter over 1/3 of log diameter at point of occurrence.
	Whorled knots	Any number, if sum of collar diameters does not exceed 1/3 of the log diameter at point of occurrence.
	Holes	Any number provided none has a diameter over 1/3 of log diameter at point of occurrence and none extends over 3 inches into included timber.
Unsound defects permitted	Surface	Any number and size if they do not extend into included timber. If they do, they can't exceed size, number, and depth, or limits of sound knots.
	Interior	None allowed; log must be sound internally, but will permit 1 shake not to exceed 1/3 the scaling diameter and a longitudinal split not extending over 5 inches into the contained timber. No center rot.

FOREST SERVICE STANDARD GRADES FOR HARDWOOD FACTORY LUMBER LOGS [a]

		Log grades							
Grading Factors*		F1			F2				F3
Position in tree		Butts only	Butts & uppers		Butts & uppers				Butts & uppers
Scaling diameter, inches		13-15[b]	16-19	20+	11+[c]	12+			8+
Length without trim, feet		10+			10+	8-9	10-11	12+	8+
Required clear[d] cuttings of each of 3 best faces[e]	Min. length, feet	7	5	3	3	3	3	3	2
	Max. number	2	2	2	2	2	2	3	No limit
	Min. proportion of log length required in clear cutting	5/6	5/6	5/6	2/3	3/4	2/3	2/3	1/2
Maximum sweep & crook allowance	For logs with less than 1/4 of end in sound defects	15%			30%				50%
	For logs with more than 1/4 of end in sound defects	10%			20%				35%
Maximum scaling deduction		40%[f]			50%[g]				50%

[a] From USDA Forest Service Research FPL. 63
[b] Ash and Basswood butts can be 12 inches if otherwise meeting the requirements for small No. 1's
[c] Ten-inch logs of all species can be #2 if they if otherwise meeting the requirements for small No. 1's
[d] A Clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth the surface of the log as divided lengthwise.
[e] A face is ¼ of the surface of the log as divided lengthwise
[f] Otherwise No. 1 logs with 41-60 percent cull can be No. 2.
[g] Otherwise No. 2 logs with 51-60 percent cull can be No. 3.

EASTERN WHITE PINE SAW-LOG GRADE SPECIFICATIONS

GRADING FACTOR	LOG GRADE 1	LOG GRADE 2	LOG GRADE 3	LOG GRADE 4
1 MINIMUM SCALING	14[1]	6	6	6
2 MINIMUM LOG LENGTH (feet)	10[2]	8	8	8
3 MAXIMUM WEEVIL INJURY (number)	NONE	NONE	2 INJURIES[3]	NO LIMIT
4 MINIMUM FACE REQUIREMENTS	Two full length or four 50% length good faces.*4* (In addition, log knots on balance of faces shall not exceed size limitations of grade 2 logs.)	NO GOOD FACES REQUIRED. Maximum diameter of log knots on three best faces: SOUND RED KNOTS not to exceed 1/6 scaling diameter and 3 inch maximum. DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/12 scaling diameter and 1 1/2 inch maximum.	SOUND RED KNOTS not to exceed 1/3 scaling diameter and 5 inch maximum. DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/6 scaling diameter and 2 1/2 inch maximum	Includes all logs not qualifying for No. 3 or better and judged to have at least one third of their gross volume in sound wood suitable for manufacture into standard lumber.
5 MAXIMUM SWEEP OR CROOK ALLOW-ANCE (percent)	20	30	40	66 2/3
6 MAXIMUM TOTAL SCALING DEDUC-TION (percent)	50	50	50	66 2/3

After the tentative log grade is established from face examination, the log will be reduced in grade whenever the following defects are evident:

7 CONKS, PUNK KNOTS, AND PINE BORER DAMAGE ON BARK SURFACE[5]

Degrade one grade if present on one face
Degrade two grades if present on two faces
Degrade three grades if present on three or more faces

8 LOG END DEFECTS: RED ROT, RING SHAKE, HEAVY STAIN AND PINE BORER DAMAGE OUTSIDE THE HEART CENTER OF THE LOG [5]

Consider log as having a total of 8 quarters (4 on each end) and degrade as indicated below:
Degrade one grade if present in 2 quarters of log ends.
Degrade two grades if present in 3 or 4 quarters of log ends.
Degrade three grades if present in 5 or more quarters of log ends.

1 12 and 13 inch logs with four full length good faces are acceptable.
2 8 foot logs with four full length good faces are acceptable.
3 8 foot Number 3 logs limited to one weevil injury.
4 Minimum 50% length good face must be at least 6 feet.
5 Factors 7 and 8 are not cumulative (total degrade based on more serious of the two). No log to be degraded below grade 4 if net scale is at least one third of gross scale.

WHITE PINE COLLAR DIAMETER LIMITS FOR RED AND BLACK KNOTS				
SCALING DIAMETER (D.I.B. inches)	GRADE 1 AND 2		GRADE 3	
	BLACK KNOTS 1/12th	RED KNOTS 1/6th	BLACK KNOTS 1/6th	RED KNOTS 1/3rd
7	7/12"	1 - 1/6"	1 - 1/6"	2 - 1/3"
8	2/3"	1 - 1/3"	1 - 1/3"	2 - 2/3"
9	3/4"	1 - 1/2"	1 - 1/2"	3"
10	5/6"	1 - 2/3"	1 - 2/3"	3 - 1/3"
11	11/12"	1 - 5/6"	1 - 5/6"	3 - 2/3"
12	1"	2"	2"	4"
13	1 - 1/12"	2 - 1/6"	2 - 1/6"	4 - 1/3"
14	1 - 1/6"	2 - 1/3"	2 - 1/3"	4 - 2/3"
15	1 - 1/4"	2 - 1/2"	**2 - 1/2" MAX**	**5" MAX**
16	1 - 1/3"	2 - 2/3"		
17	1 - 5/12"	2 - 5/6"		
18	**1 - 1/2" MAX**	**3 MAX"**		

Red knots – Visible branches, stubs or sockets that are from living branches or branches that have recently died. They are inter-grown with the surrounding wood and contain no rot.

Black knots – Visible branches, stubs or sockets that do not conform to the definition of red knots.

Overgrown knots – Identified by a distinctive circular/elliptical pattern in the bark and are treated the same as dead knots.

Average diameter of red and black knots – Measured at the point where the limb would normally be trimmed from the main stem.

LOG GRADES FOR SOFTWOOD LOGS

<u>Grade 1</u>

1. Logs must be 16" d.i.b. or larger, 10' or longer, and with deduction for defect, not over 30 % of gross scale.
2. Logs must be at least 75 % clear on each of three faces.
3. All knots outside clear cutting must be sound and not over 2 1/2" large.

<u>Grade 2</u>

1. Logs must be 12" d.i.b. or larger, 10' or longer, and with a net scale after deduction for defect of at least 50 % of the gross contents of the log.

2. Logs must be at least 50 % clear on each of three faces or 75 % clear on 2 faces.

<u>Grade 3</u>

1. Logs must be 6" d.i.b. or larger, 8' or longer, and with a net scale after deduction for defect of at least 50 % of the gross contents of the log.

Notes: Diameters are d.i.b. at small end of log
% clear refers to % clear in one continuous section

JACK PINE AND RED PINE LOG GRADES

GRADE 1 Logs with 3 or 4 clear faces *
GRADE 2 Logs with 1 or 2 clear faces.
GRADE 3 Logs with no clear faces.

After the tentative log grade is established from above, the log will be degraded one grade for each of the following defects, except that no log can be degraded below grade 3. Net scale after deduction for defect must be at least 50 percent of the gross contents of the log.

1. **SWEEP** Degrade any tentative 1 or 2 log one grade if sweep amounts to 3 or more inches and equals or exceeds one third the diameter inside bark at the small end.

2. **HEART ROT** Degrade any tentative 1 or 2 log one grade if conk, massed hyphae, or other evidence of advanced heart rot is found anywhere in the log.

---

* A face is one fourth of the circumference in width extending the full length of the log. Clear faces are those free of: knots measuring more than 1/2 inch in diameter, overgrown knots of any size, and holes more than 1/4 inch in diameter. Faces may be rotated to obtain the maximum number of clear ones.

SOUTHERN PINE TREE GRADES

Always grade the bottom 16-foot log, or the first merchantable log 12 feet or longer in the tree.

Clear face - free of knots measuring more than 1/2 inch in diameter, overgrown knots of any size, holes more than 1/4 inch in diameter. The faces may be rotated if necessary to obtain the maximum number of clear ones.

Overgrown knot - a knot overgrown and buried beneath the log surface, but indicated by a surface bump or distribution of bark pattern.

Tentative Grades

Grade 1 - trees with 3 or 4 clear faces
Grade 2 - trees with 1 or 2 clear faces
Grade 3 - trees with no clear faces

Degrade for Sweep or Heart Rot

(1) Degrade any tentative grade 1 or 2 tree one grade if sweep in the lower 12 feet of the grading sections amount to 3 or more inches and equals or exceeds one-fourth the DBH.

(2) Degrade any tentative 1 or 2 tree one grade if conks, punk knots, or otherwise evidence of advanced heart rot is found anywhere on the tree stem.

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5.15 CROWN CLASS (CCC)

Rate tree crowns in relation to the sunlight received and proximity to neighboring trees (Figure 36). Base the assessment on the position of the crown at the time of observation. Example: a formerly overtopped tree which is now dominant due to tree removal is classified as dominant.

When Collected: All live tally trees ≥ 1.0 in DBH/DRC
NC Note: Also collected on live tally trees ≥ 5.0 in DBH/DRC for subplots 101-105
Field width: 1 digit
Tolerance: No errors
MQO: At least 85% of the time
Values:

1 Open Grown – trees with crowns that received full light from above and from all sides throughout most of its life, particularly during its early developmental period.

2 Dominant – trees with crown extending above the general level of the crown canopy and receiving full light from above and partly from the sides. These trees are taller than the average trees in the stand and their crowns are well developed, but they could be somewhat crowded on the sides. Also, trees whose crowns have received full light from above and from all sides during early development and most of their life. Their crown form or shape appears to be free of influence from neighboring trees.

3 Co-dominant – trees with crowns at the general level of the crown canopy. Crowns receive full light from above but little direct sunlight penetrates their sides. Usually they have medium-sized crowns and are somewhat crowded from the sides. In stagnated stands, co-dominant trees have small-sized crowns and are crowded on the sides.

4 Intermediate – trees that are shorter than dominants and co-dominant, but their crowns extend into the canopy of co-dominant and dominant trees. They receive little direct light from above and none from the sides. As a result, intermediate trees usually have small crowns and are very crowded from the sides.

5 Overtopped – trees with crowns entirely below the general level of the crown canopy that receive no direct sunlight either from above or the sides.

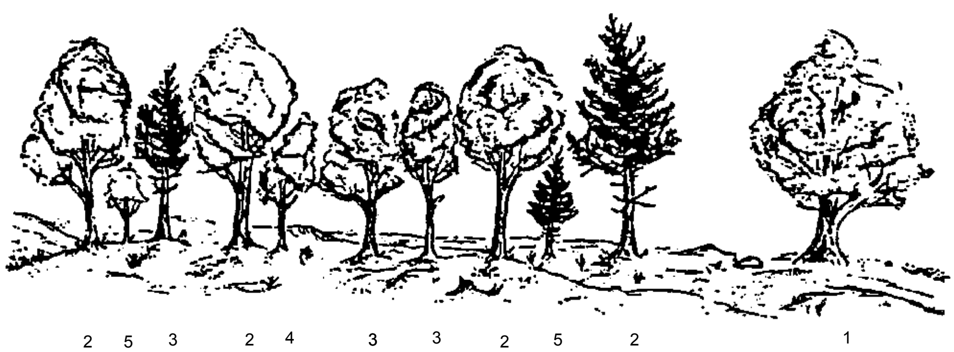
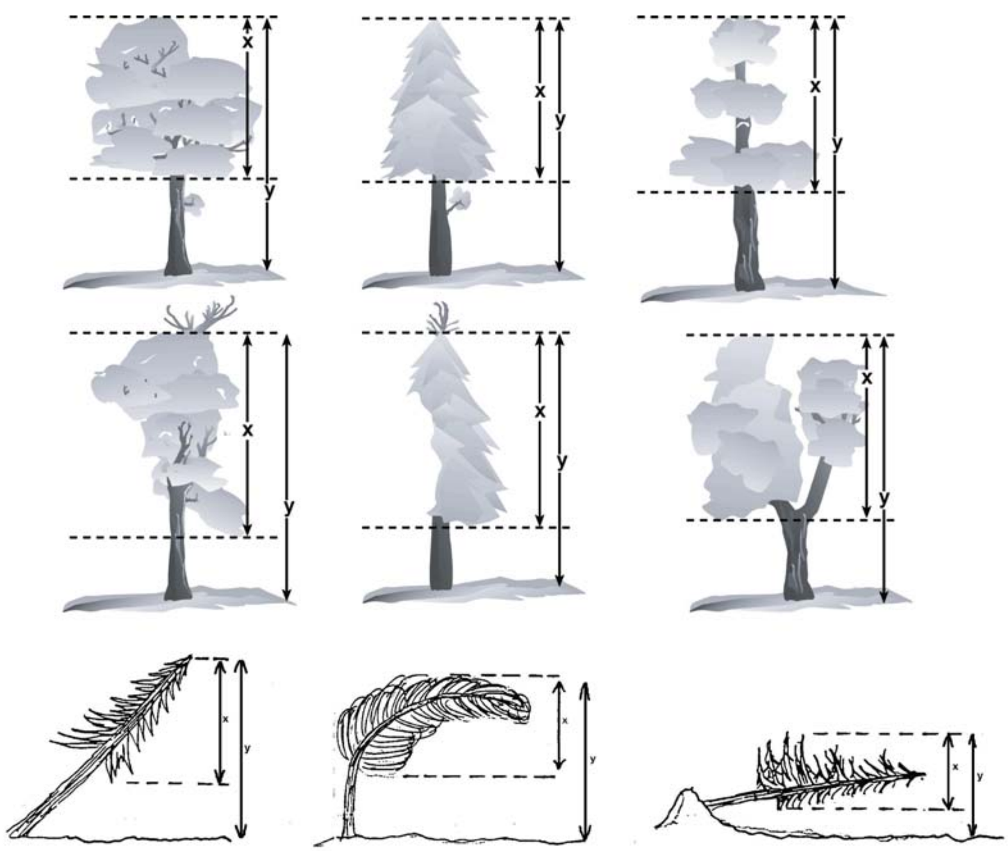


Figure 36. Examples of CROWN CLASS code definitions (numbers are the CROWN CLASS codes).

5.16 UNCOMPACTED LIVE CROWN RATIO (UCRC) (Phase 2 – CORE OPTIONAL, Phase 3 – CORE)

Record the UNCOMPACTED CROWN RATIO to the nearest one percent. UNCOMPACTED LIVE CROWN RATIO is the percentage of total tree height supporting live foliage (or in cases of extreme defoliation should be supporting live foliage) that is effectively contributing to tree growth. UNCOMPACTED LIVE CROWN RATIO is determined by the ratio of live crown length to top of live crown (Figure 37). Live crown length is determined from the last live foliage at the crown top (dieback in the upper portion of the crown is not part of the live crown) to the "base of live crown". Many times there are additional live branches below the "base of live crown". These branches are only included if they have a basal diameter greater than 1 inch and are within 5 feet of the base of the obvious live crown. 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.



$$\text{Crown ratio} = \frac{x}{y} \times 100$$

Figure 37. UNCOMPACTED LIVE CROWN RATIO examples.

Determine sapling UNCOMPACTED LIVE CROWN RATIO by dividing the live crown length by total tree height to the live crown top. Live crown length is the distance between the top live foliage (dieback and dead branches are not included) and the lowest live twig for saplings. The live crown base for saplings is different from trees 5.0 inches DBH/DRC and larger; the 1-inch/5-foot rule does not apply in this case. Do not include sprigs or leaves on the main stem below the lowest live twig (Figure 38).

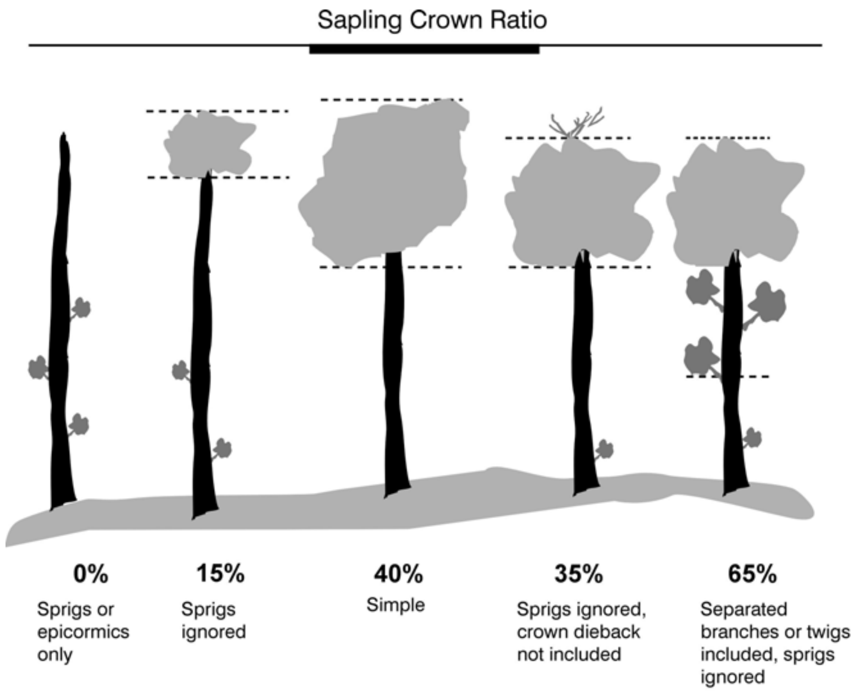


Figure 38. Sapling ratio determination examples.

When collected: Phase 2 (CORE OPTIONAL) – All live tally trees ≥ 5.0 in DBH/DRC
Phase 3 (CORE) – All live tally trees ≥ 1.0 in DBH/DRC
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 00 to 99 percent

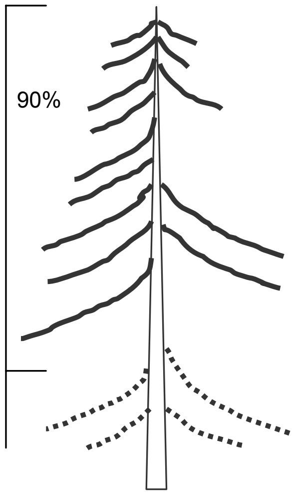
5.17 COMPACTED CROWN RATIO (CRC)

Record the COMPACTED CROWN RATIO for each live tally tree, 1.0 inch and larger, to the nearest one percent. COMPACTED CROWN RATIO is that portion of the tree supporting live foliage (or in the case of extreme defoliation should be supporting live foliage) and is expressed as a percentage of the actual tree length. To determine COMPACTED CROWN RATIO, ocularly transfer lower live branches to fill in large holes in the upper portion of the tree until a full, even crown is visualized.

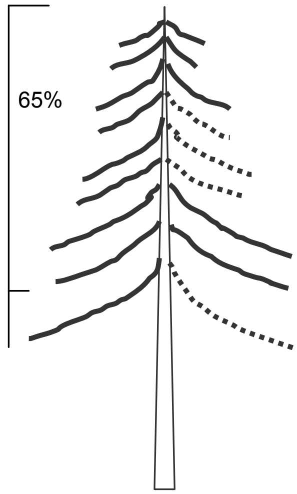
Do not over-compact trees beyond their typical full crown situation. For example, if tree branches tend to average 2 feet between whorls, do not compact crowns any tighter than the 2-foot spacing (Figure 39). Figure 40 shows an example of COMPACTED CROWN RATIO on a leaning tree.

Open-crown conifer (e.g., ponderosa pine) –

Uncompacted:

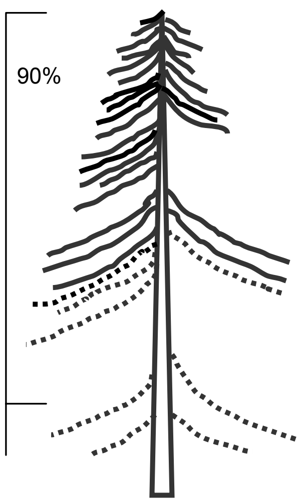


Compacted:



Dense-crown conifer (e.g., subalpine fir) –

Uncompacted:



Compacted:

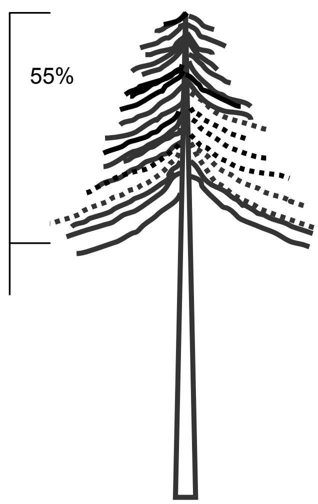


Figure 39. Examples of and comparison between COMPACTED LIVE CROWN RATIO and UNCOMPACTED LIVE CROWN RATIO of conifers.

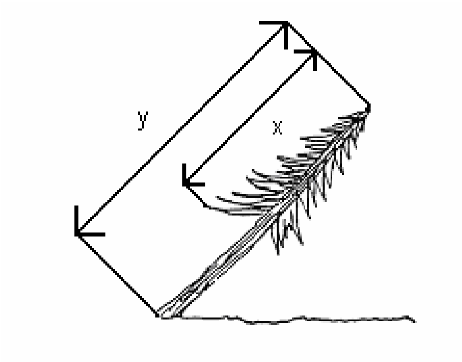


Figure 40. COMPACTED CROWN RATIO on a leaning tree. CROWN RATIO = (x/y)100.

For multi-stemmed western woodland species, ocularly transfer lower live foliage to fill large holes on all stems and form an even crown across the tree (Figure 41).

When Collected: All live tally trees $\geq$ 1.0 in DBH/DRC
Field width: 2 digits
Tolerance: +/- 10 %
MQO: At least 80% of the time
Values: 00 to 99

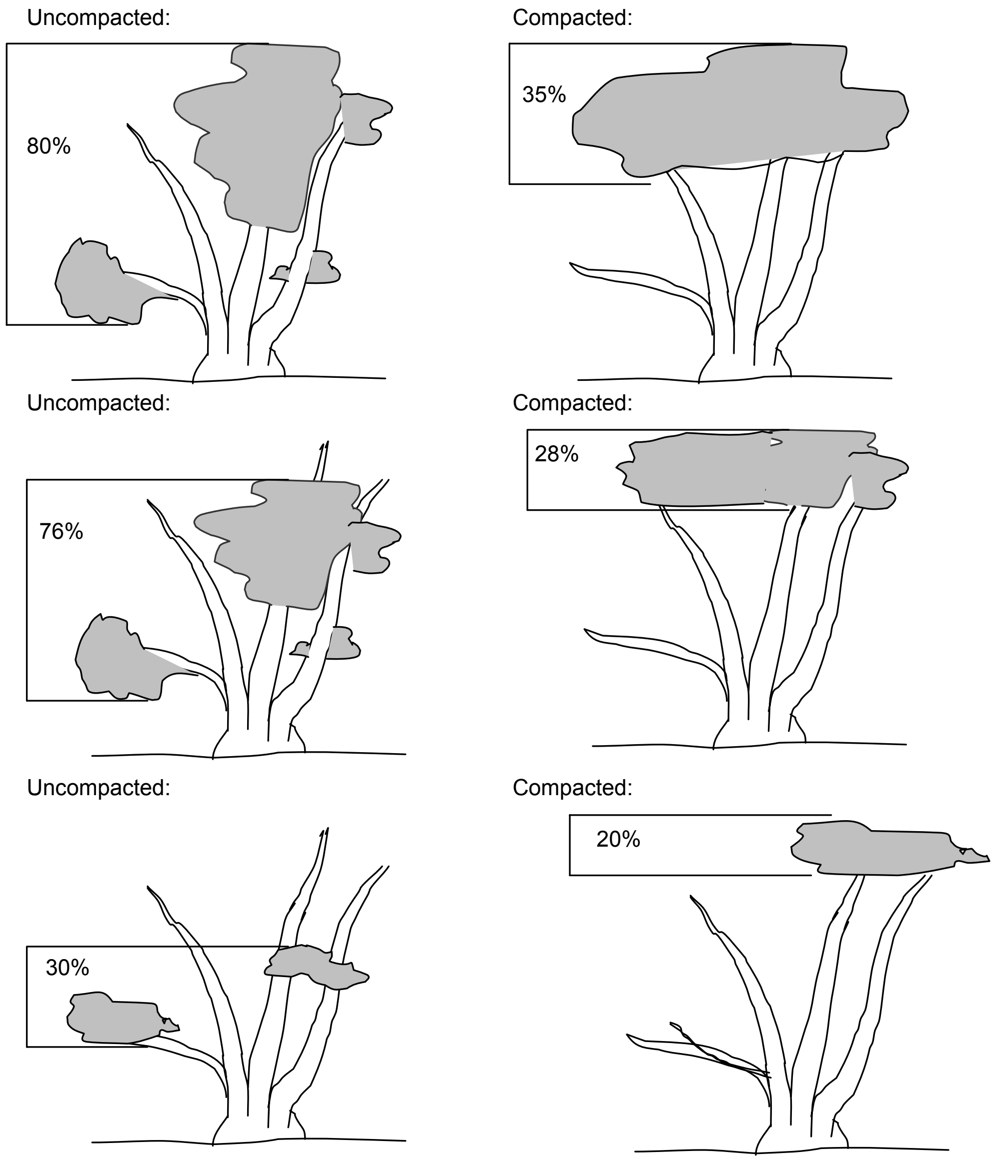


Figure 41. Examples of and comparison between COMPACTED LIVE CROWN RATIO and UNCOMPACTED LIVE CROWN RATIO of western woodland species.

5.18 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 5.18.3, 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 DAMAGE LOCATION 1-9, or record location code 0 (for no damage).

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.

5.18.1 DAMAGE LOCATION 1 (CORE OPTIONAL) **NC (CORE)** (LOC1)

Record the location on the tree where DAMAGE TYPE 1 is found (Figure 42). If the same damage continues into two or more locations, record the appropriate code, 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 43). 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 feet from the rest of the crown. See Section 5.16 (UNCOMPACTED LIVE CROWN RATIO) for more details.

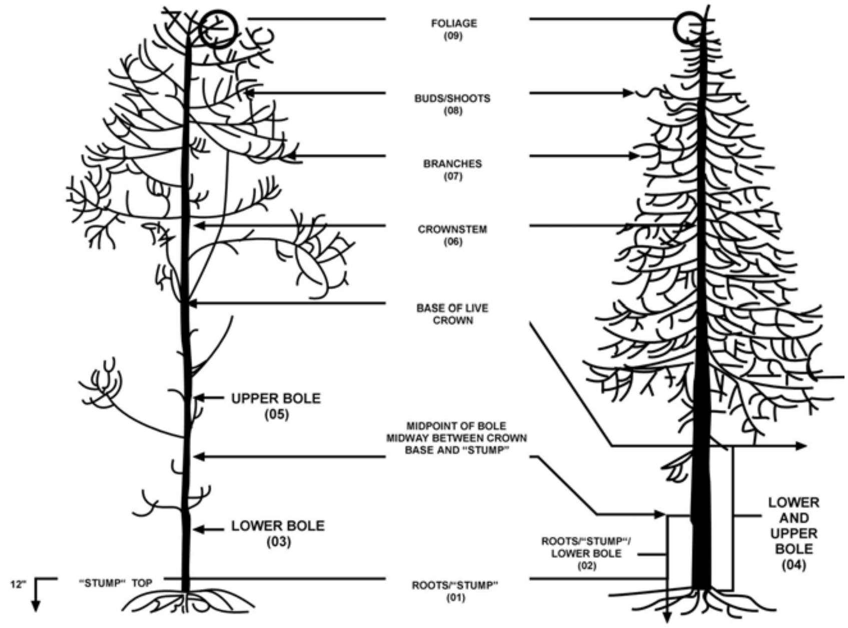


Figure 42. Location codes for damage.

When Collected: CORE OPTIONAL: All live tally trees ≥ 5.0 in DBH/DRC
CORE OPTIONAL: All live tally trees ≥ 1.0 in DBH/DRC
NC NOTE: Damage is collected in North Central FIA on all live tally trees ≥ 5.0 in DBH/DRC for subplots 1-4
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 inches, Location 1 should include the roots but stop where the branches originate, if that occurs below the 12-inch stump height. Any damage (open wound, etc.) found on a branch that originates below 12 inches 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

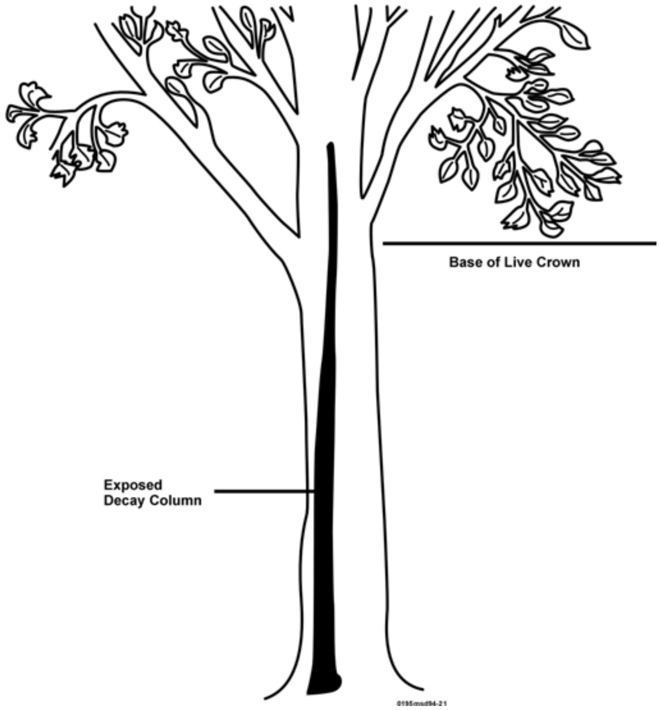


Figure 43. The damage runs from stump to crownstem. Code here should be 02 (roots and "stump" and lower bole) which represents the lowest locations of this multi-location damage.

5.18.2 DAMAGE TYPE 1 (CORE OPTIONAL) (DAM1)

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 feet. 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 feet from bole): Broken roots within 3 feet 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 feet): Roots beyond 3 feet 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 5.18.3, 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 feett from bole -- any occurrence
12 Brooms on roots or bole -- any occurrence.
13 Broken or dead roots -- exceeds 20% of roots, beyond 3 feet 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 feet from bole -- any occurrence
12 Brooms on roots or bole - -any occurrence.

13 Broken or dead roots -- exceeds 20% of roots, beyond 3 feet 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 feet 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.

5.18.3 DAMAGE SEVERITY 1 (CORE OPTIONAL) (SEV1)

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: + 1 valid class unless otherwise defined by the DAMAGE TYPE
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-foot 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 feet, respectively, must be affected, then record in 10% classes. See Figure 44.

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

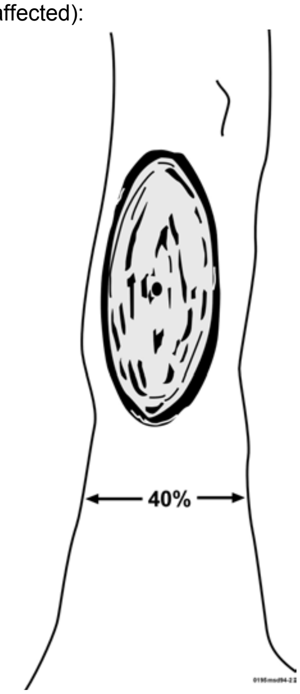


Figure 44. A canker which exceeds threshold. Since 40% of circumference is visible from any side, and since over half the visible side is taken up by the canker, it obviously exceeds the 20% minimum circumference threshold.

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 feet 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-foot 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 feet, respectively, must be affected. Then record in 10% classes. See Figure 45.

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

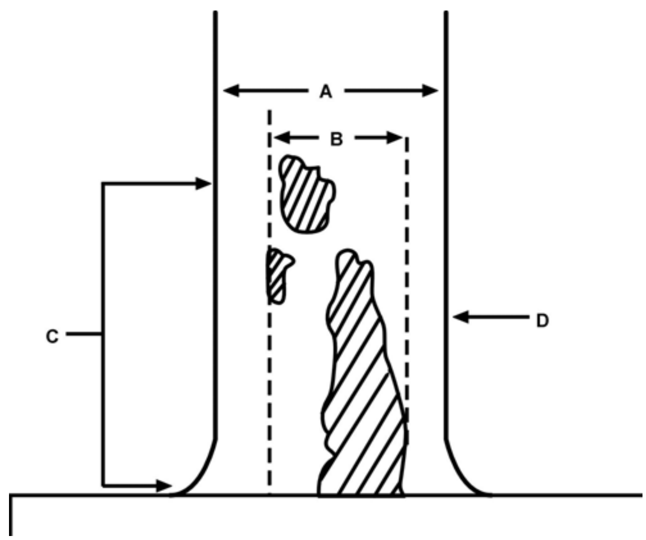


Figure 45. Multiple damage in "stump" and lower bole. A=approximately 40% of tree circumference; B=portion of tree circumference affected by damage; C=vertical distance within one meter; D=midpoint of occurence at which circumference is measured.

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 feet, 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 feet

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 feet, respectively, must be affected. Then record in 10% classes.

DAMAGE TYPE Code 11 -- Broken bole or roots less than 3 feet 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 feet 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 (> 1 inch 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

Severity classes for code 31:

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

Examples are shown in Figures 46-52.

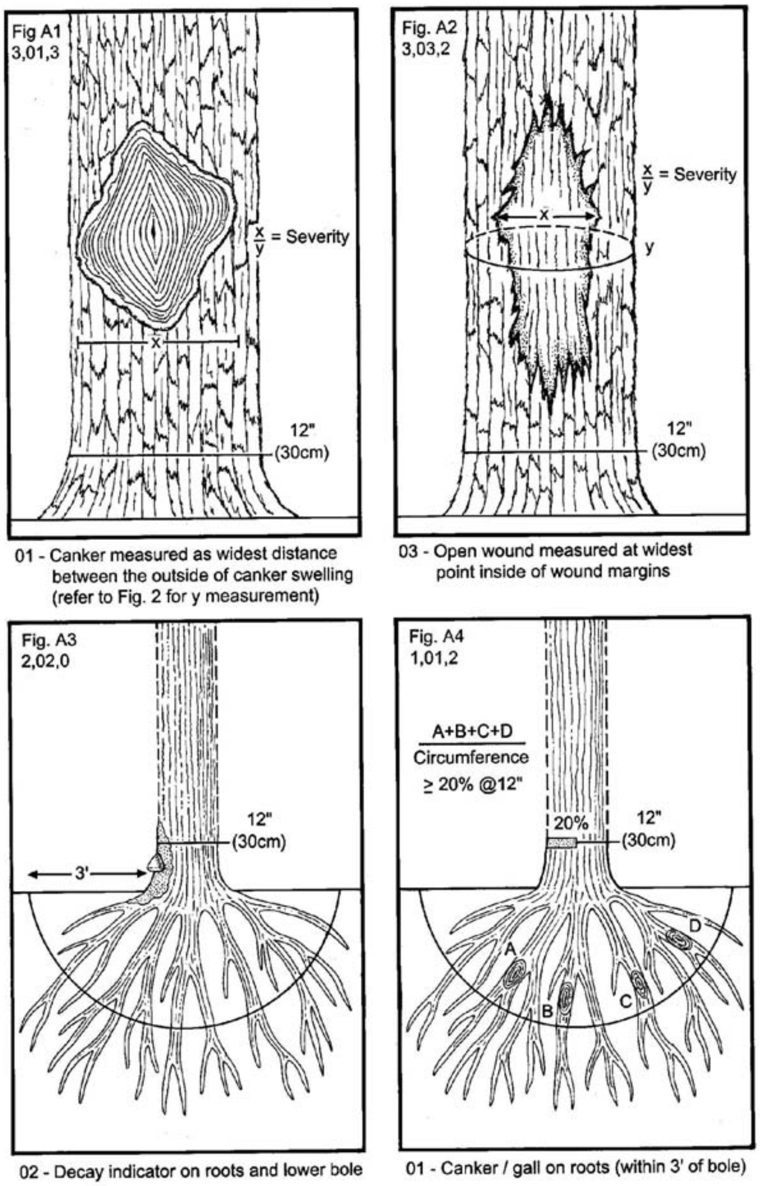


Figure 46. Examples of damage coding.

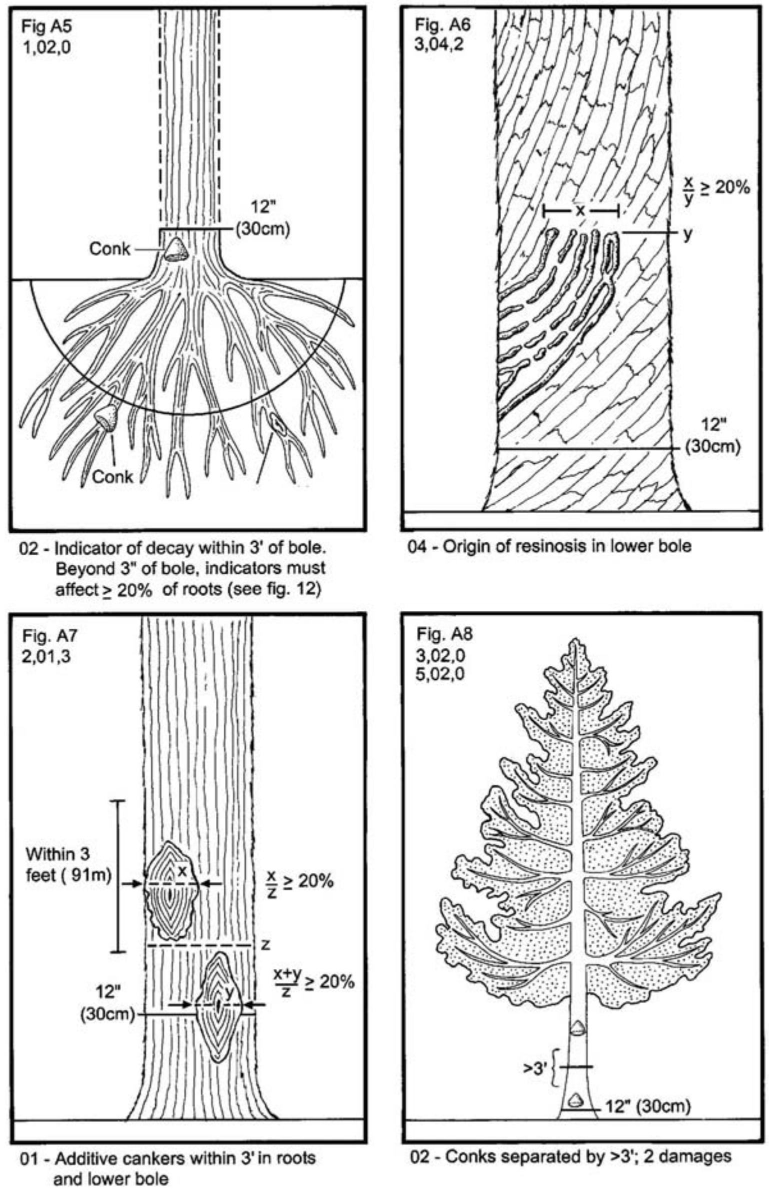
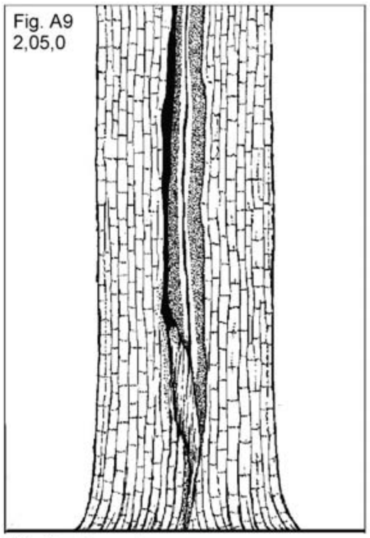
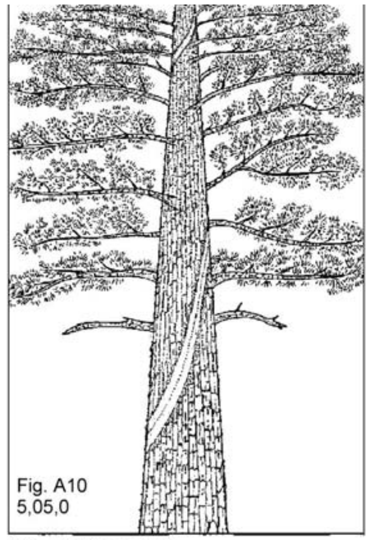


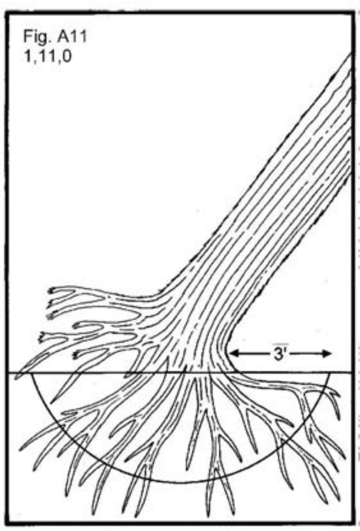
Figure 47. Examples of damage coding.



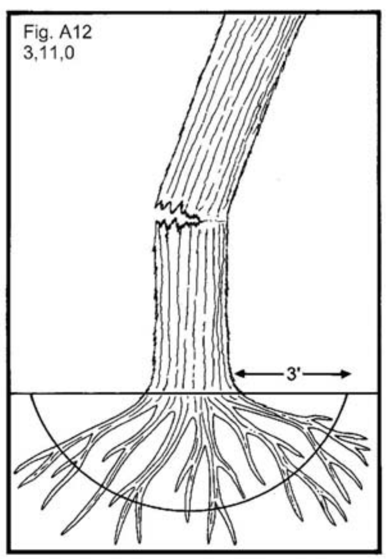
05- Cracks and seams



05 - Lightning strike

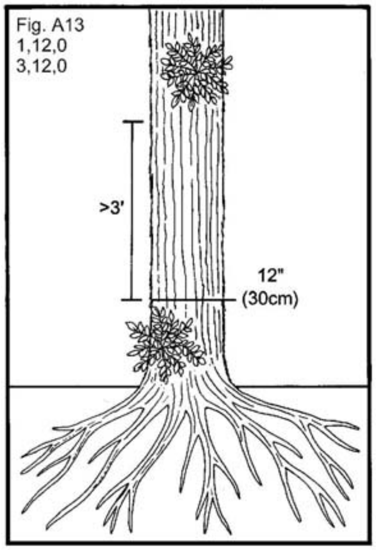


11 - Broken bole or roots <3' from bole, broken roots must be visible

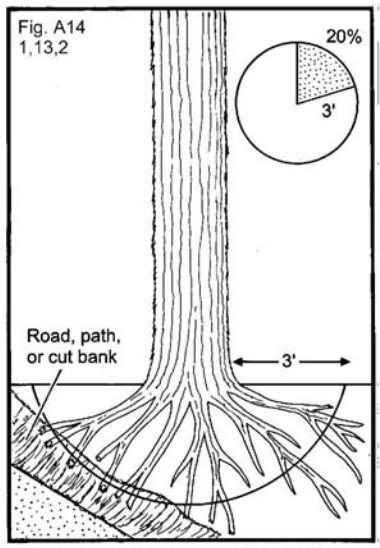


11 - Broken bole or roots <3' from bole

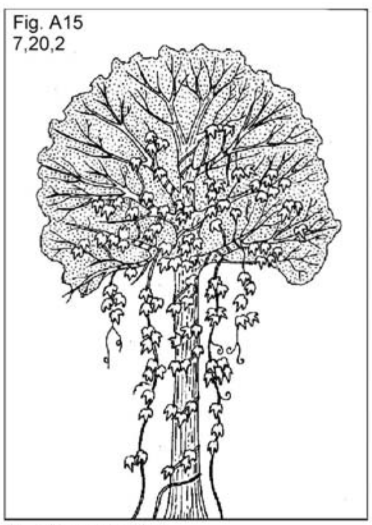
Figure 48. Examples of damage coding.



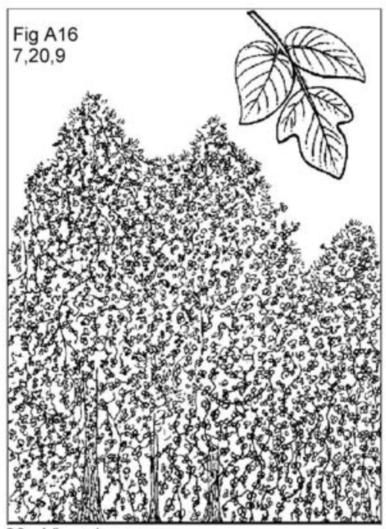
12 - Brooms on roots or bole



13 - Broken or dead roots >3' from bole



20 - Vines in crown



20 - Vines in crown

Figure 49. Examples of damage coding.

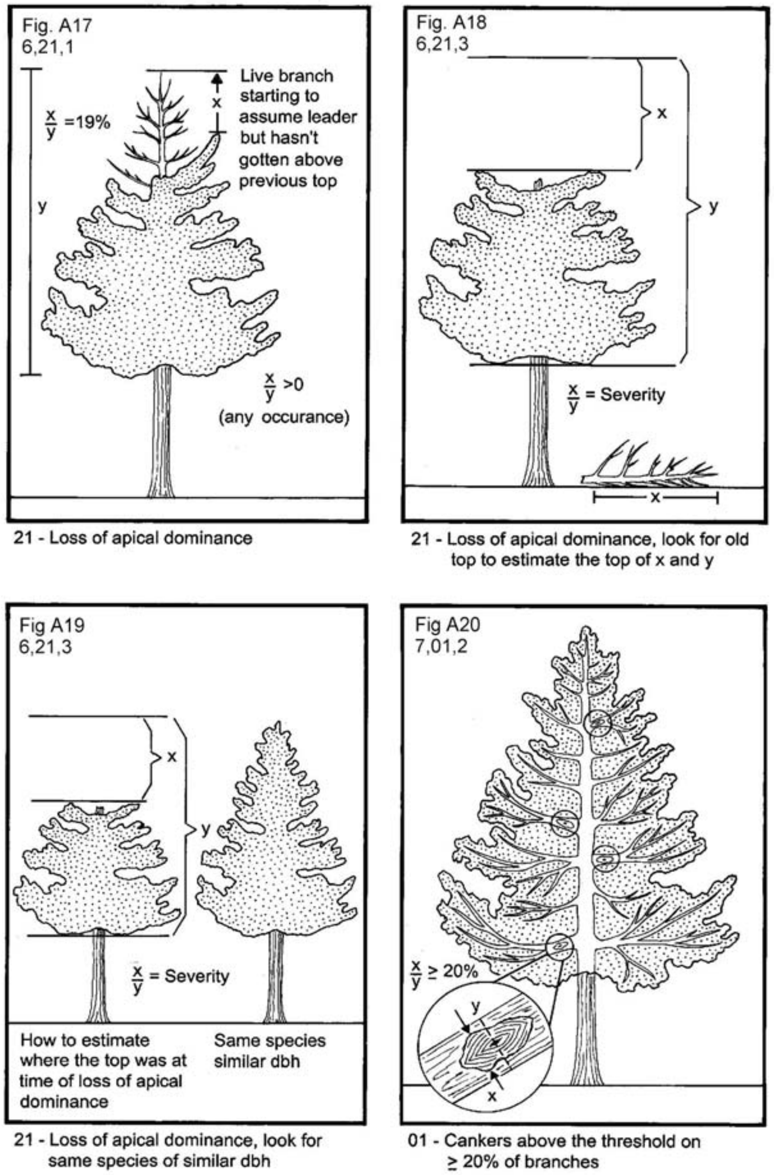
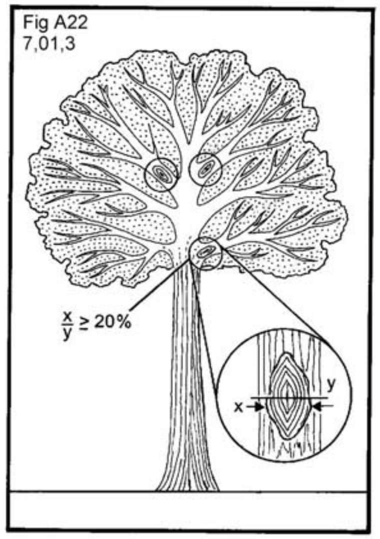
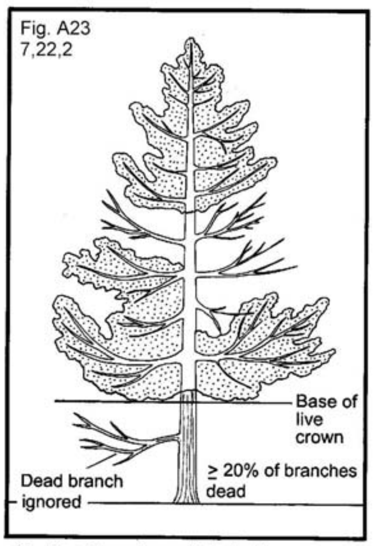


Figure 50. Examples of damage coding.

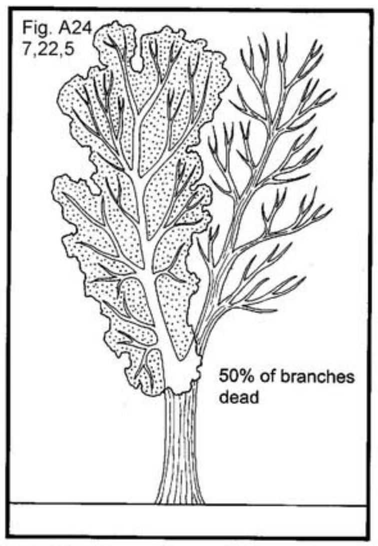
02 - Conks on ≥ 20% of branches



01 - Cankers above threshold on ≥ 20% of branches

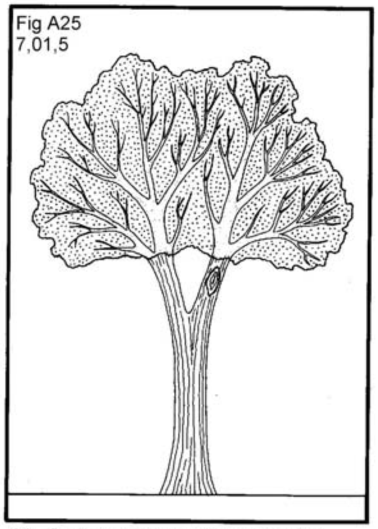


22 - Dead branches within the live crown area. If branches cannot easily be counted, estimate % area of live crown affected

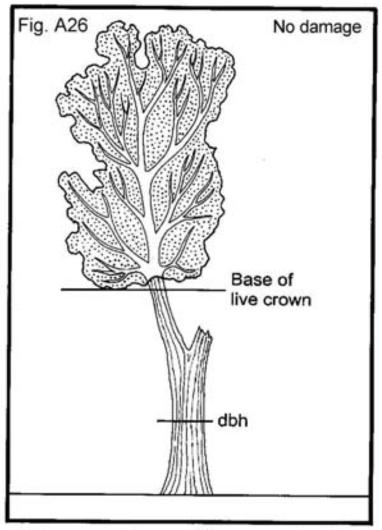


22 - Dead branches; only 2 branches present within live crown area, fines present and ≥ 20% of branch dead

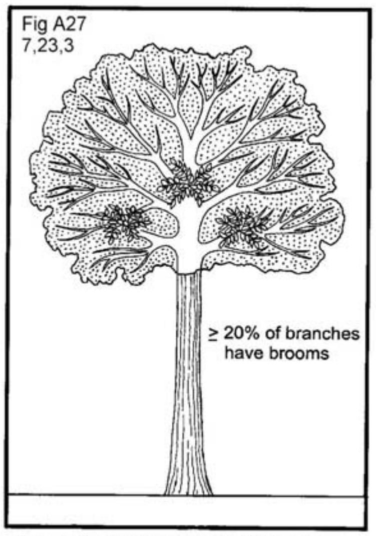
Figure 51. Examples of damage coding.



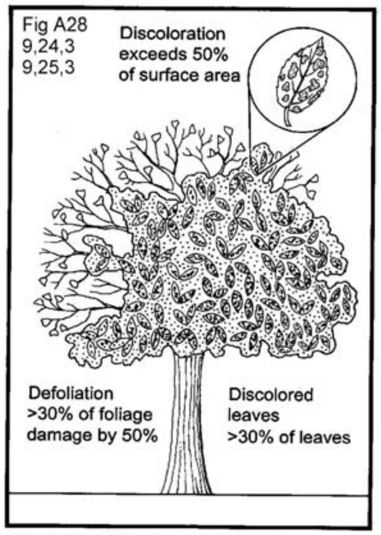
01 - Canker; no crown stem and only 2 branches present



No damage - base of live crown is above old fork, stub is a snag branch



23 - Excessive branching or brooms in crown



24 - Defoliation, 25 - Discoloration

Figure 52. 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-foot 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-foot 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-foot section (Figure 45).

Procedures to Measure Circumference Affected

A practical approach is to observe every face of the "stump", bole, or crownstem. About 40 percent 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-foot section exceeds 1/2 of any face, then the 20 percent minimum threshold has been met. The percent of the circumference affected by damage is then estimated in 10 percent 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.

5.18.4 DAMAGE LOCATION 2 (CORE OPTIONAL) (LOC2)

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

5.18.5 DAMAGE TYPE 2 (CORE OPTIONAL) (DAM2)

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.

5.18.6 DAMAGE SEVERITY 2 (CORE OPTIONAL) (SEV2)

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.

5.18NC NC DAMAGE AGENTS

5.18.1NC NC DAMAGE AGENTS STANDARD (NCD1,NCD2)

For each DAMAGE TYPE(DAM1,2) recorded, identify if available a causal agent from the Standard NC Damage Agent list. **Minnesota crews see codes under item number 5.18.2NC**.

When Collected: All live trees for each DAMAGE TYPE (DAM1, 2) recorded
Field width: 3 digit
Tolerance: No errors
MQO: None
Values: 000-909

Standard NC Damage Agent codes (all states except Minnesota)

CODE	DAMAGE OR DEATH	HOSTS
000	**Healthy**	**All species**
100	**Insect defoliators**	**All species**
113	Gypsy Moth	Hardwoods
130	**Shoot and Branch Insects**	**All species**
140	**Branch Gall Insects**	**All species**
150	**Bole Borers**	**All species**
170	**Bark Beetles**	**Conifers**
190	**Root/Root Collar Insects**	**Conifers**
200	**Foliage Diseases**	**All species**
210	**Shoot Blights**	**All Species**
220	**Mistletoe**	**Black spruce, White spruce, Tamarack, Jack pine**
240	**Bole Rusts**	**Pines**
250	**Bole Cankers**	**Hardwoods**
251	*Eutypella* Canker	Maple
252	*Hypoxylon* Canker	Aspens
254	*Nectria* Canker	Hardwoods
257	Butternut Canker	Butternut
260	**Stem Decay (heartrot)**	**All species**
271	Ash Yellows	Ashes
281	Dutch Elm Disease	Elms
282	Oak Wilt	Oaks
290	**Root/Butt Rot**	**All species**
291	*Annosus* Root Rot	Conifers
292	*Armillaria* Root Rot	All species
300	**Weather**	**All species**
400	**Animal Damage**	**All species**
500	**Fire**	**All species**
800	**Logging/TSI/Other human**	**All species**
860	**Chemical**	**All species**

5.18.2NC NC DAMAGE AGENTS MINNESOTA(NCD1,NCD2)

When collecting data in Minnesota use the list below for NCD1 and NCD2.

Minnesota Damage Agent List

NC Damage agent codes for Minnesota only		
CODE	DAMAGE OR DEATH	HOSTS
000	**Healthy**	**All species**
100	**Insect defoliators**	**All species**
101	Budworms	Balsam fir, White spruce, Black spruce, Jack pine
110	**Forest Tent Caterpillar**	**Hardwoods**
113	Gypsy Moth	Hardwoods
130	**Shoot and Branch Insects**	**All species**
131	White Pine Weevil	White pine, Jack pine, all spruces
140	**Branch Gall Insects**	**All species**

Minnesota damage agent list continued		
CODE	DAMAGE OR DEATH	HOSTS
150	**Bole Borers**	**All species**
170	**Bark Beetles**	**Conifers**
190	**Root/Root Collar Insects**	**Conifers**
200	**Foliage Diseases**	**All species**
210	**Shoot Blights**	**All Species**
212	*Scleroderris*	Pines
220	**Mistletoe**	**Black spruce, White spruce, Tamarack, Jack pine**
240	**Bole Rusts**	**Pines**
241	White Pine Blister Rust	White Pine
250	**Bole Cankers**	**Hardwoods**
251	*Eutypella* Canker	Maple
252	*Hypoxylon* Canker	Aspens
254	*Nectria* Canker	Hardwoods
257	Butternut Canker	Butternut
260	**Stem Decay (heartrot)**	**All species**
261	*Phellinus pini*	Conifers
262	*Phellinus tremulae*	Aspens
263	*Inonotus obliquus*	Birches
271	Ash Yellows	Ashes
281	Dutch Elm Disease	Elms
282	Oak Wilt	Oaks
290	**Root/Butt Rot**	**All species**
291	*Annosus* Root Rot	Conifers
292	*Armillaria* Root Rot	All species
300	**Weather**	**All species**
302	Wind	All species
307	Flooding	All species
309	Ice/Snow	All species
400	**Animal Damage**	All species
402	Moose/Elk/Deer	All species
404	Beaver	All species
409	Cattle/Domestic Livestock	All species
500	**Fire**	**All species**
800	**Logging/TSI/Other human**	**All species**
811	Imbedded objects - wire, nails	All species
850	**Land Use Conversion**	**All species**
860	**Chemical**	**All species**
900	**Unknown/uncoded Dead**	**All species**
901	Unknown/uncoded Defoliation	All species
902	Unknown/uncoded Discoloration	All species
903	Unknown/uncoded Decline/Dieback	All species
904	Unknown/uncoded Breakage	All species
905	Unknown/uncoded Abnormal Growth or Form in Crown	All species
906	Unknown/uncoded Canker	All species
907	Unknown/uncoded Crack	All species
908	Unknown/uncoded Abnormal Growth or Form on the Bole	All species

5.19 CAUSE OF DEATH (CAUS)

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/other.

When Collected: CORE: SAMPLE KIND = 2 plots: all PAST TREE STATUS = 1 and PRESENT TREE STATUS = 2 or 3; or PRESENT TREE STATUS = 2 and RECONCILE = 1, 2, or 3
CORE OPTIONAL: SAMPLE KIND = 1 plots; all MORTALITY = 1
NC Note: In addition to the core rule above all trees with Tree Status=2 on subplots 101 and higher.
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 - includes death from human activity not related to silvicultural or landclearing activity (accidental, random, etc.). TREE NOTES required.
80 Silvicultural or landclearing activity (death caused by harvesting or other silvicultural activity, including girdling, chaining, etc., or to landclearing activity)

5.20 MORTALITY YEAR (MOYR)

Record the estimated year that remeasured trees died or were cut. For each remeasured tree that has died or been cut since the previous inventory, record the 4-digit year in which the tree died. Mortality year is also recorded for trees on land that has been converted to a nonforest land use, if it can be determined that a tree died before the land was converted.

When Collected: Plots where SAMPLE KIND = 2: all PREVIOUS TREE STATUS = 1 and PRESENT TREE STATUS = 2 or 3; or PRESENT TREE STATUS = 2 and RECONCILE = 1, 2, or 3.
Field width: 4 digits
Tolerance: +/- 1 year for remeasurement cycles of 5 years
+/- 2 years for remeasurement cycles of > 5 years
MQO: At least 70% of the time
Values: 1995 or higher

5.21 DECAY CLASS (DECA)

Record for each standing dead tally tree, 5.0 inches in diameter and larger, the code indicating the tree's stage of decay.

When Collected: All standing dead tally trees ≥ 5.0 in DBH/DRC
NC Note: Not collected on subplots 101 – 105.
Field width: 1 digit
Tolerance: +/- 1 class
MQO: At least 90% of the time
Values: Use the following table for guidelines:

Decay class stage (code)	Limbs and branches	Top	% Bark Remaining	Sapwood presence and condition*	Heartwood condition*
1	All present	Pointed	100	Intact; sound, incipient decay, hard, original color	Sound, hard, original color
2	Few limbs, no fine branches	May be broken	Variable	Sloughing; advanced decay, fibrous, firm to soft, light brown	Sound at base, incipient decay in outer edge of upper bole, hard, light to reddish brown
3	Limb stubs only	Broken	Variable	Sloughing; fibrous, soft, light to reddish brown	Incipient decay at base, advanced decay throughout upper bole, fibrous, hard to firm, reddish brown
4	Few or no stubs	Broken	Variable	Sloughing; cubical, soft, reddish to dark brown	Advanced decay at base, sloughing from upper bole, fibrous to cubical, soft, dark reddish brown
5	None	Broken	Less than 20	Gone	Sloughing, cubical, soft, dark brown, OR fibrous, very soft, dark reddish brown, encased in hardened shell

*Characteristics are for Douglas-fir. Dead trees of other species may vary somewhat. Use this only as a guide.

5.22 LENGTH TO DIAMETER MEASUREMENT POINT (CORE OPTIONAL) (DIAH)

Record this item when tree diameter measurement locations are not monumented. For those trees measured directly at 4.5 feet above the ground, leave this item blank. If the diameter is not measured at 4.5 feet, record the actual length from the ground, to the nearest 0.1 inch, at which the diameter was measured for each tally tree, 1.0 inch DBH and larger. Leave this item blank for western woodland species measured for diameter at root collar.

When Collected: CORE OPTIONAL: All live and dead tally trees (except western woodland species) ≥ 1.0 in DBH
NC Note: All live and dead tally trees (when not at 4.5 ft) ≥ 1.0 in DBH
Field width: 3 digits
Tolerance: +/- 0.2 ft
MQO: At least 90% of the time
Values: 00.1 – 15.0

5.23 ROUGH CULL (CORE OPTIONAL)

For each live tally tree 5.0 inches DBH/DRC and larger, record the total percentage of cubic-foot volume that is cull due to sound dead material or tree form. Record to the nearest 1 percent. When estimating volume loss (tree cull), only consider the cull on the merchantable bole/portion of the tree, from a 1-foot stump to a 4-inch top.

For western woodland species, the merchantable portion is between the point of DRC measurement to a 1.5-inch DOB top, and rough cull includes only sound dead.

Refer to local defect guidelines as an aid in determining cull volume for various damages such as crook, fork, sweep, pistol butt, etc. Small trees (5-9 inches for softwoods and 5-11 inches for hardwoods) that have poor form and are not expected to ever produce merchantable material should be coded 99% rough cull.

When Collected: CORE OPTIONAL: All live tally trees $\geq$ 5.0 in DBH/DRC
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 00 to 99

5.24 MISTLETOE CLASS (CORE OPTIONAL)

Rate all live conifer species, except juniper species, greater than or equal to 1.0 inch diameter for dwarf mistletoe (*Arceuthobium* spp.) infection. Use the Hawksworth six-class rating system: divide the live crown into thirds, and rate each third using the following scale (Figure 53):

0 No visible infection
1 Light infection -- < 50 percent of the total branches infected
2 Heavy infection -- > 50 percent of the total branches infected

Sum the three individual ratings to obtain and record a total mistletoe class (0 to 6) for the tree.

When Collected: CORE OPTIONAL: All live conifer (except juniper) tally trees $\geq$ 1.0 in DBH/DRC
Field width: 1 digit
Tolerance: +/- 1 class
MQO: At least 90% of the time
Values: 0 to 6

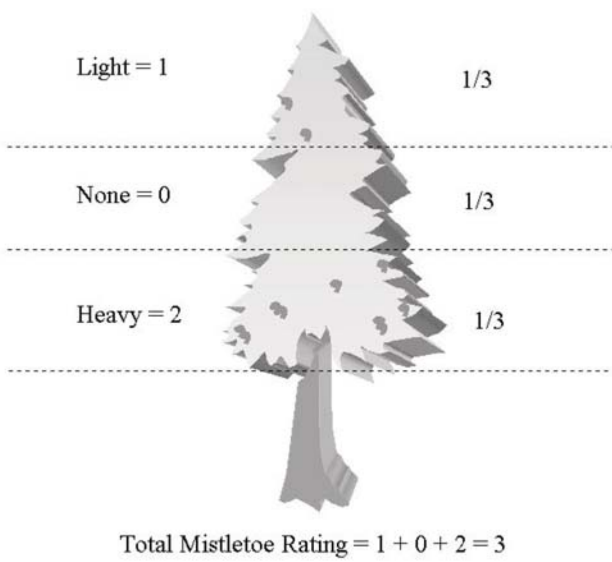


Figure 53. Example of the Hawksworth six-class rating system.

5.25 TREE NOTES

Record notes pertaining to an individual tree as called for to explain or describe another variable.

When collected: All trees
Field width: Alphanumeric character field
Tolerance: N/A
MQO: N/A
Values: English language words, phrases and numbers

5.26NC NC BALSAM FIR BOUGHS

There is an increasing interest in the collection of balsam boughs for the manufacture of evergreen products. The information collected will be available to assess the health and sustainability of the balsam bough resource in the region.

5.26.1NC NC BOUGHS AVAILABLE (BAVA)

Record the code for all live Balsam Fir (0012) ≥ 1.0 in DBH that describes if harvestable boughs are present.

Branches in the bottom 7.5 feet of the tree
At least one branch no larger in diameter than a pencil where clipped
At least 18 inches in length with live needles

When collected: All species 0012 trees ≥ 1.0 DBH on subplots 1-4 only
Field width: 1 digit
Tolerance: No errors
MQO: At least 80% of the time
Values:

0 No boughs available
1 Boughs available

5.26.2NC NC BALSAM BOUGHS HARVESTED (BHAR)

Record the code for all live Balsam Fir (0012) ≥ 1.0 in DBH that describes whether Balsam Boughs have been harvested or not.

When collected: All species 0012 trees ≥ 1.0 DBH on subplots 1-4 only
Field width: 1 digit
Tolerance: No errors
MQO: At least 80% of the time
Values:

0 Boughs have not been harvested
1 Boughs have been harvested

5.26.3NC NC BOUGH HARVESTING GUIDELINES (GUID)

Record the code for all live Balsam Fir ≥ 1.0 in DBH that have had Balsam Bough harvesting, whether Standard Balsam Bough Harvesting Guidelines have been used.

Branches cut were no larger in diameter than a pencil
Part of the cut branches were left for growth and regeneration
On smaller trees at least 50% of the trees limbs were left in the upper portion of the tree

When collected: When BALSAM BOUGHS HARVESTED=1
Field width: 1 digit
Tolerance: No errors
MQO: At least 80% of the time
Values:

0	Guidelines not used
1	Guidelines used

5.27NC NC PAPER BIRCH BARK CHARACTERISTICS

The Anishinaabe (also referred to as the Ojibwe and Chippewa) use the outer bark of the paper birch (*Betula papyrifera*) for many different purposes. Tribal members who use or have used birch bark have said that the different characteristics of birch bark determine its eventual use (baskets, canoes, shelter, etc.).

The full document on the development and methods of these data elements was done by: Great Lakes Indian Fish & Wildlife Commission, Biological Services Division, P. O. Box 9, Odanah, WI 54861. See appendix 11 for more information.

The primary objective of this protocol is to acquire information on the status, abundance, and distribution of an important special forest product, birch bark, harvested by tribal members and non-Indians alike. As the stature of special forest products continues to increase, inventory and monitoring of these products may become necessary to promote sustainable harvest.

This protocol was developed with the following considerations:

1. Maximize usefulness by consulting with tribal harvesters. Six tribal members were interviewed on twenty separate occasions to identify the birch characteristics used most often to select the bark to be harvested. The tribal members are members of different Ojibwe bands and gather birch bark for a variety of purposes.

2. Maximize objectivity of birch bark assessments. Identified birch characteristics had to be described and categorized to ensure that the developed assessment methodology could be easily replicated by new field technicians with minimal training.

3. Maximize integration with previously established Forest Inventory and Analysis (FIA) protocols. The birch assessment was designed to be easily incorporated into existing methodology to minimize additional labor and time.

DATA ELEMENTS
See the color copies of the trees for examples of each data element (separate item handed out at training). This data is collected on two sections of the tree:

- Lower– 4.0 feet to 8.0 feet from the ground
- Upper – 8.0 feet to 16.0 feet from the ground

5.27.1NC NC LOWER TRUNK CURVATURE (LTRU)

Trunk curvature refers to the relative straightness of the tree trunk in the lower bole (4.0 feet – 8.0 feet from the ground).

When collected: All live or dead Paper Birch (0375) ≥5.0” dbh on subplots 1 – 4 only.
Field width: 1 digit

Tolerance: No errors
MQO: At least 99% of the time
Values:

0 – no curvature
1 – moderate curvature
2 – extreme curvature

5.27.2NC NC LOWER BARK HARVESTED (LHAR)

Trees from which bark has been harvested are recorded by using codes defining a range of years since past harvest. For the area on the trunk Lower– 4.0 feet to 8.0 feet from the ground where past harvest has occurred complete only this section.

<u>Less than one year since harvest</u>: The color of the outermost layer of the second growth bark (*L1 bark*) varies from tan on a freshly peeled tree, aging to a dark brown. Cracks begin to form on the dark brown *L1 bark*.

<u>One year to less than three years since harvest</u>: *L1 bark* color is dark brown to blackish. Cracks deepen, with some *L1 bark* pieces beginning to fall off exposing the next layer of the second growth bark (*L2 bark*)

<u>Three years to less than six years since harvest</u>: *L1 bark* color is dark brown to blackish. More *L1 bark* pieces falling off with over 25% and less than 75% of *L2 bark* exposed.

<u>Six years to less than ten years since harvest</u>: Over 75% of *L2 bark* exposed. *L2 bark* color is brownish-grey to light grey.

<u>Ten years and over since harvest</u>: *L1 bark* no longer or minimally present. *L2 bark* color is dark grey to light grey, often cracked and sometimes exfoliating.

Choose the most resent harvest category.

When collected: All live or dead Paper Birch (0375) ≥5.0" dbh on subplots 1 – 4 only
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0 – No bark harvest
1 – < 1 year
2 – 1 year and <3 years
3 – 3 years and <6 years
4 – 6 years and <10 years
5 – >10 years

5.27.3NC NC LOWER SURFACE FEATURES (LSUR)

Record any or all of the surface features present in the lower bole (4.0 feet – 8.0 feet from the ground) on all paper birch trees that are at least 5.0 inches in diameter. See each item for more description of the features. Some of the items describe coarseness of the surface bark and some are just features on the bark that are not considered coarseness.

Record all that are present on the tree, there are no severity limits.

When collected: All live or dead Paper Birch (0375) ≥5.0" dbh on subplots 1 – 4 when LOWER BARK HARVESTED = 0

Field width: 6 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:
Bark features

1 – Lichens and Moss	If any of these are present record this code.
2 – Branching	Branching refers to the presence of lateral stems, regardless if the stems are alive or dead.

Coarse bark features

3 – Coarse lenticels	Lenticels are structurally different portions of the bark where gaseous exchange occurs. Dominant lenticel characteristics are determined for those lenticels that comprise the area of rough texture on the bark.
4 – Branch Scars	Branch scars refers to the presence of any characteristic bark texture indicating the former location of branching stems.
5 – Blemishes	Blemishes include any compromises to the integrity of the bark. The blemishes can be formed by the tree itself, animals, attempted bark harvest, or vandalism. Vandalism is any wound that appears to be caused by human that is not attempted bark harvest.
6 – Fungus	Fungus includes all species of stem cankers and conks.

5.27.4NC NC LOWER BARK CHARATER (LCHA)

Use the first digit to describe the bark texture and the second digit to describe the amount of exfoliation bark in the lower bole (4.0 feet – 8.0 feet from the ground).

Bark Texture
Bark texture ranges from smooth to rough. Roughness is caused by various bark characteristics including lenticels, branch scars and wounds. Lichens and moss are not considered as part of bark texture. Bark texture is recorded using codes defining the percentage of rough bark around the trunk circumference.

Exfoliating Bark
Exfoliating bark refers the presence of peeling or shedding bark characteristic to paper birch around the entire trunk circumference

The following codes 1-4 are used to record the percent of either rough bark or percent of exfoliating bark present or both in this section of the bole.
1 – 0-25%
2 – 26-50/%
3 – 51-75%
4 – 76-100%

When collected: All live or dead Paper Birch (0375) ≥5.0” dbh on subplots 1 – 4 when LOWER BARK HARVESTED = 0
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time

Values:
First digit:(Bark Texture):
Second digit: (Exfoliating Bark)

1 – 0-25%
2 – 26-50/%
3 – 51-75%
4 – 76-100%

5.27.5NC NC UPPER TRUNK CURVATURE (UTRU)
Trunk curvature refers to the relative straightness of the tree trunk.

When collected: All live or dead Paper Birch (0375) ≥5.0” dbh on subplots 1 – 4 only.
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0 – no curvature
1 – moderate curvature
2 – extreme curvature

5.27.6NC NC UPPER BARK HARVESTED (UHAR)
Trees from which bark has been harvested are recorded by using codes defining a range of years since past harvest. For the area on the trunk (lower and/or upper) where past harvest has occurred complete only this section.
Less than one year since harvest: The color of the outermost layer of the second growth bark (*L1 bark*) varies from tan on a freshly peeled tree, aging to a dark brown. Cracks begin to form on the dark brown *L1 bark*.

One year to less than three years since harvest: *L1 bark* color is dark brown to blackish. Cracks deepen, with some *L1 bark* pieces beginning to fall off exposing the next layer of the second growth bark (*L2 bark*)

Three years to less than six years since harvest: *L1 bark* color is dark brown to blackish. More *L1 bark* pieces falling off with over 25% and less than 75% of *L2 bark* exposed.

Six years to less than ten years since harvest: Over 75% of *L2 bark* exposed. *L2 bark* color is brownish-grey to light grey.

Ten years and over since harvest: *L1 bark* no longer or minimally present. *L2 bark* color is dark grey to light grey, often cracked and sometimes exfoliating.

Choose the most resent harvest category.

When collected: : All live or dead Paper Birch (0375) ≥5.0” dbh on subplots 1 – 4 only

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

0 – No bark harvest
1 – < 1 year
2 – 1 year and <3 years
3 – 3 years and <6 years
4 – 6 years and <10 years
5 – >10 years

5.27.7NC NC UPPER SURFACE FEATURES (USUR)

Record any or all of the surface features present on all paper birch trees that are at least 5.0 inches in diameter. See each item for more description of the features. Some of the items describe coarseness of the surface bark and some are just features on the bark that are not considered coarseness.

List all present on the tree bole: Upper – 8.0 feet to 16.0 feet from the ground.

When collected: All live or dead Paper Birch (0375) ≥5.0” dbh on subplots 1 – 4 when UPPER BARK HARVESTED = 0
Field width: 6 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

Bark features

1 – Lichens and Moss	If any of these are present record this code.
2 – Branching -	Branching refers to the presence of lateral stems, regardless if the stems are alive or dead.

Coarse bark features

3 – Coarse lenticels	Lenticels are structurally different portions of the bark where gaseous exchange occurs. Dominant lenticel characteristics are determined for those lenticels that comprise the area of rough texture on the bark.
4 –- Branch Scars	Branch scars refers to the presence of any characteristic bark texture indicating the former location of branching stems.
5 – Blemishes	Blemishes include any compromises to the integrity of the bark. The blemishes can be formed by the tree itself, animals, attempted bark harvest, or vandalism. Vandalism is any wound that appears to be caused by human that is not attempted bark harvest.
6 – Fungus	Fungus includes all species of stem cankers and conks.

5.27.8NC NC UPPER BARK CHARATER (UCHA)

Use the first digit to describe the bark texture and the second digit to describe the amount of exfoliation bark.

Bark Texture

Bark texture ranges from smooth to rough. Roughness is caused by various bark characteristics including lenticels, branch scars and wounds. Lichens and moss are not considered as part of bark texture. Bark texture is recorded using codes defining the percentage of rough bark around the trunk circumference.

Exfoliating Bark
Exfoliating bark refers the presence of peeling or shedding bark characteristic to paper birch around the entire trunk circumference

The following codes 1-4 are used to record the percent of either rough bark or percent of exfoliating bark present or both in this section of the bole.

1 - 0-25% rough or exfoliating
2 - 26-50/% rough or exfoliating
3 - 51-75% rough or exfoliating
4 - 76-100% rough or exfoliating

When collected: All live or dead Paper Birch (0375) ≥5.0" dbh on subplots 1 – 4 when UPPER BARK HARVESTED = 0
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:
First digit: (Bark Texture):
Second digit: (Exfoliating Bark)
1 - 0-25%
2 - 26-50/%
3 - 51-75%
4 - 76-100%

6.0 SEEDLING DATA

Stocking and regeneration information are obtained by counting live seedlings within the 6.8-foot radius microplot located 90 degrees and 12.0 feet from each subplot center within each of the four subplots. Conifer seedlings must be at least 6.0 inches in length and less than 1.0 inch at DBH/DRC in order to qualify for tallying. Hardwood seedlings must be at least 12.0 inches in length and less than 1.0 inch at DBH/DRC in order to qualify for tallying. For western woodland species, each stem on a single tree must be less than 1.0 inch in DRC. Seedlings are counted in groups by species and condition class, up to five individuals per species. Counts beyond five estimated. Only count seedlings occurring in accessible forest land condition classes.

6.1 SUBPLOT NUMBER

Use the procedures outlined in Section 3.1.

When Collected: All counts of seedlings

6.2 SPECIES (SPP)

Use the procedures outlined in Section 5.8.

When Collected: All counts of seedlings
Field width: 4 digits
Tolerance: No errors for genus, no errors for species
MQO: At least 90% of the time for genus, at least 85% of the time for species
Values: See Appendix 3

6.3 CONDITION CLASS NUMBER (CON#)

Use the procedures outlined in Section 2.0.

When Collected: All counts of seedlings

6.4 SEEDLING COUNT (SED#)

On each microplot, record the number of live tally tree seedlings, by species and condition class. Count up to five individuals by species: estimate the total count if there are more than five individuals of any given species in any given condition class. When seedlings are distributed evenly on a microplot, a suggested method of estimating is to count the number of seedlings on one quarter of the microplot and multiply by four (given that there is only one condition class on the microplot). Repeat for each species. Conifer seedlings must be at least 6.0 inches in length and less than 1.0 inch at DBH to qualify for counting. Hardwood seedlings must be at least 12.0 inches in length and less than 1.0 inch at DBH in order to qualify for counting.

For western woodland species, each stem on a single tree must be less than 1.0 inch at DRC.

Multiple “suckers” that originate from the same location, and stump sprouts are considered one seedling. Do not tally or count “layers” (undetached branches partially or completely covered by soil, usually at the base) as seedlings. Do not tally any seedlings that sprout from a live tally tree.

When Collected: Each accessible forest land condition class on each microplot
Field width: 3 digits
Tolerance: No errors for 5 or less per species; +/- 20% over a count of 5
MQO: At least 90% of the time
Values: 001 through 999

7.0 SITE TREE INFORMATION

Site trees are a measure of site productivity expressed by the height to age relationship of dominant and co-dominant trees. If suitable site trees are available, site tree data are required for every accessible forest land condition class defined on a plot. An individual site tree may be used for more than one condition class where differences in condition classes are not the result of differences in site productivity. For example, when different condition classes are caused solely due to differences in reserved status, owner class, and/or disturbance-related differences in density (e.g., heavily thinned vs. unthinned), a site tree may be used for more than one condition class. When in doubt, do not use a site tree for more than one condition class.

7.1 SITE TREE SELECTION

Select at least one* site tree for each accessible forest land condition class; select site tree based on the criteria listed in Appendix 4. Use only trees that have remained in a dominant or co-dominant crown position throughout their entire life span. If possible, trees should be 5.0 inches in diameter, or larger, and at least 20 years old. Trees that are visibly damaged, trees with ring patterns that exhibit signs of suppression, and trees with rotten cores should be rejected. If there are no acceptable site trees, record that in the plot notes and leave this section blank.

***NC Note:** The requirement in the North Central FIA region is for 2 site trees to be collected for each accessible forest land condition. The same trees may be used for more than one condition, when appropriate. Use only tree species that are listed in Appendix 4 as having a curve for the North Central region. If the original site trees listed on the new plot sheet are found and still sound as site trees please reuse these and update the information for them. If no site trees are available but the forest type is Red or southern pines you may use the growth intercept method. If no site trees are available and growth intercept is not an option leave site tree information blank.

7.2 SITE TREE DATA VARIABLES

7.211NC NCTREE RECORD NUMBER (TR#)

Record a code to uniquely and permanently identify each tree. Find any old site trees that are listed on the plot sheet if possible and still usable. Assign them TREE RECORD NUMBER using the next available tree. These trees will keep this new tree number in the next re-measurent.

7.2.10NC NC SITE INDEX METHOD (NCSI)

Suitable site trees may not be available. When this occurs there is a still need to know something about the site.

When code 2 is used the only data needed on the site record are NC site index method (NCSI), NC field site index (SITR), Condition Class List (CONL), species (SPP).

When Collected: All plots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 Site tree collected
2 Intercept method

<u>GROWTH INTERCEPT METHOD</u> In the event suitable trees are not available for use with site index curves the growth intercept method of measuring site index may be an alternative. This

method has been proposed and tables developed for some tree species that have limbs showing distinct annual whorls (ex. Red pine and southern pines). This method is applied in situations where only young trees (less than 25 year old) of these species are available for site index indicators.

Growth Intercept
For red Pine:

Height growth during Last 5 years	Site Index (estimated)
4 feet	46
5 feet	50
6 feet	53
7 feet	57
8 feet	60
9 feet	63
10 feet	67
11 feet	70
12 feet	74

7.2.11NC NC FIELD SITE INDEX (SITR)

Record the site index for a selected tree species. Using provided site index curves.

When Collected: Only when NC Site Index Method is 2
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000 to 999

7.2.1 CONDITION CLASS LIST (CONL)

List all CONDITION CLASSES that the site index data from this tree represent.

When Collected: All site trees
Field width: 5 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9 or 10000 to 98765

7.2.2 SPECIES (SPP)

Use the same procedures described in Section 5.8 (Appendix 4 lists preferred site tree species by region).

When Collected: All site trees

7.2.3 DIAMETER (DBH)

Use the same procedures described in Section 5.9.

When Collected: All site trees

7.2.4 SITE TREE LENGTH (HGHT)

With a clinometer or other approved instrument, measure the total length of the site tree from the ground to the top of the tree. Record to the nearest 1.0 foot. SITE TREE LENGTH must be measured; no estimates are permitted on site trees.

When Collected: All site trees
Field width: 3 digits
Tolerance: +/- 10% of true length
MQO: At least 90% of the time
Values: 005 to 999

7.2.5 TREE AGE AT DIAMETER (AGE)

Record the tree age as determined by an increment sample. Bore the tree at the point of diameter measurement (DBH/DRC) with an increment borer. Count the rings between the outside edge of the core and the pith. Do not add years to get total age.

When Collected: All site trees
Field width: 3 digits
Tolerance: +/- 5 years
MQO: At least 95% of the time
Values: 001 to 999

7.2.6 SITE TREE NOTES

Record notes pertaining to an individual site tree.

When collected: All site trees as necessary
Field width: alphanumeric character field
MQO: N/A
Values: English language words, phrases and numbers

7.2.7 SUBPLOT NUMBER (CORE OPTIONAL) (SUB#)

Record the subplot number to which the site tree is referenced.

When Collected: All site trees **NC Note:** All site trees
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

7.2.8 AZIMUTH (CORE OPTIONAL) (AZM)

Record the AZIMUTH from the subplot center; 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 site trees **NC Note:** All site trees
Field width: 3 digits

Tolerance: +/- 10 degrees
MQO: At least 90% of the time
Values: 001 to 360

7.2.9 HORIZONTAL DISTANCE (CORE OPTIONAL) (DIST)

Record the measured HORIZONTAL DISTANCE, to the nearest 0.1 foot, from the subplot center to the pith of the tree at the base.

When Collected: All site trees **NC Note:** All site trees
Field width: 4 digits (xxx.y)
Tolerance: +/- 5 ft
MQO: At least 90% of the time
Values: 0001 to 2000

8.0 NONFOREST/NONSAMPLED PLOTS

8.1 OVERVIEW

This section describes field procedures for attempted, field-visited nonforest/nonsampled plots. These plots are of interest from the standpoint that they may once have been forest, or that they may revert to forest or become accessible in the future. Thus, they are monitored to account for lands that move into and out of the forest land base. Only basic plot identification data are recorded on these plots.

A plot is considered nonforest if no part of it is currently located in forest land (CONDITION CLASS STATUS = 1). A plot is nonsampled if the entire plot is not sampled for one of the reasons listed in PLOT NONSAMPLED REASON.

If a forest plot has been converted to nonforest or becomes a nonsampled plot, the previous data are reconciled and an attempt is made to visit the plot during the next inventory. If a nonforest plot becomes forest or access is gained to a previously nonsampled plot, a new forest ground plot is installed. All nonforest and nonsampled plots are visited if there is any reasonable chance that they might include some forest land condition class.

NC Note: All nonforest plots (all 4 subplots have no forested condition) will be monumented with a metal pin when the forest-nonforest call was made due to the stocking level (number of trees in the acre.)

NC Note: All plots Nonforest plots require a Starting Point and Starting Point description filled out on the field plot sheet and in the data recorder.

8.2 PROCEDURE

Trees on previously forest land plots will be reconciled during data processing. There is a distinction between plots that have been clearcut, and plots that have been converted to another land use. A clearcut plot is considered to be forest land until it is actively converted to another land use. The procedures in this section do not apply to clearcuts unless and until the land is converted to a nonforest use. Additional information concerning land use classifications is contained in Section 2.3.

In cases where a plot is inaccessible, but obviously contains no forest land, record PLOT STATUS = 2. In cases where a plot is access-denied or hazardous land use and has the possibility of forest, record PLOT STATUS = 3.

8.3 DATA RECORDED

8.3.21NC NC CYCLE (CYCL)
This is the number assigned by state for each group of 5 panels which will complete one full state inventory. This number is in all downloaded plot files and on all plotsheets and should never be changed in the field.

When collected: All plots (assigned and set with download data)
Field width: 2 digits
Tolerance: No Errors
MQO: None
Values:

State	**Cycle**	**State**	**Cycle**	**State**	**Cycle**
Illinois	5	Michigan	6	North Dakota	4
Indiana	6	Minnesota	13	South Dakota	5
Iowa	5	Missouri	6	Wisconsin	6
Kansas	5	Nebraska	4		

8.3.22NC NC SUBCYCLE (SUBC)
Each cycle is broken down to 5 sub-cycles and these are the sub-cycles assigned to each state for this year of data collection. . This number is in all downloaded plot files and on all plotsheets and should never be changed in the field.

When collected: All plots (assigned and set with download data)
Field width: 2 digits
Tolerance: No Errors
MQO: None
Values:

State	**SubCycle**	**State**	**SubCycle**	**State**	**SubCycle**
Illinois	4	Michigan	5	North Dakota	4
Indiana	1	Minnesota	1	South Dakota	4
Iowa	1	Missouri	1	Wisconsin	5
Kansas	4	Nebraska	4		

8.3.1 STATE (ST)
Record the unique FIPS (Federal Information Processing Standard) code identifying the State where the plot center is located.

When Collected: All plots.
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 1

8.3.23NC NC UNIT (UNIT)
Record the unique one digit North Central code identifying the unit where the plot center is located.

When collected: All plots
Field width: 1 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 1

8.3.2 COUNTY (CNTY)
Record the unique FIPS (Federal Information Processing Standard) code identifying the county, parish or borough (or unit in AK) where the plot center is located.

When Collected: All Nonforest plots
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 1

8.3.3 PLOT NUMBER (PLT#)
Record the identification number for each plot, unique within a county, parish, or borough (survey unit in AK).

When Collected: SAMPLE KIND = 1 or SAMPLE KIND = 2
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 0001 to 9999

8.3.4 PLOT STATUS (STAT)
Record the code that describes the sampling status of the plot.

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

2 Sampled – no accessible forest land condition present on plot and no previously accessible forest land condition on plot
3 Nonsampled

8.3.5 PLOT NONSAMPLED REASON (REAS)
For entire plots that cannot be sampled, record one of the following reasons.

When collected: When PLOT STATUS = 3
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

01 Outside U.S. boundary – Assign this code to condition classes beyond the U.S. border. Entire plots would only be assigned this code if it is determined that a previously measured plot is currently beyond the U.S. border.

02 Denied access area – Any area within the sampled area of a plot to which access is denied by the legal owner, or to which an owner of the only reasonable route to the plot denies access. 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. In some regions denied access plots may be replaced; check with the field supervisor regarding regional

protocols for plot replacement.

03 Hazardous situation – 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 substance 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. In some regions hazardous plots may be replaced; check with the field supervisor regarding regional protocols for plot replacement.

05 Lost data – The plot data file was discovered to be corrupt after a panel was completed and submitted for processing. This code is assigned to entire plots or full subplots that could not be processed, and is applied at the time of processing after notification to the region. Note: This code is for office use only.

06 Lost plot – This code applies to whole plots that cannot be relocated. This situation requires notification of the field supervisor. Whenever this code is assigned, a replacement plot is required. The plot that is lost is assigned SAMPLE KIND = 2 and NONSAMPLED REASON = 6. The replacement plot is assigned SAMPLE KIND = 3.

07 Plot in wrong location – This code applies to whole plots that can be relocated, but their placement is beyond the tolerance limits for plot location. This situation requires verification by the regional office. Whenever this code is assigned, a replacement plot is required. The plot that is lost is assigned SAMPLE KIND = 2 and NONSAMPLED REASON = 7. The replacement plot is assigned SAMPLE KIND = 3.

08 Skipped visit – This code applies to whole plots that are skipped (i.e., the entire plot should be assigned to this condition class). It is used for plots that are not completed prior to the time a panel is finished and submitted for processing. Note: This code is for office use only.

09 Dropped intensified plot - This code applies only to regions engaged in intensification. It is used for intensified plots that have been dropped due to a change in grid density.
Note:

- This code is for office use only.
- This code is primarily intended for regions engaged in sub-paneling for intensification purposes.
- Plot records for dropped subpanels may be generated with the information management system.

10 Other – This code is used whenever a plot or condition class is not sampled due to a reason other than one of the specific reasons already listed. A field note is required to describe the situation.

8.3.6 SAMPLE KIND (SK)
Record the code that describes the kind of plot being installed.

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

1 Initial plot establishment - the initial establishment and sampling of a national design plot (FIA Field Guide versions 1.1 and higher). SAMPLE KIND 1 is assigned under the following circumstances:
- Initial activation of a panel or subpanel
- Reactivation of a panel or subpanel that was previously dropped
- Resampling of established plots that were not sampled at the previous visit

2 Remeasurement – remeasurement of a national design plot that was sampled at the previous inventory.

3 Replacement plot - a replacement plot for a previously established plot. Assign SAMPLE KIND = 3 if a plot is re-installed at a location other than the original location (i.e., plots that have been lost, moved, or otherwise replaced). Note that replacement plots require a separate plot file for the replaced plot. Replaced plots are assigned SAMPLE KIND = 2, PLOT STATUS = 3, and the appropriate NONSAMPLED REASON code. The plot number for the new (replacement) plot is assigned by NIMS.

8.3.7 PREVIOUS PLOT NUMBER

Record the identification number for the plot being replaced by this new plot.

NC Note: This is applied after the field in the data base at North Central.

When collected: When SAMPLE KIND = 3
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 0001 to 9999

8.3.8 FIELD GUIDE VERSION

Record the version number of the National Core Field Guide that was used to collect the data on this plot. FIELD GUIDE VERSION will be used to match collected data to the proper version of the field guide.

NC Note: The FIELD GUIDE VERSION will be applied by St. Paul after the field data is returned.

When collected: All plots
Field width: 2 digits (x.y)
Tolerance: No errors
MQO: At least 99% of the time
Values: 2.0

8.3.9 CURRENT DATE

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

8.3.9.1 YEAR (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: $\geq$ 2003

8.3.9.2 MONTH (MONT)
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

8.3.9.3 DAY (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

8.3.10 DECLINATION (CORE OPTIONAL)
Record the azimuth correction used to adjust magnetic north to true north. All azimuths are assumed to be magnetic azimuths unless otherwise designated. The Portland FIA unit historically has corrected all compass readings for true north. This field is to be used only in cases where units are adjusting azimuths to correspond to true north; for units using magnetic azimuths, this field will always be set = 0 in the office. This field carries a decimal place because the USGS corrections are provided to the nearest half degree. DECLINATION is defined as:

DECLINATION = (TRUE NORTH - MAGNETIC NORTH)

When collected: CORE OPTIONAL: All plots
Field width: 5 digits including sign (+xxx.y)
Tolerance: No errors
MQO: At least 99% of the time
Values: -359.0 to +359.0

8.3.11 QA STATUS (CORE OPTIONAL) (QAST)
Record the code to indicate the type of plot data collected, using the following codes:
NC NOTE: Collected in North Central FIA region.

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

1 Standard production plot
2 Cold check
3 Reference plot (off grid)
4 Training/practice plot (off grid)
5 Botched plot file (disregard during data processing)
6 Blind check
7 Hot check (production plot)

8.3.12 CREW TYPE (CORE OPTIONAL) (CRTY)

Record the code to specify what type of crew is measuring the plot.

NC NOTE: Collected in North Central FIA region.

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

1 Standard field crew
2 QA crew (any QA crew member present collecting data)

8.3.13 GPS Coordinates

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

8.3.13.1 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. Most will use the NAD 27 Datum (also known as NAS-C or NA 27 CONUS/CLK66), 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.

NC Note: North Central FIA collects all GPS coordinates in the field using NAD 83.

8.3.13.2 Collecting Readings

Collect at least 180 GPS readings at the plot center. These may be collected in a file for post processing or may be averaged by the GPS unit. Each individual position should have an error of less than 70 feet if possible (the error of all the averaged readings is far less).

Soon after arriving at plot center, use the GPS unit to attempt to collect coordinates. If suitable positions (180 readings at error less than or equal to 70 feet) cannot be obtained, try again before leaving the plot center.

If it is still not possible to get suitable coordinates from plot center, attempt to obtain them from a location within 200 feet of plot center. Obtain the azimuth and horizontal distance from the "offset" location to plot center. If a PLGR unit is used, use the Rng-Calc function in the PLGR to compute the coordinates of the plot center. If another type of GPS unit is used, record the azimuth and horizontal distance in Sections 8.3.13.12 and 8.3.13.13.

Coordinates may be collected further than 200 feet away from the plot center if a laser measuring device is used to determine the horizontal distance from the "offset" location to plot center.

Again, if a PLGR unit is used, use the Rng-Calc function in the PLGR to compute the coordinates of the plot center. If another type of GPS unit is used, record the azimuth and horizontal distance in Sections 8.3.13.12 and 8.3.13.13.

In all cases try to obtain at least 180 positions before recording the coordinates.

NC Note: North Central FIA collects all GPS coordinates in the field using NAD 83.

8.3.13.3 GPS UNIT (UNIT)

Record the kind of GPS unit used to collect coordinates. If suitable coordinates cannot be obtained, record 0.

NC Note: Garmin GPS units used in the NC region are capable of field-averaging.

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

0 GPS coordinates not collected
1 Rockwell Precision Lightweight GPS Receiver (PLGR)
2 Other brand capable of field-averaging
3 Other brands capable of producing files that can be post-processed
4 Other brands not capable of field-averaging or post-processing

8.3.13.4 GPS SERIAL NUMBER (GPS#)

Record the last six digits of the serial number on the GPS unit used.

When collected: When GPS UNIT > 0
Field width: 6 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000001 to 999999

8.3.13.5 COORDINATE SYSTEM

Record a code indicating the type of coordinate system used to obtain readings.

NC Note: North Central FIA region always collects using code 1 : Geographic coordinate system (Latitude and Longitude).

When collected: When GPS UNIT > 0
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1 Geographic coordinate system
2 UTM coordinate system

8.3.13.6 LATITUDE (N:)

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

NC Note: Collected in degrees and decimal minutes. Record decimal minutes to the 3rd decimal place and do not round.

When collected: When COORDINATE SYSTEM = 1
Field width: ~~8 digits (DDMMSSSS)~~ **NC Note:** 7 digits collected as Degrees and decimal minutes.
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values: **NC Note:** Vary by State.

8.3.13.7 LONGITUDE (W:)

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

NC Note: Collected in degrees and decimal minutes. Record decimal minutes to the 3rd decimal place and do not round.

When collected: When COORDINATE SYSTEM = 1
Field width: ~~9 digits: (DDDMMSSSS)~~ **NC Note:** 8 digits collected as Degrees and decimal minutes.
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values: **NC Note:** Vary by State.

8.3.13.8 UTM ZONE

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

NC NOTE: Not collected in North Central FIA region.

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

8.3.13.9 EASTING (X) UTM

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

NC NOTE: Not collected in North Central FIA region.

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

8.3.13.10 NORTHING (Y) UTM

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

NC NOTE: Not collected in North Central FIA region.

When collected: When COORDINATE SYSTEM = 2
Field width: 7 digits

Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values:

8.3.13.11 Correction for "Offset" Location (OFFSET)

As described in Section 8.3.13.2, coordinates may be collected at a location other than the plot center (an "offset" location). If a PLGR unit is used all offset coordinates will be "corrected" back using the Rng/Calc function. If a GPS unit other than a PLGR is used, then record items 8.3.13.12 and 8.3.13.13.

NC Note: The OFFSET items are only collected if there is not an option with the GPS unit to do the range calculations to determine the Lat/longs of the plot center that coordinates were not able to be located from.

8.3.13.12 AZIMUTH TO PLOT CENTER (AZM)

Record the azimuth from the location where coordinates were collected to actual plot center. If coordinates are collected at plot center, record 000.

When collected: When GPS UNIT = 2, 3 or 4
Field width: 3 digits
Tolerance +/- 3 degrees
MQO: At least 99% of the time
Values: 000 when coordinates **are** collected at plot center
001 to 360 when coordinates **are not** collected at plot center

8.3.13.13 DISTANCE TO PLOT CENTER (DIST)

Record the horizontal distance in feet from the location where coordinates were collected to the actual plot center. If coordinates are collected at plot center, record 000. As described in Section 8.3.13.2, if a laser range finder is used to determine DISTANCE TO PLOT CENTER, offset locations may be up to 999 feet from the plot center. If a range finder is not used, the offset location must be within 200 feet.

When collected: When GPS UNIT = 2, 3 or 4
Field width: 3 digits
Tolerance: +/- 6 ft
MQO: At least 99% of the time
Values: 000 when coordinates **are** collected at plot center
001 to 200 when a Laser range finder **is not** used to determine distance
001 to 999 when a Laser range finder **is** used to determine distance

8.3.13.14 GPS ELEVATION (ELEV)

Record the elevation above mean sea level of the plot center, in feet, as determined by GPS.

When collected: When GPS UNIT = 1, 2 or 4
Field width: 6 digits
Tolerance:
MQO: At least 99% of the time
Values: -00100 to 20000

8.3.13.15 GPS ERROR (ERRS)

Record the error as shown on the GPS unit to the nearest foot. As described in Section 8.3.13.2, make every effort to collect readings only when the error less than or equal to 70 feet. However, if after trying several different times during the day, at several different locations, this is not possible, record readings with an error of up to 999 feet.

When collected: When GPS UNIT =1 or 2
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000 to 070 if possible
071 to 999 if an error of less than 70 cannot be obtained

8.3.13.16 NUMBER OF READINGS (READ)

Record a 3-digit code indicating how many readings were averaged by the GPS unit to calculate the plot coordinates. Collect at least 180 readings if possible.

When collected: When GPS UNIT = 1 or 2
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 001 to 999

8.3.13.17 GPS FILENAME (CORE OPTIONAL)

Record the filename containing the GPS positions collected on the plot.

NC Note: Not collected in the North Central FIA region.

When collected: When GPS UNIT = 3
Field width: 8 characters.3 characters (e.g., R0171519.ssf)
Tolerance: No errors
MQO: At least 99% of the time
Values: Letters and numbers

8.3.14 CONDITION CLASS STATUS 1 (CDST)

Record the CONDITION CLASS STATUS at the center of Subplot 1. Record the code that describes the status of the condition. The instructions in Section 2.2 and 2.3 apply when delineating condition classes that differ by CONDITION CLASS STATUS.

When collected: ~~All plots~~ **NC Note:** All PLOT STATUS 2 in the field, and PLOT STATUS 3 will be applied in the data processing
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

2	Nonforest land
3	Noncensus water
4	Census water
5	Nonsampled

8.3.24NC NC LAND USE (NCLU)

All conditions defined will also receive an NC Land Use. This item is not a condition class defining variable and will only be added to the ancillary data collected on a condition. When the PLOT STATUS = 3 the NC LAND USE will be applied in thedata processing.

When any of the following NC LAND USE codes occur where they both have the same PLOT STATUS code, record the land use that is closest to plot center (PC):

PLOT STATUS	PLOT NONSAMPLED REASON	Closest NC LAND USE to PC
2 - Sampled	Not needed	46, 72, 50-56, 58, 60 – 69, 80, 89, 90
3 - Nonsampled	01,05,06, 07, 08, 09, 10	Not needed
3 - Nonsampled	02	99 (data processing)
3 - Nonsampled	03	96 (data processing)

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

46 **Christmas Tree Plantations** Forest land sufficiently productive to qualify as commercial forest land but withdrawn from timber utilization for exclusive use in Christmas tree production. There must be evidence of annual shearing, or other management practices that indicate the exclusive use for Christmas trees.

The following NC landuse codes of 50-58 must have one or more trees, 5.0 inches DBH or larger, within the visual acre surrounding the subplot center.

50 **Reserved, nonforest with trees** Nonforest land with trees that is withdrawn from timber utilization, by a public agency or by law.

51 **Cropland with trees** Cropland with scattered inclusions of single trees or small groups of trees. Orchards are also included in this class.

52 **Pasture and rangeland with trees** Land used for grazing with a stocking value of less than 10.0 in all live trees 1" DBH or larger. Examples of grazing evidence include:

- cattle trails
- cow pies
- water tanks
- bush hogged periodically
- evidence of being bush hogged (maximum height of seedlings three to four feet and basal scars present on trees)
- area periodically treated with herbicides.

53 **Wooded strip** An acre or more of continuous forest land that meets the definition of forest land (code 20, 21, 22, 40, 41, 45) except that it is less than 120 feet wide.

54 **Idle farmland with trees** Farmland that has not been tended within the last two years and has a stocking value of less than 10.0 in all live trees. **Caution:** Do not confuse this with non-stocked forest land which is GLU 20 and should have a stand-size class code 4.

55 **Marsh with trees** Land that has a stocking value of less than 10.0 in all live trees; characteristically supports low, generally herbaceous or shrubby vegetation and is intermittently covered with water.

56 **Narrow windbreaks** A group of trees, less than 120 feet wide, used for the protection of buildings in use.

58 **Shelterbelt** A group of trees, less than 120 feet wide, used for the protection of soil and crop fields. Do not confuse this land use with an old fence line between two fields that contains a few trees.

72 **Urban and other with trees** Area with trees that is developed for residential, industrial, recreational, or other urban use. For example city park, cemetery, golf course, maintained backyard, farmsteads with trees. The 120 feet/one acre rule does not apply in the case of a maintained yard.

79 **In another country.**

The following NC Land Uses must have no tree species present 5.0 inch DBH or larger, within the visual acre surrounding the subplot center.

61 **Cropland without trees** Presently cropped or fallow up to two years.

62 **Pasture and rangeland without trees**

64 **Idle farmland without trees** Farmland that has not been tended within the last two years and has no trees. Do not confuse with non-stocked forest land.

65 **Marsh without trees**

66 **Other farmland** Including farmsteads and farm buildings.

67 **Urban and other areas without trees** Areas without trees that are developed for residential, industrial, recreational, or other use than those covered in other land use codes. The 120 feet/one acre rule does not apply in the case of a maintained yard.

68 **Rights-of-way** Transportation, utility, and communication rights-of-way. This includes railroads, power lines, pipelines, and maintained roads. A right-of-way of any width qualifies as non-forest land--this is an exception to the one acre, 120 feet rule.

69 **Nonforest without trees** (reserved)

80 **Noncensus Water** A body of water 30 feet wide but less than 200 feet, and one acre in size but less than 4.5 acres in size (normal water level)

89 **Noncensus Water** (reserved)

90 **Census Water** A body of water equal to or greater than 200 feet wide; or equal or greater than 4.5 acres (normal water level).

96 **Inaccessible plot** When any portion of a forest plot cannot be reached or measured because permanent physical conditions prohibit **safe** access (e.g. steep slopes) no field measurements are required. Explain in notes why the plot is inaccessible. **–** Applied to the data in data processing

97 **Dropped plot** Determined in office by field supervisor or crew leader.

98 **Lost (not relocated) plot –** Applied to the data in data processing
99 **Denied access plot –** Applied to the data in data processing

8.3.15 CONDITION CLASS STATUS 2 (CORE OPTIONAL)

Record the CONDITION CLASS STATUS at the center of Subplot 2. Use the same procedure described in Section 8.3.14.

When collected: All plots

8.3.16 CONDITION CLASS STATUS 3 (CORE OPTIONAL)

Record the CONDITION CLASS STATUS at the center of Subplot 3. Use the same procedure described in Section 8.3.14.

When collected: All plots

8.3.17 CONDITION CLASS STATUS 4 (CORE OPTIONAL)

Record the CONDITION CLASS STATUS at the center of Subplot 4. Use the same procedure described in Section 8.3.14.

When collected: All plots

8.3.18 PLOT-LEVEL NOTES

Use these fields to record notes pertaining to the entire plot. If the notes apply only to a specific subplot or other specific aspect of the plot, then make that clear in the notes.

When collected: All plots
Field width: Unlimited alphanumeric character field
Tolerance: N/A
MQO: N/A
Values: English language words, phrases and numbers

8.3.19 P3 HEXAGON NUMBER

Record the unique code assigned to each Phase 3 (former FHM) hexagon.

NC Note: This data item will be attached to the data by St. Paul after the data is collected. The information is printed on the North Central Re-measurement tree list portion of the Plot sheet. This data item is added to the data in the office before processing.

When collected: All Phase 3 plots
Field width: 7 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

8.3.20 P3 PLOT NUMBER

Record the Phase 3 PLOT NUMBERS that are used to identify individual plots within the same Phase 3 (former FHM) hexagon.

NC Note: This data item will be attached to the data by St. Paul after the data is collected. The information is printed on the North Central Re-measurement tree list portion of the Plot sheet. This data item is added to the data in the office before processing.

When collected: All Phase 3 plots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

APPENDICES

1. State and County, Parish or Borough FIPS Codes

   These are the standard federal 2- and 3-digit codes for States and Counties, Parishes, or Boroughs, respectively.

2. FIA Forest Type Codes

   These are the codes that correspond to the National FIA forest typing algorithm. Definitions for the types will be included in a future draft. Units may choose to also add local forest type groupings.

3. FIA Tree Species Codes

   This list includes all species deemed to be tally trees with western woodland trees measured for DRC indicated.

4. Site Tree Selection Criteria and Species List

5. Determination of Stocking Values for Land Use Classification

6. Glossary

7. NC Tolerance / MQO / Value / Units Table

8. NC Regional Helps

9. NC GPS

10. NC Tatum Guides

11. Paper Birch Data Collection References

12. NC Plot Data Sheets

Section 9. Ozone Bioindicator Plants (East)

9.1 OVERVIEW

Air pollutants, such as ground-level ozone, are known to interact with forest ecosystems. Ozone is the only regional gaseous air pollutant that is frequently measured at known phytotoxic levels (Cleveland and Graedel 1979; Lefohn and Pinkerton 1988). Ozone pollution has been shown to have an adverse effect on tree growth and alter tree succession, species composition, and pest interactions (Forest Health and Ozone 1987; Miller and Millecan 1971; Smith 1974). In addition, we know that ozone causes direct foliar injury to many species (Skelly and others 1987; Treshow and Stewart 1973). We can use this visible injury response to detect and monitor ozone stress in the forest environment. This approach is known as biomonitoring and the plant species used are known as bioindicators (Manning and Feder 1980). Ozone bioindicator plants are used to monitor changes in air quality across a region, and to assess the relationship between ozone air quality and Phase 2 and Phase 3 indicators of forest condition (e.g., growth increment and dieback).

A useful bioindicator plant may be a tree, a woody shrub, or a nonwoody herb species. The essential characteristic is that the species respond to ambient levels of ozone pollution with distinct visible foliar symptoms that are easy to diagnose. Field studies and/or fumigation experiments have identified ozone sensitive species and characterized the ozone specific foliar response for both eastern (Davis and Umbach 1981; Duchelle and Skelly 1981; Krupa and Manning 1988) and western (Richards and others 1968; Mavity and others 1995; Brace 1996) bioindicators. Foliar injury symptoms include distinct patterns of coloration, often associated with accelerated senescence.

This section describes procedures to select field sites for ozone biomonitoring and to evaluate ozone injury on the foliage of sensitive plant species using the FIA ozone grid. Additional ozone sites, on an intensified ozone grid, may also be established by State and federal cooperators to improve the interpretive value of this indicator. This intensified sampling is done using the same methodology as the regular grid activities and is just as important.

9.1.1 SCOPE AND APPLICATION

The scope of this indicator is national, but procedures are amended regionally as needed, particularly with regard to suitable sites and target species. Other variables, such as number of species, number of plants, and methods of scoring are standardized nationally. The procedures, reporting, and assessment goals were developed with the following considerations:

1. Ozone plot distribution across the landscape covers both the more remote and expansive forests away from population centers and the more fragmented forests located in close proximity to urban areas;

2. Ozone plot stratification nation-wide reflects regional differences in air quality regimes and perceived risks to different forest types;

3. Sampling intensity in different regions is designed to allow links between ozone biomonitoring data and other FIA indicators;

4. Seasonal variability in ozone injury is addressed. We know that ozone injury must reach an undefined threshold within a leaf before the injury becomes visible to the human eye, and then tends to be cumulative over the growing season until fall senescence masks the symptoms.

NOTE: There are certain regions of the country where ambient ozone concentrations, during the growing season, routinely exceed levels that are known to injure sensitive plants. Other regions have relatively clean air. In regions with poor air quality, the crew data underscore the extent and severity of ozone pollution in the nation’s forests. In regions with better air quality, the emphasis must be on establishing a baseline for the ozone indicator. In this regard, field crews that do not find ozone injury (zero values for the ozone injury variables) are making a significant contribution to the national FIA database.

9.1.2 SUMMARY OF METHOD

Field procedures include the selection of a suitable site for symptom evaluation, identification of three or more known ozone-sensitive species at the site, and identification of ozone injury on the foliage of up to 30 plants of each species. Each plant is evaluated for the percentage of injured area and severity of injury on a five-point scale. Field crews record information on the location and size of the opening used for biomonitoring, and record injury amount and severity ratings for each plant.

In the East, to eliminate problems with seasonal variability in ozone response, all foliar evaluations are conducted during a four-week window towards the end of the growing season. In the West, due to differences in growing season, topography, target species, and other regional factors that influence plant response to ozone, the identification of an optimum evaluation window for this indicator is problematic. Nevertheless, to maintain national consistency and improve crew logistics, the western regions use a mid-season, five or six-week window for foliar injury evaluations.

In some States with a particular interest in air quality, foliar injury data are also collected from ozone sites on an intensified ozone grid. These supplementary ozone sites are standardized for certain site characteristics that influence ozone uptake by sensitive plants (Heck 1968; Krupa and Manning 1988), and are often co-located with physical air quality monitors. They are intended to improve the regional responsiveness of the ozone indicator.

Voucher specimens (pressed leaves with symptoms) are collected for each species for proper symptom identification. For each voucher, injury type and location codes are recorded to fully describe the injury observed in the field. Additional quality control measures include field audits and remeasurement of 10% of the biomonitoring sites.

The implementation of an ozone grid independent of the traditional FIA plot system allows greater flexibility in plot location on the ground and greater sampling intensity in areas believed to be at high risk for ozone impact. In addition, plots are deliberately chosen for ease of access and for optimal size, species, and plant counts, thus maximizing data quality. Ozone is a regional pollutant, understood to have regional effects on vegetation. Therefore, data collected on the ozone grid will have direct application to the FIA P2 and P3 plots within the same region

No specialized safety precautions are necessary to complete the fieldwork for the ozone indicator.

9.1.3 SUMMARY OF PDR SCREENS AND TALLY PROCEDURES

Ozone indicator data are recorded on portable data recorders (PDRs). For crews using the Tally application, all of the ozone bioindicator data are entered under Option 07 on the Tally main menu. There are three data entry screens for ozone data: the Bioindicator Plot Identification Screen, the Plot Notes Screen, and the Bio Species Screen. On the handheld units, the corresponding screens are Plot Data, Ozone Notes, and Species Data. The Bioindicator Plot Identification Screen (Plot Data) includes a record of plot location and status as well as detail on site characteristics that influence ozone injury expression. The Plot Notes Screen (Ozone Notes) prompts crews to record safety tips and additional information that will help analysts interpret the results or assist subsequent crews collecting data at the same location. The Bio Species Screen (Species Data) prompts crews for injury amount and severity codes on a plant by plant basis. This screen includes a pop-up menu, which keeps a running total of numbers of plants and species evaluated by the field crews. Help screens may be accessed for any variable from any of the three data entry screens.

For a written summary of the data entry procedures, definitions, and codes for the ozone measurement variables refer to section 9.4 through 9.6.

9.1.4 EQUIPMENT AND SUPPLIES

- A large diameter, 10X hand lens for close examination of plant leaves for ozone injury.
- Reference photographs and laminated leaf samples to aid in symptom identification.
- A forester-grade PLANT PRESS with cardboard inserts to store leaf vouchers collected in the field.

- Envelopes ready for mailing the leaf vouchers to the National Ozone Advisor.
- Stiff paper or cardboard for protecting the leaf vouchers in the mailing envelopes.
- Flagging: for temporary marking of sites or sample plants.
- Three field data sheets: (1) For documenting Foliar Injury Data in the event of a PDR failure; (2) For preparing the plot location map; and (3) For recording Voucher Leaf Samples Data for QA. (see Appendix 9.B).

9.1.5 TRAINING **AND QUALITY ASSURANCE**

Each field crew member is trained and tested for familiarity with the site selection, species selection, and data collection procedures, and their ability to recognize ozone injury and discriminate against mimicking symptoms. Field crews are certified just prior to the beginning of the evaluation window for this indicator.

The National Ozone Advisor and one or more individuals in each region assume quality control responsibilities for the field season. Regional Advisors meet during a preseason session to refine methods and establish a unified approach to training, audits, and debriefing. Their responsibilities include: (1) training and certifying the State trainers and/or field crews as needed for their region, (2) documenting hot audits of the field crews, (3) overseeing the field crew refresher session held just prior to the evaluation window for this indicator, (4) assisting in the field with remeasurement procedures for symptom quantification, and (5) conducting a debriefing for the indicator.

A field audit crew remeasures a subsample of the ozone ground plots in each region. Auditing procedures cover species selection, symptom identification, and quantification of injury, as well as foliar sample collection, preservation and shipment.

Results of the field audits and remeasurement activities are used to determine if the measurement quality objectives are being met. Regional Advisors and Field Supervisors who are certified for the ozone indicator have the authority to implement whatever corrective action is needed in the field (e.g., retraining and retesting).

9.1.6 VOUCHER SPECIMENS

Leaf samples are collected by field crews, cooperators, and all QA staff. They are to be placed in a small plant press immediately after removal from the selected plant. This is to preserve the integrity of the leaf sample and the injury symptoms until they can be validated by the National Indicator Advisor. A data sheet identifying the field crew and plot location is to be filled out and mailed with each sample.

Field crews, cooperators, and all QA staff collect leaf samples on the ozone biomonitoring sites according to procedures outlined in Subsection 9.2.7. These voucher specimens are pressed and mailed to the National Indicator Advisor for validation of the ozone symptom. If QA staff and regular field crews happen to be evaluating the same site at the same time, they collect and mail separate vouchers.

9.1.7 COMMUNICATIONS

Any questions arising during the field season that cannot be answered by the Field Supervisor or State Coordinator, should be directed to the Regional Advisor for the ozone indicator. If any field crew or cooperator is uncertain about whom to call for information, or if a Regional Advisor is not indicated, they should contact the National Ozone Advisor. Keep in mind that Advisors may be in the field and, therefore, unavailable for phone calls during normal workday hours. Messages left on answering machines should clearly identify who you are and when, where, and how to return your call. Field crews should be aware of differences in time zones and use email, if possible.

National Advisor (East and West) and Regional Advisor for the Northeast and Mid-Atlantic States:

Gretchen Smith Phone: (413) 545-1680
Holdsworth Hall (978) 544-7186 (before 7am; after 7pm)
University of Massachusetts
Department of Forestry and Wildlife Management

Amherst, MA 01003-0130
e-mail: gcsmith@forwild.umass.edu

Regional Advisor for the North Central States:

Ed Jepsen Phone: (608) 266-3538
Wisconsin Department of Natural Resources
101 South Webster Street
Madison, WI 53707
e-mail: jepsee@dnr.state.wi.us

Regional Advisor for the South:

Dan Stratton Phone: (828) 257-4352
USDA Forest Service
P.O. Box 2680
Asheville, NC 28802
e-mail: dstratton@fs.fed.us

9.2 OZONE BIOMONITORING PROCEDURES

NOTE: In the following discussion the words site, biosite, and plot are used interchangeably to refer to the open area used for the ozone biomonitoring evaluations.

The primary objective of the field crew procedures for the ozone indicator is to establish an ozone biomonitoring site within each polygon on the FIA ozone grid using the site selection guidelines provided in the Decision Table – section 9.2.2. These sites are used to detect and monitor trends in ozone air pollution injury on sensitive species. Procedures include the selection of a suitable site for symptom evaluation, identification of three or more known ozone-sensitive species at the site, symptom identification and scoring on the foliage of up to 30 plants of each species, and the collection of voucher leaf samples. Each individual plant with ozone injury is scored for amount and severity of injury. Plants used for the selection of leaf vouchers are also evaluated for injury location and type. If a plant does not have ozone injury, it is still tallied with zeros for the amount and severity measurements. A hardcopy map, providing directions, plot coordinates, and key characteristics of the bioindicator site, is prepared for each plot.

All foliar evaluations are conducted during the latter half of the field season. This is necessary to eliminate differences between plots that are caused by timing. During the evaluation window, all ozone sites on the ozone grid are evaluated for ozone injury. The same sites are evaluated every year.

9.2.1 EVALUATION WINDOW

The evaluation window for crews in the Northern Regions begins the last week of July and extends through the third week in August. In the Southern Region, the window is open from the third week in July through the third week in August.

All established biomonitoring sites are evaluated each year. The ozone injury evaluations are generally completed over a 5 to 20 day period during the window depending on the size of the State and the number of crews dedicated to the ozone survey. If possible, crews should adjust the timing of their evaluations so that the biomonitoring sites within each State are done at approximately the same time every year.

NOTE: States in the Northern Region that border the southern regions and have ozone exposure seasons more typical of the South may choose to select the evaluation window for the Southern Region. This may only be done with approval from the National Advisor.

9.2.2 SITE SELECTION PROCEDURES

Site selection procedures begin with an in-office review of the ozone grid for each State. Candidate sites must be easily accessible open areas greater than one acre in size that are more than 100 feet (30 m) from a busy (paved) road. A site must contain at least thirty individuals of at least two bioindicator species to be evaluated for ozone injury. It is preferable that all sites have three or more species. The following table may be used as a decision guide for site selection:

Decision Table	First Choice = **Best Site**	Second Choice
Access:	Easy	Easy
Location:	Single location is used.	One or two locations (split-plot).
Size of opening:	>3 acres (1.2h); wide open area; <50% crown closure.	Between 1-3 acres; long narrow or irregularly sized opening.
Species count:	More than three species.	Two or more species.
Plant count:	30 plants of 3 species; 10-30 plants of additional species.	30 plants of 2 species; 10-30 plants of additional species.
Soil conditions:	Low drought potential. Good fertility.	Moderate dry. Moderate fertility.
Site disturbance:	No recent (1-3 years) disturbance; No obvious soil compaction.	Little or no disturbance; No obvious soil compaction.

The best ozone sites are often associated with wildlife preserves on public land. Private landowners are often eager to participate in the ozone program. State and county parks and wildlife openings also provide good ozone sites. Other examples of suitable openings include old logging sites and abandoned pasture or farmland where you are reasonably certain that soil/site conditions are stable and free of chemical contaminants. Generally, if bedrock is exposed throughout an open area, then the soil conditions may be shallow, infertile, and often too dry to allow plants to respond to ozone stress. Sites that are routinely waterlogged are similarly unsuitable for biomonitoring. Avoid open areas where plants are obviously stressed by some other factor that could mimic or inhibit the ozone response. For example, the wooded edges of large parking lots in recreational areas are often highly compacted by car and foot traffic and should not be used. Do not select a site under a high-tension power line or on or near an active or reclaimed landfill. Do not select plants within 50 feet of the open edge around a cultivated field or tree plantation.

FIA crews and State Cooperators that have an established network of ozone sites may need to select and map replacement sites when previously mapped areas become overgrown or disturbed. Some sites may be split between two near-by locations to improve species and plant counts. In the case of split-plots, separate plot files (i.e., Tally files) are maintained for each location. Both have the same plot identification number (i.e., OZONE HEXAGON NUMBER) but different values for the plot number variable (i.e., PLOT NUMBER) as defined in Subsection 9.4.4. A split-plot is considered a unique ozone plot and should not be confused with grid intensification when two or more plots with different hex numbers fall in the same polygon.

No more than one half day should be spent locating a new or replacement bioindicator evaluation site. Crews must provide geographic coordinates (i.e., latitude and longitude) for all newly established ozone sites. If a site is split between two locations, the geographic coordinates for both locations are recorded.

9.2.3 SITE MAPPING

Once a bioindicator site is selected, the field crew records the estimated size of the site opening and other key site characteristics identified on the PDR or data sheet. The crew then maps the location of the site relative to some obvious and permanent marker such as a telephone pole, building, or property marker. Directions to the site, including road names and distances, are added to the map. Crews also mark the starting point for plant selection (see section 9.2.5) and approximate location of plant groupings used for evaluation (see section 9.2.6) on the site map. If available, a GPS unit is used to determine plot coordinates and elevation. Otherwise, this information is obtained from a USGS topographic map, generally the 7½ minute series quadrangle.

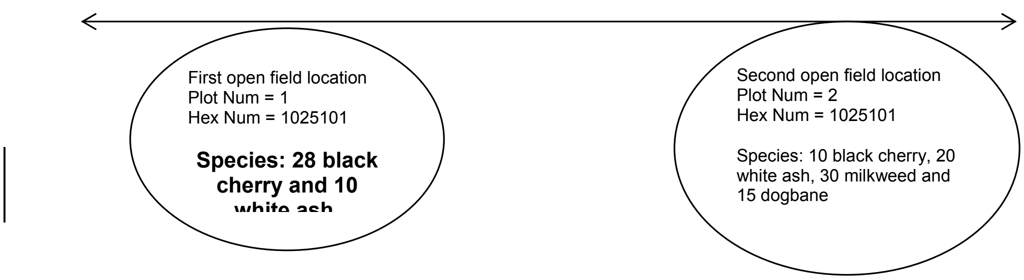
Ozone site maps are used by audit and regular crews in subsequent visits to the plot (see Figure 9-1) to ensure that the same site and the same population of plants are remeasured every year. This bioindicator site map must be kept with the appropriate state or federal cooperator so that it is readily available to whoever needs it.

9.2.4 SPLIT PLOTS

With the 2002 implementation of the national ozone grid, there is an emphasis on maximizing the quality of each ozone plot with respect to the number of plants and species that are evaluated for ozone injury. As indicated in the site selection Decision Table in section 9.2.2, the best sites have more than 3 species; 30 plants of 3 species and between 10 and 30 plants of 1, 2, or 3 additional species. Finding high plant counts at a single wide-open location can be challenging. Split plots are intended to address this challenge. A split-plot consists of two different locations within 3 miles of each other, preferably with similar site characteristics. Species and plant counts from one location are combined with the species and plant counts from the second location to meet the species and plant count standards for site selection. On the PDR or data sheet, the same OZONE HEXAGON NUMBER is assigned to each location. However, each location is assigned a unique PLOT NUMBER; PLOT NUMBER = 1 for the first location that is evaluated by the field crew and PLOT NUMBER = 2 for the second location. In this way, separate Tally files are maintained for each location. On the national grid, the two locations are considered a single and unique ozone plot and should not be viewed as an intensification of the grid.

In the following example, the site selection criteria for a high quality ozone plot are met as the total species and plant counts for OZONE HEXAGON NUMBER 1025101 are black cherry = 38, white ash = 30, milkweed = 30, and dogbane = 15.

Example: Road access to the biomonitoring plot – Distance between locations is about 2 miles



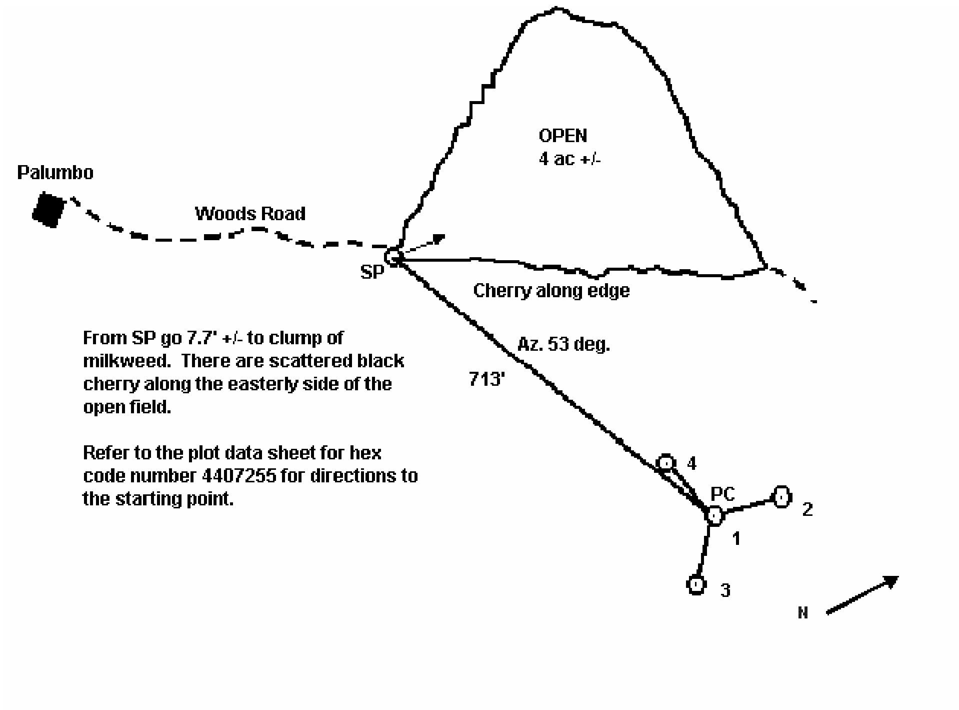


Figure 9-1. Example of a well-drawn map showing the location of the biosite and the approximate location of the bioindicator species and other key landmarks. Road names and north arrow are also included.

9.2.5 SPECIES SELECTION

At the selected bioindicator site, the crew evaluates 30 individuals of three or more bioindicator species. If three species cannot be found at the site, then two species are still evaluated. Crews may combine species and plant counts from neighboring locations to obtain the required plant counts for each site. <u>If 30 plants of two or more species cannot be found at the site, then a new site or additional location must be selected</u>. A prioritized list of species is provided to the field crews for each region. The top three species in each list are the most common throughout the sampling region and should be selected for evaluation whenever possible. Species with 30 or more individual plants should be a first priority for choice of species, regardless of their position on the list. Key identifying characteristics of each species are provided in the Appendix 9.A.

Field crews record the species code number for each selected species in the PDR or on the data sheet. The target species and codes for the North and South Regions are presented in the following table.

Code	Definition – Bioindicator Species	Scientific Names
0915	Blackberry	*Rubus allegheniensis* (second year canes only)
0762	Black Cherry	*Prunus serotina*
0365	Common and Tall Milkweed	*Asclepias spp.*
0621	Yellow Poplar	*Liriodendron tulipifera*
0541	White Ash	*Fraxinus americana*
0931	Sassafras	*Sassafras albidum*
0366	Spreading Dogbane	*Apocynum androsaemifolium*
0364	Big Leaf Aster	*Aster macrophylum*
0611	Sweetgum	*Liquidambar styraciflua*

NOTE: Site selection requirements for species and plant counts (section 9.2.2, Decision Table for site selection) must be met using the species listed on the preceding table. Field crews may receive supplemental lists of regional species (e.g., Paw-paw, *Asimina triloba* in the South) that may be used as additional species for a selected biomonitoring site. Species on supplemental lists are for field trials only as they have not yet been adequately tested for ozone sensitivity under controlled conditions. Use the Plot Notes screen to make a record of when supplemental species have been used at a site.

SPECIAL NOTE: Field crews in the Plains States including North Dakota, South Dakota, Nebraska, Kansas, Oklahoma and Texas should refer to Appendix 9.D for a special insert on western bioindicator species that can be used in addition to the target species and codes presented in the preceding table.

9.2.6 PLANT SELECTION

After site and species selection, the next task is to contiguously sample 30 individual plants of each species. Thirty plants of a target species must be sampled, if they are available on site. In fact, crews are strongly encouraged to evaluate 150 plants at each site (30 plants of five species), if possible. The value of the bioindicator data increases significantly with increased numbers of plants evaluated. This is true even if the crew records 30 consecutive zeros on three different species.

NOTE: The borders of some biomonitoring sites are difficult to determine and crews may be uncertain how much ground area to cover to complete the plant selection procedures. Specific guidelines are not set because the constraints on crew time and resources vary considerably from one State to the next. Time and safety concerns should take priority. Each crew must make every effort to maximize the number of plants and species evaluated for ozone injury at each plot location. Generally, ozone injury evaluations take 1 hour to complete and, assuming routine travel, crews are expected to complete 3 ozone sites in a ten hour work day.

The following procedures help crews to collect the bioindicator data in as systematic or unbiased a way as possible.

1. Identify a starting point at the edge of the opening. This point is mapped on the site data sheet so that audit and regular crews evaluate roughly the same population of plants in subsequent visits to the plot.
2. Move away from the starting point, towards the center of the opening.
3. Begin locating individuals in a sweeping pattern, selecting plants that are growing under the same or similar growing (microhabitat) conditions. Do not skip plants with little or no injury.
4. Select the more exposed plants (high sunlight exposure) and avoid suppressed and shaded individuals. Plants along the edge of an opening may be used if, in your judgment, they receive direct sunlight for three to four hours each day.
5. Avoid plants under 12 inches in height or so tall that you cannot see or touch at least half of the crown area.
6. Evaluate the foliage that you can see and touch on 30 plants of each species in the opening.
7. Record the amount and severity of injury for each plant evaluated (with or without symptoms) on the PDR, personal data assistant, or data sheet.

NOTE: A pop-up menu keeps track of the plant counts by species. For any one species, stop when the pop-up display indicates you have tabulated 30 plants, or when no additional plants of that species can be found on site. You can tabulate 30 plants of 5 species or any combination of species and plants that adds up to 150 data line entries.

Several bioindicator species (e.g., milkweed and blackberry) can spread vegetatively. This means that neighboring plants are often genetically identical. To avoid repeat sampling of clonal material, take several steps between each plant selected for evaluation. This same approach should be used for all species to minimize bias in the plant selection process. For example, select the plant closest to your left side then take several steps and select the plant closest to your right side and repeat. In addition, it is often difficult to distinguish individual plants or stems for species, like blackberry, that grow in clumps. In this case, use an approximate 2-foot square area to represent a single plant.

9.2.7 SYMPTOM IDENTIFICATION AND SCORING

The bioindicator species selected for each region are those that have been determined through field and laboratory studies to be highly sensitive to ozone air pollution. However, within a species, differences in genetics between individuals result in differential sensitivities to ozone. This means that you often find an individual of a species with severe air pollution injury growing immediately adjacent to another individual of the same species with few or no symptoms.

In addition to genetics, the age of the leaves (position on the stem, branch, or rosette) affects a plant's susceptibility to ozone air pollution. In general, leaves at 75% full expansion are the most sensitive and tend to show symptoms most definitively toward the center of the leaf. Older leaves show symptoms more widespread over the leaf surface, while younger leaves show symptoms more commonly near the leaf tip. If leaves on one branch are affected, then leaves at a similar leaf position on another branch should be affected, especially for branches on the same side of the plant under similar environmental conditions (sun or shade leaves).

When scoring foliar symptoms on bioindicator plants check for the following characteristics of ozone injury.

- Symptoms are more severe on mid-aged and older leaves. New leaves will have no or very little injury.
- Symptoms are most likely confined to the upper leaf surface, and are typically visible as tiny purple-red to black spots (stippling).
- Check leaves covering each other. Overlapped leaves will have no injury on the bottom leaf.
- There will be some uniformity to size and shape of the lesions (stippling) on a leaf.
- Later in the growing season, stippling may be associated with leaf yellowing or premature senescence. Check the ground for fallen leaves.

Each plant with ozone injury is evaluated for the percent of the plant that is injured and the average severity of injury. For each plant located, the percentage of injured area and the severity of injury are both rated on a scale of 0 to 5 (see below). Both injury AMOUNT and injury SEVERITY estimates are confined to the exposed portion of the plant. If a plant does not have injury, it is still tallied with zeros for these measurements.

Percent Scale for injury AMOUNT: Estimate and record the percentage of leaves on the plant with ozone injury symptoms relative to the total number of leaves on the plant.

CODE	DEFINITION
0	No injury; the plant does not have any leaves with ozone symptoms.
1	1 to 6 percent of the leaves have ozone symptoms.
2	7 to 25 percent of the leaves are injured.
3	26 to 50 percent of the leaves are injured.
4	51 to 75 percent of the leaves are injured.
5	>75 percent of the leaves have ozone symptoms.

Percent Scale for SEVERITY of injury: Estimate and record the mean severity of symptoms on injured foliage.

CODE	DEFINITION
0	No injury; the plant does not have any leaves with ozone symptoms.
1	On average, 1 to 6 percent of the leaf area of injured leaves have ozone symptoms.
2	On average, 7 to 25 percent of the leaf area of injured leaves have ozone symptoms.
3	On average, 26 to 50 percent of the leaf area of injured leaves have ozone symptoms.
4	On average, 51 to 75 percent of the leaf area of injured leaves have ozone symptoms.
5	On average, >75 percent of the leaf area of injured leaves have ozone symptoms.

NOTE: Blackberry and white ash have compound leaves. Use the whole leaf, not each leaflet, to estimate injury AMOUNT and injury SEVERITY. A typical clump of blackberry plants will have both current year (vegetative) and second year (flower and fruit bearing) canes available for evaluation. The injury AMOUNT and injury SEVERITY measurements are confined to the foliage on the second year canes. The foliage on the current year canes is naturally resistant to ozone injury. Do not use blackberry if you can find only current year canes.

NOTE: The recognition of ozone injury symptoms in the field is not an exact science, and mimicking symptoms can make field diagnosis difficult. Crews are expected to record AMOUNT and SEVERITY estimates for injury that they are unsure of as well as the more obvious or classic injury symptoms.

Proceed as follows:

1. Record the injury AMOUNT and the injury SEVERITY ratings for each plant on the PDR or data sheet.

2. Use the notes section on the PDR or data sheet to add other information that will help interpret the results (e.g., below average rainfall for the area).

3. Collect a voucher leaf sample (three leaves of each injured species evaluated at each location) and mail them to the National Advisor using the guidelines presented in Subsection 9.6.7.

NOTE: Do not take measurements in steady rain. Foliar symptoms are easiest to see under overcast skies. Bright sun will make it difficult to see the ozone stipple. Stand so that you reduce the glare on the leaf surface. Long periods without rain will inhibit symptom development even on the most sensitive plants. If you are experiencing below average rainfall for your area, please note this in the PDR or on the data sheet.

9.2.8 COLLECTION OF LEAF SAMPLES AND VOUCHER DATA

The <u>voucher leaf samples are a critical aspect of the data collection procedures</u> as they provide the necessary validation of the ozone injury symptom observed in the field by the field crews. <u>A plant press is essential</u> to the collection of useable leaf samples and must be taken into the field by the field crews. <u>Crew data that do not include a useable voucher leaf sample with a completed voucher data sheet are removed from the FIA database</u>.

During the evaluation window, a voucher leaf sample must be collected for each injured species evaluated on the bioindicator site. For each injured species, the voucher consists of three leaves that clearly show the ozone injury symptom. For example, if a field crew records ozone injury on blackberry, black cherry, and milkweed then a minimum of one voucher (3 LEAVES) from each of the three species (9 LEAVES IN ALL) is collected and mailed, with the corresponding voucher data sheet(s), to the National Indicator Advisor.

The most useful voucher leaf samples show obvious foliar injury symptoms. If injury symptoms are not obvious and severe, send whatever leaf sample is available even if it is only one leaf with faint symptoms. Cut the leaf at the petiole, shake off any excess moisture, and place the leaf on blotter paper in the plant press. Each leaf is placed in the press so that it <u>does not overlap another leaf</u>. Include a label with each leaf sample placed into the plant press that identifies which plot the sample came from (i.e., OZONE HEXAGON

NUMBER) and the date. Petiole labels are provided for this purpose. Record the information on the labels with indelible ink and then wrap them around the petiole of at least one leaf per sample

NOTE: Blackberry and white ash have compound leaves. Select the whole leaf (not individual leaflets) when preparing a voucher sample.

NOTE: If QA staff and regular field crews happen to be evaluating the same site at the same time, they collect and mail separate vouchers.

NOTE: The recognition of ozone injury symptoms in the field is not an exact science, and many other foliar injury symptoms can be mistaken for ozone injury. Crews are encouraged to collect and mail in voucher specimens of both known and suspected ozone injury for verification by the National Advisor.

The voucher data sheet must be completed for plot identification codes (e.g., STATE, COUNTY, OZONE HEXAGON NUMBER and PLOT NUMBER), CURRENT DATE, CREW ID, CREW TYPE, and SPECIES code(s). This sheet is filled out at the bioindicator site on the same day the sample is collected. In addition, the plants from which the leaf vouchers are selected must be evaluated by the field crews for INJURY LOCATION and INJURY TYPE (defined below), and for the amount of injury present on the leaf that is not ozone stipple. This information, together with the visible injury symptoms on the leaf samples, is used to validate the ozone injury data observed and recorded in the field by the field crews. For each species, the INJURY LOCATION and INJURY TYPE codes are intended to <u>represent</u> what the crew observed on the majority of the injured plants in the sample population. In contrast, the recorded estimates of percent injury caused by some stress other than ozone are based on what the crew observed on the injured leaf samples mailed in with the voucher data sheet.

The INJURY LOCATION and INJURY TYPE codes are recorded on the upper half of the voucher data sheet as follows:

INJURY LOCATION: Specify the leaf age or position of the leaves with ozone injury.

CODE	DEFINTION
1	>50% of the injured leaves are younger leaves. Younger leaves are usually located towards the branch tip (e.g., blackberry, black cherry, yellow poplar, white ash, sassafras, sweetgum, pin cherry, and spreading dogbane) or top of the plant (e.g., milkweed and big-leaf aster).
2	>50% of the injured leaves are mid-aged or older leaves. Mid-aged and older leaves are located halfway along the branch (e.g., blackberry, black cherry, yellow poplar, white ash, sassafras, sweetgum, pin cherry, and spreading dogbane), or main stem of the plant (e.g., milkweed and big-leaf aster), or more towards the base of the branch or stem.
3	Injured leaves are not concentrated in any one location, leaf age or position. Injury may be spread more or less evenly over the plant or is, otherwise, difficult to describe.

INJURY TYPE: Specify the visible injury symptom.

CODE	DEFINITION
1	The injury on >50% of the injured leaves is best described as upper-leaf-surface stipple, i.e., tiny purple-red to black spots occurring between the veins. Stippling may be associated with leaf yellowing and leaf drop late in the evaluation window; When injury is severe, stipples may coalesce and appear as uniform discoloration of the leaf surface.
2	The injury on >50% of the injured leaves is something other than upper-leaf-surface stipple. For example, small white to tan flecks occurring between the veins, or injury that is clearly visible on both leaf surfaces, or a general discoloration of the leaf that resembles early fall coloration.
3	The visible injury is varied or, otherwise, difficult to describe.

NOTE: Not all location and type codes are indicative of ozone injury. Certain combinations of location and type codes, considered with a questionable leaf voucher, may invalidate the injury data. Other combinations provide quality assurance for the injury assessment. Crews should describe any unusual or questionable symptoms on the upper half of the voucher data sheet.

9.2.9 VOUCHER MAILING PROCEDURES

Vouchers are mailed in bulk at the end of the evaluation window, or earlier, depending on the crew's work schedule. It is very important to mail only dry, pressed leaf samples. Before mailing, make sure the upper half of the voucher data sheet is filled out. This sheet is filled out on the same day the sample is collected even if the sample is not mailed on that day. Please comment on the weather or general plot conditions that might help interpret the injury data. For example, *"It's been 14 days now without rain," "Every plant showed the same response and it was very obvious," or "This was a highly disturbed site."* Avoid noting whether the crew thinks the leaf sample shows ozone injury or a mimicking symptom, and referring to the amount and severity ratings so as not to influence the validation process.

The lower half of the voucher data sheet is filled out by the National Ozone Advisor to whom the sample is being sent. Place the voucher data sheet and the leaf sample between two pieces of stiff paper or cardboard before placing into a mailing envelope addressed to the National Advisor. Manila folders and newspaper may also be used for voucher mailings. Do not tape the leaves to the folders, paper or cardboard. Taped samples often break apart when they are handled, making evaluation difficult. Include as many samples as fit easily into each mailing envelope. There must be a unique voucher data sheet for each sample or species, unless the form is being used for multi-species. Keep leaf samples and the corresponding leaf voucher data sheets together. Leaf samples that are separated from the corresponding leaf voucher data sheets may be mislaid, especially if the petiole leaf labels are missing or incomplete.

9.2.10 CREW MEMBER RESPONSIBILITIES

1. Although one or two crew partners may be trained for this indicator, one person typically takes the lead responsibility for site selection, plant selection, and ozone injury evaluations. All procedures can be successfully completed by one person. Two person crews are recommended for safety reasons.

   2. All members of the field crew may assist each other in the site selection process. Once a site is selected, one crew member is responsible for mapping the site and the location of bioindicator species on the field data sheet.

3. Only the crew member trained and certified in ozone injury evaluations may collect the amount and severity data and the leaf voucher. Other crew members may assist by recording the injury scores on the PDR or data sheet and by getting the plant press supplies ready.

4. The crew member that evaluates the plants for injury is responsible for collecting and mailing the voucher sample with air pollution symptoms.

9.2.11 FIELD PROCEDURES FOR UNTRAINED FIELD CREWS

There are certain procedures for the ozone indicator that may be performed by individuals that have not attended the ozone training and been certified to collect ozone data. These procedures still require some explanation and oversight by the certified crew member. Untrained personnel may assist in the selection and mapping of the ozone biomonitoring site and in the location and identification of bioindicator species on the selected site. They may not rate plant injury. It may also be helpful for the untrained crew person to act as the data recorder for the certified crew member, thus speeding up the data collection process.

9.3 SITE INTENSIFICATION

In addition to the unique ozone plots that are identified by the base ozone grid, some Cooperators have established additional biomonitoring sites to represent the local plant populations and environmental conditions. This is not an auxiliary effort, but an integral part of the monitoring activities for this indicator. In some States, additional biomonitoring sites are limited in number and are deliberately located close to weather and air quality monitoring stations. In other States, the ozone grid is intensified to allow for an unbiased allocation of additional biomonitoring sites. It is recommended that additional sites, whether few or many in number, be located on public land to facilitate the annual measurement activities.

Ozone biomonitoring sites added to the base grid typically possess attributes of an ideal site for evaluating ozone injury on sensitive species. They are larger than three acres, contain the maximum number of indicator species, and have soil/site conditions with low drought potential and adequate fertility. They are evaluated for ozone injury using the same methods and during the same time frame as described above in section 9.2.

9.4 PLOT LEVEL DATA

All plot-level measurement codes for the ozone indicator are defined below. The codes and definitions are the same whether the crew is entering data using Tally (Paravant or Husky) or a personal data assistant (Handspring or Palm).

Ozone plots vary in size and do not have set boundaries. When describing plot-level characteristics, use the predominant characteristics where most of the plant species are located. If conditions vary markedly across the site, or by species, then describe this in the plot notes or on the site map. Specify the elevation, aspect, terrain position, soil depth, soil drainage, and disturbance for the highest priority species (Subsection 9.6.4) found on the site. The soil depth, soil drainage, and disturbance variables are intended to describe general conditions on the plot and are not based on actual measurements. For a complete explanation of the procedures associated with these measurement codes, refer to section 9.2.

9.4.1 STATE

Record the unique FIPS (Federal Information Processing Standard) code identifying the State where the plot center is located.

When collected: All plots
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 1

9.4.2 COUNTY

Record the unique FIPS (Federal Information Processing Standard) code identifying the county, parish, Borough (or unit in AK) where the plot center is located.

When collected: All plots
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 1

9.4.3 OZONE HEXAGON NUMBER

Record the unique code assigned to each ozone hexagon. In some cases this will be a former FHM or P3 hexagon.

When collected: All plots
Field width: 7 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

9.4.4 PLOT NUMBER

Record the plot number that describes whether an ozone plot consists of one or two locations. If two locations are selected, they must be within 3 miles of each other. Two locations are selected as needed to obtain optimal species and plant counts for each ozone plot. The OZONE HEXAGON NUMBER is the same for both locations. Note: The PLOT NUMBER value is not related to the GRID DENSITY value.

When collected: All plots

Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 2

1 The ozone plot consists of a single location or this is the first location of a plot split between two locations.
2 The ozone plot is split between two locations. This code identifies the second location added by the field crew to increase species and plant counts for a single hexagon number.

9.4.5 QA STATUS

Record the code to indicate the type of plot data collected.

When collected: All plots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1to 2 and 4 to 7

1 Standard ozone plot
2 Cold check

4 Training/practice plot (off grid)
5 Botched plot file
6 Blind check
7 Hot check (production plot))

9.4.6 CREW TYPE

Record the code to specify what type of crew is measuring the plot.

When collected: All plots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 2

1 Standard field crew
2 QA crew (any QA crew member present collecting remeasurement data)

9.4.7 OZONE SAMPLE KIND

Record the code that describes the kind of plot being visited. Note: OZONE SAMPLE KIND has a value of 1 only when an ozone plot is established in a previously empty polygon.

When collected: All plots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 3

1 Initial plot establishment on the base grid or on a newly intensified grid..
2 Remeasurement of a previously established plot.
3 Replacement of a previously established plot that was replaced because the original plot could not be relocated or because it no longer met ozone plot measurement criteria.

9.4.8 CURRENT DATE

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

9.4.8.1 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

9.4.8.2 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

9.4.8.3 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

9.4.9 OZONE GRID DENSITY

Record the code that identifies whether the plot is on the base ozone grid or on an intensified ozone grid. Note: The OZONE GRID DENSITY value = 2 when there are two ozone plots with different OZONE HEXAGON NUMBERS in the same polygon. The two plots may be located in different States.

When collected: All plots
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 2

1 Unique ozone plot within a polygon. (1 site:1polygon)
2 One of two or more ozone plots within the same polygon.

9.4.10 PLOT SIZE

Record the code that indicates the size of the opening used for biomonitoring.

When collected: All plots
Field width: 1 digit
Tolerance: No errors
MQO: Repeatable estimate
Values: 1 to 2

1 Greater than three acres.
2 Greater than one acre, but less than three acres.

9.4.11 ASPECT

Record the code that identifies the direction of slope for land surfaces with at least 5 percent slope as measured with a hand compass to the nearest degree.

When collected: All plots
Field width: 3 digits
Tolerance: +/- 30°
MQO: At least 99% of the time
Values:

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

9.4.12 TERRAIN POSITION

Record the code that identifies the position of the plot in relation to the surrounding topography.

When collected: All plots
Field width: 1 digit
Tolerance: Repeatable estimate
MQO: At least 99% of the time
Values: 1 to 5

1 Ridge top or upper slope
2 Bench or level area along a slope
3 Lower slope
4 Flat land unrelated to slope
5 Bottom land with occasional flooding

9.4.13 SOIL DEPTH

Record the code that indicates the general depth of the soil where most of the bioindicator species are growing.

When collected: All plots
Field width: 1 digit
Tolerance: Repeatable estimate
MQO: At least 99% of the time
Values: 1 to 2

1 Bedrock is not exposed.
2 Bedrock is exposed; Soil is generally shallow.

9.4.14 SOIL DRAINAGE

Record the code that identifies the general soil drainage conditions where most of the bioindicator species are growing.

When collected: All plots
Field width: 1 digit
Tolerance: Repeatable estimate
MQO: At least 99% of the time
Values: 1 to 3

1 Soil is well drained
2 Soil is generally wet
3 Soil is excessively dry

9.4.15 DISTURBANCE

Record the code that identifies the presence and kind of disturbance where most of the bioindicator plants are growing. The area affected by any human caused or natural disturbance must be clearly visible and recent enough to influence plant health and condition. Disturbance that results in significant soil compaction is especially significant.

When collected: All plots
Field width: 1 digit
Tolerance: Repeatable estimate
MQO: At least 99% of the time
Values: 0 to 2

0 No recent or significant disturbance.
1 Evidence of overuse; Human activity causing obvious soil compaction or erosion.
2 Evidence of natural disturbance including fire, wind, flooding, grazing, pests, etc.

9.4.16 INJURY CHECK

Record the code that indicates whether ozone injury was observed on non-tallied plants or species. This variable allows a plot to be identified as impacted by ozone even though there is no quantitative data on injury severity for trend analyses. A leaf voucher must be collected to validate the injury.

When collected: All plots
Field width: 1 digit
Tolerance: No error
MQO: At least 99% of the time
Values: 0 to 1

0 No injury was observed on non-tallied plants or species.
1 Ozone injury was observed on non-tallied plants or species and a leaf voucher collected.

9.4.17 ELEVATION

Obtain elevation data from USGS topographic maps, generally the 7½ minute series quadrangle. Locate the area where most of the bioindicator species are growing and record elevation to the nearest foot.

When collected: When GPS UNIT = 0
Field width: 6 digits
Tolerance: +/-200 feet
MQO: At least 99% of the time
Values:

9.4.18 Plot Notes

Use these fields to record notes pertaining to the entire plot. If the notes apply to a specific aspect of the plot, then make that clear in the notes. Record the location where GPS coordinates were collected, and GPS file name, as needed. If no GPS Unit was available, record the geographic coordinates (i.e., latitude and longitude) of the plot center in Degrees, Minutes, and Seconds using USGS topographic maps, generally the 7½ minute series quadrangle.

9.4.18.1 REMARK1 and REMARK2

Record any information on site characteristics, use of supplemental species, safety, plant location, injury patterns, or recent rainfall amounts that will assist subsequent crews visiting the site or help interpret the results.

When collected: All plots
Field width: Unlimited alphanumeric character field
Tolerance: N/A
MQO: N/A
Values: English language words, phrases and numbers

9.5 GPS COORDINATES

Use a global positioning system (GPS) unit to determine the plot coordinates and elevation of all ozone plot locations. GPS readings are collected according to procedures outlined in the FIA National Core Field Guide for Phase 2 & 3 Plots, Version 2.0. The ozone data entry applications accept GPS readings obtained using a geographic coordinate system (not UTM). If you are using UTM, record readings on the field data sheet for mapping and on the PDR Plot Notes screen. If GPS coordinates cannot be collected, elevation and plot coordinates are obtained from USGS topographic maps, generally the 7½ minute series quadrangle. Record elevation on the Plot ID screen and approximate latitude and longitude on the Plot Notes screen.

Use a global positioning system (GPS) unit to determine the plot coordinates and elevation of all field-visited plot locations.

NOTE: For several of the following GPS variables, the term plot center is used. There may be no obvious center to the ozone plots. Coordinates are collected as close as possible to a central location or marker that clearly locates the plot for returning crews. Explanatory notes are added to the plot map and Plot Notes screen as needed.

9.5.1 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. Most will use the NAD 27 Datum (also known as NAS-C or NA 27 CONUS/CLK66), 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; the regions using the UTM coordinate system will collect UTM Easting, Northing, and Zone.

9.5.2 Collecting Readings

Collect at least 180 GPS readings at the plot center (see Note above). These may be collected in a file for post-processing or may be averaged by the GPS unit. Each individual position should have an error of less than 70 feet if possible (the error of all the averaged readings is far less).

Soon after arriving at plot center, use the GPS unit to attempt to collect coordinates. If suitable positions (180 readings at error less than or equal to 70 feet) cannot be obtained, try again before leaving the plot center.

If it is still not possible to get suitable coordinates from plot center, attempt to obtain them from a location within 200 feet of plot center. Obtain the azimuth and horizontal distance from the "offset" location to plot center. If a PLGR unit is used, use the Rng-Calc function in the PLGR to compute the coordinates of the plot center. If another type of GPS unit is used, record the azimuth and horizontal distance as described in Sections 1.14.12 and 1.14.13.

Coordinates may be collected further away than 200 feet from the plot center if a laser measuring device is used to determine the horizontal distance from the "offset" location to plot center. Again, if a PLGR unit is used, use the Rng-Calc function in the PLGR to compute the coordinates of the plot center. If another type of GPS unit is used, record the azimuth and horizontal distance as described in Sections 1.14.12 and 1.14.13.

In all cases try to obtain at least 180 positions before recording the coordinates.

9.5.3 GPS UNIT

Record the kind of GPS unit used to collect coordinates. If suitable coordinates cannot be obtained, record 0.

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

0	GPS coordinates not collected
1	Rockwell Precision Lightweight GPS Receiver (PLGR)
2	Other brand capable of field-averaging
3	Other brands capable of producing files that can be post-processed
4	Other brands not capable of field-averaging or post processing

9.5.4 GPS SERIAL NUMBER

Record the last six digits of the serial number on the GPS unit used.

When collected: When GPS UNIT >0
Field width: 6 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000001 to 999999

9.5.5 GPS LATITUDE

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

When collected: When GPS UNIT = 1, 2, 3 or 4
Field width: 8 digits (DDMMSSSS)
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values:

9.5.6 GPS LONGITUDE

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

When collected: When GPS UNIT = 1, 2, 3 or 4
Field width: 9 digits (DDDMMSSSS)
Tolerance: +/- 140 ft
MQO: At least 99% of the time
Values:

9.5.7 GPS ELEVATION

Record the elevation above mean sea level of the plot center, in feet, as determined by GPS. If no GPS Unit is available, record elevation from the appropriate USGS topographic map.

When collected: When GPS UNIT = 1, 2 or 4
Field width: 6 digits
Tolerance:

MQO: At least 99% of the time
Values: -00100 to 20000

9.5.8 GPS ERROR

Record the error as shown on the GPS unit to the nearest foot.

When collected: When GPS UNIT = 1 or 2
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000 to 070 if possible
071 to 999 if an error of less than 70 cannot be obtained

9.5.9 NUMBER OF GPS READINGS

Record a 3-digit code indicating how many readings were averaged by the GPS unit to calculate the plot coordinates. Collect at least 180 readings if possible.

When collected: When GPS UNIT = 1 or 2
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 001 to 999

9.5.10 GPS FILENAME (CORE OPTIONAL)

Record the filename containing the GPS positions collected on the plot.

When collected: When GPS UNIT = 3
Field width: 8 characters.3 characters e.g. R0171519.ssf
Tolerance: No errors
MQO: At least 99% of the time
Values: Letters and numbers

9.6 FOLIAR INJURY DATA

All measurement codes for the foliar injury data are defined below. Plants selected for ozone injury evaluations are rated for the percent of injured area and the severity of injury on a scale of 0 to 5 (see section 9.2.6). If a plant does not have injury, it is tallied with zeros for these measurements. A pop-up menu keeps track of plant counts by species. The plot is complete only when you have tallied 30 plants of at least 3 species, or when no additional plants can be found on the plot. Ozone plots vary in size and do not have set boundaries. Time and safety concerns should dictate how much ground area to cover to complete the foliar injury evaluation procedures.

9.6.1 SPECIES

Record the three-digit code that identifies each species on the plot. Species codes may be entered in the order they are encountered as you walk through the plot evaluating plants. A pop-up menu keeps a running total of numbers of plants and species evaluated.

When collected: All plots
Field width: 4 digits
Tolerance: No error
MQO: At least 90% of the time
Values: See 9.2.5

9.6.2 AMOUNT

Record the code that identifies the percentage of leaves on the plant with ozone injury symptoms relative to the total number of leaves on the plant. The percent scale code and definitions are fully described in Subsection 9.2.7.

When collected: All plots
Field width: 1 digit
Tolerance: +/- 1 class
MQO: At least 90% of the time
Values: 0 - 5

0 No injury; The evaluated plant does not have any leaves with ozone symptoms.
1 1 to 6 percent of the leaves have ozone symptoms
2 7 to 25 percent of the leaves are injured.
3 26 to 50 percent of the leaves are injured.
4 51 to 75 percent of the leaves are injured.
5 Greater than 75 percent of the leaves have ozone symptoms.

9.6.3 NUMBER OF PLANTS

Record the number of plants tallied so far with no injury. When 0 is entered for AMOUNT, the PDR prompts for the NUMBER OF PLANTS with no injury. When a number greater than zero is entered for AMOUNT, the PDR prompts for the associated SEVERITY value. Zero and non-zero values for any species can be entered as they are encountered on the plot. The pop-up menu keeps track of plant counts by species.

When collected: When AMOUNT = 0
Field width: 2 digits
Tolerance: No error
MQO: At least 90% of the time
Values: 1 to 30

9.6.4 SEVERITY

Record the code that identifies the mean severity of symptoms on injured foliage. The percent scale code and definitions are fully described in Subsection 9.2.7.

When collected: When AMOUNT > 0
Field width: 1 digit
Tolerance: +/- 1 class
MQO: At least 90% of the time
Values: 0 - 5

0 No injury. The evaluated plant does not have any leaves with ozone symptoms.
1 On average, 1 to 6 percent of the leaf area of injured leaves has ozone symptoms.
2 On average, 7 to 25 percent of the leaf area of injured leaves has ozone symptoms.
3 On average, 26 to 50 percent of the leaf area of injured leaves has ozone symptoms.
4 On average, 51 to 75 percent of the leaf area of injured leaves has ozone symptoms.
5 On average, greater than 75 percent of the leaf area of injured leaves has ozone symptoms.

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Appendix 9.A Key Identifying Characteristics of the Ozone Bioindicator Species

1. ***Blackberry*** is an upright or arching shrub; greenish to greenish-red stems are ridged with stout prickles. Alternate leaves have 3-7, mostly 5, leaflets, sparingly pubescent above, velvety beneath, green on both sides. Flowers white, May-July. Fruits black, July-September. Dewberry is very similar to common blackberry, but it is a vine with prickly stems trailing over the ground. Raspberry has smaller leaves and rounded stems covered with a whitish bloom. Blackberry is found in dry fields, clearings, and sunny thickets.

2. ***Black Cherry*** is a small to large tree. Twigs have a bitter-almond smell and taste. The alternate leaves are narrow, shiny, 2-6 inches long, and blunt-toothed, with the midrib prominently fringed beneath with white to brown hair. Leaves of choke cherry, a similar species, have a hairless midrib beneath and are sharp toothed. Leaves of pin cherry are longer and narrower with finely serrated margins. Black cherry is found on a variety of forest soils, deep and moist to dry and gravelly, and along the edges of disturbed areas.

3. ***Common Milkweed*** is recognized by a solitary, simple stem 1-6 feet tall that may or may not be covered with hair. The opposite or whorled leaves are twice as long (2 to 12 inches) as they are wide, have smooth margins, and stems with milky juice. The surface of the leaf is hairy below and smooth above. The petioles are short and thick. Flowers are borne in large clusters on stalks in the upper nodes. They appear rose or greenish-white, from June to August. You may see developmental stages of the Monarch butterfly or feeding injury on the plants. Milkweed is common along roadsides, in fields and meadows.

4. ***Yellow Poplar*** is a tall, straight, forest tree found on good sites with many hardwoods and loblolly pine in the South. Leaves are 4 to 6 inches in diameter, squarish at base, mostly 4-lobed, with smooth margins. Twigs stout, bitter to taste, with diaphragmed pith. Bud shaped like a duck's bill.

5. ***White ash*** is characterized by opposite, compound leaves; leaflets 5-9, stalked, green above and white or pale beneath, usually with smooth margins, slightly toothed near the leaf tips. Buds are inset in the leaf scar. Twigs are round, shiny, and mostly hairless. White ash is difficult to distinguish from green ash; Green ash leaves tend to be narrower, with more teeth, and hairy beneath; buds are set above the leaf scar and branch stems are usually hairy. Ash is sometimes confused with hickory, but can be readily distinguished by its opposite leaves and buds.

6. ***Sassafras*** has a characteristic odor and taste, spicy. Leaves are simple, narrowly lobed (mitten shaped) or entire. Twigs are green. Found from southwestern Maine, south to Florida, north to central Michigan, and west.

7. ***Sweetgum*** has star shaped leaves, deeply 5-7 lobed, margin finely serrate, bright green above, hairy in the axils of the leaf veins below. Twigs shiny and green to yellowish brown, somewhat fragrant when crushed. Fruit a spiny ball, often hanging. Common on bottomland soils and old fields from southern Connecticut, south to Florida and west.

8. ***Pin Cherry*** is a small, shrubby tree often found on cut over, burned, or abandoned sites. Leaves are long, narrow, finely serrate, and yellow-green; less shiny than those of black cherry. Pin cherry leaves may look like black cherry leaves, but they have no hair beneath. Maine to northern Georgia and west.

9. ***Spreading Dogbane*** is a perennial herb characterized by its opposite leaves with smooth margins and red stems with milky juice. The simple leaves are oblong or egg-shaped, dark green above and pale beneath; 2-3 inches long. The plant grows 1-4 feet high and has wide-spreading branches that give the plant an awkward appearance. It flowers throughout the summer; pinkish with a pink stripe in the center. Pods are long and narrow, in pairs. Young milkweed may be confused with dogbane, but differs in having larger, thicker leaves, hairy on the under surface. If evident, milkweed flowers are showy and the pods are large. Dogbane prefers the edges of dry woods from Canada to Mexico, but is also found in dry fields and thickets.

10. ***Bigleaf Aster*** is a perennial wild flower commonly found as an understory plant in dry woods. The leaves of this aster are heart shaped, 3 or more inches wide, with unevenly toothed margins, and have a stem nearly as long as the length of the leaf. Near the flat-topped flower cluster, the leaves become smaller and the stems are margined by a wavy leaf portion called a wing. Flowers may be violet, lavender, or light blue; evident in August and September. The plant grows 1-4 feet high and is native over eastern U.S. and south to North Carolina, west to Illinois.

Appendix 9.B Ozone Data Sheets.

OZONE BIOINDICATOR PLANTS - 2003

Site Characteristics

This sheet must be completed only if you have *not* entered this same information on the Bioindicator Plot ID screen.

To be filled out by the FIELD CREW or Cooperator: Refer to Field Guide 1.6 for code definitions.

State	County	Ozone Hexagon Number	Plot Number[1]	Month	Day	Crew ID	Crew Type
							regular QA

[1]Plot Number refers to the number of locations (1 or 2) used for each hexagon number. A separate sheet should be used for each location.

√ Please put a check mark beside the correct information. Please complete all data fields.

Ozone Sample Kind:	
	Initial plot establishment on the FIA ozone grid.
	Remeasurement of a previously established plot.
	Replacement of a previously established plot that was replaced to meet the site selection guidelines (or lost site).

Ozone Grid Density: (Is the grid intensified, or not?)	
	This hex number identifies a unique ozone plot within a polygon (1 site:1 polygon)
	One of two or more ozone plots within the same polygon, each with their own hexagon number.

Plot size:		Terrain position:	
	> 1.2 hectares (3.0 acres)		Ridge top or upper slope
	0.4 – 1.2 hectares (1 to 3 acres)		Bench or level area along a slope
	Other: please describe		Lower slope
			Flat land unrelated to slope
			Bottom land with occasional flooding

Aspect: 000° = no aspect; 360° = N aspect	Elevation: record estimate in feet or meters	
Record to nearest degree =	Feet =	Meters =

Soil Drainage:		Soil Depth:	
	Well-drained		Bedrock not exposed
	Wet		Bedrock exposed
	Excessively dry		

Disturbance: Disturbance on the site or in localized areas where the bioindicator plants are growing.	
	No recent or significant disturbance; Do not count disturbance >3 years old.
	Evidence of overuse; Human activity causing obvious soil compaction or erosion.
	Evidence of natural disturbance including fire, wind, flooding, grazing, pests, etc.

Fill in below all that apply. Check here if geographic coordinates were obtained from a topographic map: ☐

GPS Type:	GPS Serial Number:
Latitude =	GPS Error =
Longitude =	Number of Readings =
Elevation =	GPS File Name =

[1]If no GPS Unit is available, please use a map and record estimated latitude, longitude, and elevation for each plot location.

Comments: Include information on additional species in the area, safety, directions, or additional site characteristics that may be useful.

File this completed data sheet with the sheet used for mapping the Bioindicator Site Location and then store it in the appropriate Ozone Plot Folder for your State or Region.

OZONE BIOINDICATOR PLANTS - 2003

Foliar Injury Data – Use this sheet *only* if no PDR is available for data entry!

State	Cty	Hexagon No.	Plot No.	Month	Day	Measurement Type (check one):
						___ Regular crew ___ QA crew

[1]Plot Number refers to the number of locations (1 or 2) used for each hexagon number. A separate sheet should be used for each location.

Record species code number (use additional sheets for >3 species at one site): **0915** Blackberry **0762** Black cherry **0365** Milkweed **0621** Yellow Poplar **0541** White ash **0931** Sassafras **0611** Sweetgum **0366** Dogbane spp. **0364** Big leaf aster **0761** Pin cherry. Record the percent of the leaves injured relative to the total leaf number (**Amount**) and the average severity of symptoms on the injured leaves (**Severity**). Add notes to the back of this sheet.

0 = No injury; 1 = 1-6%; 2 = 7-25%; 3 = 26-50%; 4 = 51-75%; 5 = >75%

	Species Code		Species Code		Species Code	
Plant	Amount	Severity	Amount	Severity	Amount	Severity
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
Enter codes	Injury Location	Injury Type	Injury Location	Injury Type	Injury Location	Injury Type

Did you collect 3 leaves that clearly show ozone stipple, for each injured species?

OZONE BIOINDICATOR PLANTS

Data Sheet for Mapping the Bioindicator Site Location

To be filled out by the FIELD CREW or State Cooperator: Refer to Field Guide 1.6 for code definitions.

State	County	Ozone Hexagon Number	Plot Number	Month	Day	Year	Crew ID

[1]Plot Number refers to the number of locations (1 or 2) used for each hexagon number. A separate mapping sheet should be used for each location.

PLGR Information: (Please fill in this information, if available)

Easting	Northing	+/- Error (ft.)	Grid Zone

Include the following information on the map:
(1) Location of the site relative to some obvious and permanent marker
(2) Road names and distances as needed
(3) North arrow
(4) Starting point for plant selection
(5) Species codes and approximate location of plant groupings used for the ozone injury evaluations.

Return the original of this map to the corresponding Plot Folder so that it can be used by audit and regular crews in subsequent visits to the plot. Mail a copy to the National Indicator Advisor the year that the site is established.

Geographic coordinates	
GPS Latitude	GPS Longitude
Latitude estimated from a topographic map:	
Longitude estimated from a topographic map:	

OZONE BIOINDICATOR PLANTS
Summary Sheet on Field Methods

Decision Table	First Choice = **Best Site**	Second Choice
Access:	Easy	Easy
Location:	Single location is used.	One or two locations (split-plot).
Size of opening:	>3 acres (1.2h); wide open area; <50% crown closure.	Between 1-3 acres; long narrow or irregularly sized opening.
Species count:	More than three species.	Two or more species.
Plant count:	30 plants of 3 species; 10-30 plants of additional species.	30 plants of 2 species; 10-30 plants of additional species.
Soil conditions:	Low drought potential; good fertility.	Moderate dry; Moderate fertility.
Site disturbance:	No recent (1-3 years) disturbance; No obvious soil compaction.	Little or no disturbance; No obvious soil compaction.

Unbiased Plant Selection:

1. Identify a starting point at the edge of the opening and record this on the site map.
2. Move towards the center of the opening, locating individuals in a sweeping pattern and selecting plants that are growing under similar growing conditions.
3. Select the more exposed plants and avoid suppressed and shaded individuals. Do not skip plants with little or no injury.
4. Evaluate the foliage on each plant for the amount and severity of injury. Record it electronically.
5. Collect a leaf voucher (3 leaves) showing ozone injury on each species. Store it in a leaf press.

Characteristics of ozone injury on broad-leaf plants:

1. Symptoms are usually more severe on mid-aged and older leaves.
2. New leaves will have no or very little injury.
3. Symptoms are most likely confined to the upper leaf surface as tiny purple-red to black spots.
4. Check leaves covering each other. Overlapped leaves will have no injury on the bottom leaf.
5. There will be some uniformity to size and shape of the lesions (stippling) on a leaf.
6. Stippling may be associated with leaf yellowing or premature senescence.

INJURY AMOUNT: Estimate and record the percentage of leaves on the plant with ozone injury symptoms relative to the total number of leaves on the plant.

CODE	DEFINITION
0	No injury; the plant does not have any leaves with ozone symptoms.
1	1 to 6 percent of the leaves have ozone symptoms.
2	7 to 25 percent of the leaves are injured.
3	26 to 50 percent of the leaves are injured.
4	51 to 75 percent of the leaves are injured.
5	>75 percent of the leaves have ozone symptoms.

INJURY SEVERITY: Estimate and record the mean severity of symptoms on injured foliage.

CODE	DEFINITION
0	No injury; the plant does not have any leaves with ozone symptoms.
1	On average, 1 to 6 percent of the leaf area of injured leaves have ozone symptoms.
2	On average, 7 to 25 percent of the leaf area of injured leaves have ozone symptoms.
3	On average, 26 to 50 percent of the leaf area of injured leaves have ozone symptoms.
4	On average, 51 to 75 percent of the leaf area of injured leaves have ozone symptoms.
5	On average, >75 percent of the leaf area of injured leaves have ozone symptoms.

0915 Blackberry 0762 Black cherry 0365 Milkweed 0621 Yellow poplar 0541 White ash 0931 Sassafras
0366 Spreading dogbane 0364 Bigleaf aster 0611 Sweetgum 0761 Pin cherry.
The best sites are large open areas with 3, 4, or 5 species and close to 30 plants of each species.

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OZONE BIOINDICATOR PLANTS

Data Sheet for the Voucher Leaf Samples

To be filled out by the FIELD CREW or State Cooperator: Refer to Field Guide 1.6 for code definitions.

State	County	Ozone Hexagon Number	Plot Number	Month	Day	Year	Crew ID

[1]Plot Number refers to the number of locations (1 or 2) used for each hexagon number. A separate mapping sheet should be used for each location.

To be filled out by the Cooperator (only needed when the hex number and tally numbers are not known).

Ozone plot name or identification number	Name and e-mail address of data collector

Fill in the required codes. Code definitions are in the Field Guide. For quick reference, see below.

Bioindicator Species	Injury Location	Injury Type	Is the leaf sample injury close to 100% ozone stipple, or is some other upper-leaf-surface injury also present?
			Close to 100% ______ Estimated percent other _______
			Close to 100% ______ Estimated percent other _______
			Close to 100% ______ Estimated percent other _______
			Close to 100% ______ Estimated percent other _______

Notes: Add notes on the leaf samples, supplemental species, plot conditions, safety, and weather as needed.

0915 Blackberry 0762 Black cherry 0365 Milkweed 0621 Yellow poplar 0541 White ash 0931 Sassafras
0611 Sweetgum 0761 Pin cherry 0366 Spreading dogbane 0364 Bigleaf aster.
Injury Location codes: 1 = greater than 50% of the injured leaves are younger leaves; 2 = greater than 50% of the injured leaves are mid-aged or older; 3 = injured leaves are all ages.
Injury Type codes: 1 = greater than 50% of the injury is upper-leaf-surface stipple; 2 = greater than 50% is not stipple (tan flecks, bifacial or general discoloration); 3 = injury is varied or difficult to describe.

Mail this sheet with the leaf samples to :

Gretchen Smith
Department of Natural Resources Conservation
160 Holdsworth Way
University of Massachusetts
Amherst. MA 01003

QA/QC PERSON: To be filled out by the National Ozone Advisor or Regional Expert. √

Date checked	Date rechecked	Sample Condition			Plot Status
		Good:	Fair:	Poor:	

Bioindicator Species	Positive for Ozone	Negative for Ozone	Explanation

Appendix 9.C Detailed Procedures for Handling Leaf Vouchers

Leaf Collection in the Field

1. Collect 3 leaves from each species showing ozone injury symptoms
   - These 3 leaves should be from different plants, if possible
   - These 3 leaves should show <u>obvious</u> injury rather than the range of different symptoms you may have observed
2. Once the leaf vouchers are cut from a plant they should be placed immediately into a plant press
   - Each leaf should have its own space on the blotter paper – do not overlap leaves
   - Each leaf should be marked with the date and the hex number in case they get shuffled
   - Leaves that are not put into a plant press immediately will wrinkle and break easily when handled
   - Leaves that are laid on top of each other will "bleed" such that all overlapped leaves become murky and the ozone injury symptom is no longer visible
3. Before you leave the plot where you have collected voucher leaves, fill out the leaf voucher data sheet and complete the Tally PlotID screen on the PDR. There is important information on the voucher sheet and on the PDR screen that you need to record while you are standing on the biosite. You will not remember these details later on, so take the time to get it right while you are on the plot.
4. Pressed leaves can be removed from the plant press after 36 hours. Once they are flat and dry they can be kept in mailing envelopes, folders, or newspaper until you have time to mail them in to be validated.

Leaf Preparation for Mailing

1. First, label each mailing envelope with the 7-digit hex numbers that you insert into each envelope. Mark the outside of the mailing envelope on the side where the list of numbers will not interfere with the address information.
2. Each mailing envelope may contain the leaves from ONE or SEVERAL hexes (biosites). Use common sense to decide how many leaves will fit comfortably into each envelope. Don't forget to mark the outside with each OZONE HEXAGON NUMBER that has been included.
3. Each pile of leaves from each plot should be placed on top of the corresponding voucher data sheet. It is very helpful to include an additional blank piece of recycled paper or newspaper to help keep larger piles of leaves separated from each other.
4. At least 1 of the 3 leaves (and preferably all 3 leaves) you have selected for each species should have a petiole label with the hex number written on it. This will prevent data loss, if the leaf pile is dropped and separated from its corresponding voucher data sheet when the leaves are removed from the envelope.
   - <u>Do not</u> put large piles of leaves into a single mailing envelope. Help minimize human error by mailing the leaves and data sheets 1 plot per envelope or, up to 5 plots per envelope, depending on how many species were injured and how many leaves and data sheets must be mailed in.
   - Use the 10"x12" size mailing envelopes that are provided at training. If you make a substitution, make sure it is approximately the same size or larger.
   - If you choose to mail larger piles in a single large mailing container, please use newspaper or manila folders to separate vouchers and their corresponding data sheets <u>by OZONE HEXAGON NUMBER.</u>
   - The only way it is safe and acceptable to mail unmarked leaves (no petiole label), is if each group of leaves from each biosite is contained in a separate mailing envelope (10"x12") that contains the corresponding voucher data sheet and is clearly marked with the appropriate OZONE HEXAGON NUMBER.
5. If you have the time and the resources, supply a cover sheet that lists all of the hex numbers you have included in your mailing(s). It is also extremely helpful if the leaves and vouchers are organized by OZONE HEXAGON NUMBER in increasing or decreasing order, e.g., 4207328, 4207422, 4307521, etc.
6. Feel free to ask for the return of your leaves and a copy of the voucher data sheets. This will <u>only</u> be done on request. Remember that the validation process begins in mid-September and may take until December to complete. If you have a time constraint and need a quick response, please note this on the OUTSIDE of the mailing envelope so that it will be noticed upon arrival.
7. If you have mailed extra leaves (>3 per species) for any purpose, please attach a handwritten note explaining what you have done. Clearly mark which 3 leaves should be used to validate the ozone injury at each site. Explain clearly what additional review of leaf samples is of interest to you and include a separate voucher data sheet for this purpose.
8. If you have mailed in samples of supplementary species that are not on the official bioindicator list, please keep these separated by hex number or off grid location and provide a separate data sheet for these extra species, 1 sheet per species. If possible, provide GPS coordinates of any off-grid sampling locations. Species found within approximately 3 miles of the established biosite are still on the grid and do not require additional GPS data.

Appendix 9.D Plain States – Special Insert
For: ND, SD, NE, KS, OK, and TX.
Includes: (1) species key for western bioindicators, (2) foliar injury data sheet for western bioindicators, and (3) voucher data sheet for western bioindicators.

Key Identifying Characteristics of the Western Ozone Bioindicator Species**

**NOTE: A double asterisk (**) denotes the 8 western species that may be used by field crews working in North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas in addition to the 10 species on the eastern bioindicator list. Additional western species shown here and on the Foliar Injury Data Sheet are considered supplemental and should not be used to meet site selection guidelines. Use the Plot Notes screen to make a record of when supplemental species have been used at a site.

1. ***Ponderosa Pine*** is a large tree, up to 230 feet in height. Young tree bark is often thin and dark brown to black. Older tree bark is thick becoming yellow-red to cinnamon red and forming plates which slough off freely. Needles in bundles of three, 5-10 inches in length, not glaucous and yellow-green in color. Buds are resinous with red-brown scales and dark-hairy. Cones with a prickle at the tip of each scale. May be confused with Jeffrey pine which differs by having non-resinous, light-brown buds, and grayish blue-green glaucous needles.

2. **Jeffrey Pine** is a smaller tree than ponderosa pine, with darker cinnamon-red bark that may be tinged with lavender on old trunks. Needles in bundles of three, 5-10 inches in length, blue-green, and somewhat twisted. Crushed needles and twigs have a violet-like or pineapple odor. Buds are *never* covered with resin droplets. Cones with a prickle at the tip of each scale. May be confused with ponderosa pine.

3. ***Quaking Aspen*** is a medium sized tree up to 118 feet in height. Bark is smooth, greenish-white. Buds shiny but not resinous. Leaf petiole is strongly flattened. The leaf blade is broadly ovate (almost round) with a tapering tip and finely toothed margins, upper surface smooth, lower surface covered with a bloom. Aspen could be confused with black cottonwood which differs in its resinous buds, rough bark and round leaf petioles.

4. ***Scouler's Willow*** is a small tree or shrub up to 32 feet in height. Leaf blade is 1-4 inches in length, narrowly elliptic with the widest portion toward the tip, entire to irregularly toothed margins, lower surface smooth, upper surface shiny. This willow is NOT restricted to riparian zones. It can be easily confused with a number of other willow species. The combination of leaves widest toward the tip (mostly rounded ends and narrowly tapered bases) and the tolerance for upland (drier) habitats makes this willow relatively easy to identify.

5. ***Pacific Ninebark*** is a deciduous shrub 6-12 feet in height. Leaves alternate, 3 or 5 lobed (maple-like), 2-3 inches long, serrate, dark green and smooth above, paler and hairy below. Twigs red to grayish brown, splits longitudinally into long strips. Flowers small, white, borne in a cluster, stems hairy. Very similar to ninebark (see below) which is generally smaller, in drier habitats, and with densely hairy ovaries.

6. ***Ninebark*** is an erect, loosely branched shrub with maple-like leaves and shreddy bark. May be up to 6 feet in height. Leaves and flowers similar to Pacific ninebark except the ovaries are densely hairy. May be confused with Douglas maple which has opposite leaves, or sticky currant, which has leaves that are sticky to the touch. Often associated with ponderosa pine and Douglas-fir forests at low to mid-elevation.

7. ***Huckleberry*** is an erect shrub 3 to 5 feet high. Leaves 1 to 2 inches long, half as wide, thin and pale green on both surfaces, smooth or occasionally minutely hairy, margins toothed, apex and base both acute. Fruit deep purple to black round berry around 6 mm diameter. Twigs slender, green and ridged. Found on dry to moist sites, sun or shade. Similar, and often found with oval-leaved huckleberry which has entire (smooth) rather than toothed leaves.

8. ***Blue Elderberry*** is a tall deciduous shrub, sometimes tree-like, up to 20 feet in height. Twigs with a soft pith inside. Leaves opposite, pinnately compound, the 5-9 leaflets sharply serrate and strongly uneven at the base. Flowers small, white, flat-topped cluster. Fruit a blue-black berry covered with a white powdery bloom. This species could be confused with red elderberry which differs by having flowers in a spike and red-purple fruit. Found mostly on moist, well-drained sites in the sun; sea level to 9,000 ft.

9. ***Red Elderberry*** is a tall deciduous shrub, sometimes tree-like, up to 20 feet in height. Twigs with a soft pith inside. Leaves opposite, pinnately compound, the 5-7 leaflets sharply toothed and often uneven at the base. Flowers small, white, and clustered into a long spike. Fruit is a berry, most often red in color but sometimes purplish-black or yellow. Similar to blue elderberry which has a flat-topped flower cluster and a blue-black berry.

10. ***Western Wormwood*** is an aromatic perennial herb, 1 to 3 feet in height. Leaves mostly 3-11 1-4 in cm long, variable in shape but most often with 3-5 narrow lobes, white hairy beneath, sometimes above as well. Flowers small and arranged in a loose, narrow flower cluster, 2-12 inches long. May be confused with Douglas' wormwood which has wider leaves and is usually found in moister habitats. Also similar to Riverbank wormwood which occurs only near streams and outwash areas.

11. ***Mugwort*** is a large perennial herb 2 to 5 feet tall, usually found in large colonies in wet areas, ditches, or drainages. Leaves are evenly-spaced, 0.4 to 4.0 inches long, the upper leaves are narrowly elliptical, the lower widely oblanceolate, often coarsely 3 to 5 lobed near the leaf tip, 0.8 to 1.0 inches wide, green above, covered with dense white hair beneath. Differs from western wormwood in having wider lower leaves and in its generally damp habitat.

12. ***Evening Primrose*** is a large biennial with elliptical leaves up to 10 inches long in a dense rosette the first year. The large (>3ft) flowering stalk with long red-tinged elliptical leaves and large bright yellow four-petaled flowers forms in the second year. Both the leaves and stem are densely hairy, and the hairs often have red, blister-like bases. Usually found in moist, sunny habitats, like seeps or meadows.

13 ***Mountain Snowberry*** is a shrub, 1.5 to 5 feet in height with a solid brown pith. Bark: shreddy, brownish. Young twigs: hairy. Leaves opposite, elliptical, 0.4 to 1.4 inches long and half as wide. Flowers (May-June) tubular-shaped, the petals white with a pink tube. Fruit a white berry. Common snowberry differs by having non-tubular flowers and a hollow pith. Trailing snowberry is a trailing shrub with non-tubular flowers; and Utah honeysuckle has larger leaves and a solid white pith.

14 ***Red Alder*** is a deciduous tree up to 65 feet tall with dark green leaves 2.4 to 4.7inches long. The leaves are coarsely toothed, with smaller teeth on the leaf margins, and the leaf veins are also tightly inrolled. Red alder is a common tree in damp situations and is a frequent colonizer of clearings, especially following clearcuts in coniferous forests.

15 ****Skunkbush** is a small, diffusively-branched shrub, 1.6 to 3.3 feet tall. The tips of the branches often droop down almost to ground level. The leaves are alternate, compound, with three leaflets, each of which is 3-lobed. The leaves resemble those of poison oak, but the leaflets of skunkbush are smaller, more hairy, and much more deeply-lobed. The leaves of skunkbush also emit a strong, ill-scented odor when crushed. However, if unsure, DO NOT crush the leaves of a shrub with three leaflets to determine the odor. Skunkbush is usually found on dry, open, brushy hillsides, while poison oak prefers damp or shaded forested areas and riparian habitats. Skunkbush is found throughout the southwest, from California and Arizona north to Colorado and Idaho.

OZONE BIOINDICATOR PLANTS - 2003

Foliar Injury Data – Use this sheet *only* if no PDR is available for data entry!

State	Cty	Hexagon No.	Plot No.	Month	Day	Measurement Type (check one):
						___ Regular crew ___ QA crew

[1]Plot Number refers to the number of locations (1 or 2) used for each hexagon number. A separate sheet should be used for each location.

Record species code number (use additional sheets for >3 species at one site): 0122 **Ponderosa Pine** 0116 **Jeffrey Pine** 0746 **Quaking Aspen** 0924 **Scouler's Willow** 0351 **Red Alder** 0906 **Pacific Ninebark** 0905 **Ninebark** 0965 **Huckleberry** 0960 **Blue Elderberry** 0961 **Red Elderberry** 0907 **Western Wormwood** 0908 **Mugwort** 0968 **Evening Primrose** 0969 **Mountain Snowberry** 0909 **Skunkbush. Then use the codes from the percent injury scale to record the percent of the leaves or needles injured relative to the total leaf number (amount) and the average severity of symptoms on the injured leaves (severity). Add notes on back of sheet as needed.**

0 = No injury; 1 = 1-6%; 2 = 7-25%; 3 = 26-50%; 4 = 51-75%; 5 = >75%

	Species Code		Species Code		Species Code	
Plant	amount	severity	Amount	severity	Amount	Severity
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						

29									
30									

OZONE BIOINDICATOR PLANTS

Data Sheet for the Voucher Leaf Samples

To be filled out by the FIELD CREW or Cooperator:

State	County	Hexagon No.	Plot No.	Month	Day	Year	Crew ID

[1]Plot Number refers to the number of locations (1 or 2) used for each hexagon number. A separate sheet should be used for each location.

To be filled out by the Cooperator (only needed when the hex number and tally numbers are not known).

Ozone plot name or identification number	Name and e-mail address of data collector

Fill in the required codes. Code definitions are in the Field Guide. For quick reference, see below.

Bioindicator Species	Injury Location	Injury Type	Is the leaf sample injury close to 100% ozone stipple or chlorotic mottle or is some other leaf surface injury also present?
			Close to 100% ______ Estimated percent other _______

Notes: Add notes on the leaf samples, plot conditions, safety, and weather as needed.

Species codes: 0122 Ponderosa pine 0116 Jeffrey pine 0746 Quaking aspen 0924 Scouler's willow 0351 Red alder 0818 California black oak 0960 Blue elderberry 0961 Red elderberry 0965 Huckleberry 0905 Ninebark 0906 Pacific ninebark 0907 Western wormwood 0908 Mugwort 0909 Skunkbush 0968 Evening primrose 0969 Mountain snowberry. *Injury Location codes:* 1 = greater than 50% of the injured leaves are younger leaves (broadleaf) or current whorl (pine); 2 = greater than 50% of the injured leaves are mid-aged or older (broadleaf) or on whorls 1 year and older (pine); 3 = injured leaves are all ages. *Injury type codes:* 1 = greater than 50% of the injury is upper-leaf-surface stipple (broadleaf) or chlorotic mottle (pine); 2 = greater than 50% is not stipple (tan flecks, bifacial or general discoloration), or something other than chlorotic mottle (pine); 3 =

Questions? Call your Regional Advisor. **West: Pat Temple (909) 680-1583**; 264-8883; **PNW:** Sarah Butler (503) 808-2083; **RM:** Roger Boyer (801) 625-5541; **South**: Dan Stratton (828) 257-4350;
National: Gretchen Smith (413) 545-1680 [gcsmith@forwild.umass.edu];

Mail this sheet with the leaf samples to:
[Note: One sheet for each species.]

Pat Temple
USDA FS, PSW Experiment Station
4955 Canyon Crest Drive
Riverside, CA 92506

QA/QC PERSON: To be filled out by the regional ozone expert.

Positive for ozone	Negative for ozone	Date validated	Date rechecked	Sample condition

Notes: Explanation of symptoms or questions for the data collector.

Section 11. Soil Measurements and Sampling

11.0 INTRODUCTION

The objective of the Phase 3 (P3) Soils Indicator is to assess forest ecosystem health in terms of the physical and chemical properties of the soils. The soil resource is a primary component of all terrestrial ecosystems, and any environmental stressor that alters the natural function of the soil has the potential to influence the vitality, species composition, and hydrology of forest ecosystems.

Specifically, soils data are collected on P3 plots to assess (Santiago Declaration 1995):

- the potential for erosion of nutrient-rich top soils and forest floors.
- factors relating to the storage and cycling of nutrients and water.
- the availability of nutrients and water to plants (dependent upon soil structure and texture).
- carbon sequestration (the amount of carbon tied up in soil organic matter).
- deposition of toxic metals from pollution.
- acidification of the soil from deposition of pollutants.

Chemical properties of the soil are analyzed in order to develop indices for plant nutrient status, soil organic matter, and acidification. Together, these three factors largely determine the fertility and potential productivity of forest stands. Soil nutrient status refers to the concentration of plant nutrients (e.g., potassium, calcium, magnesium, and sodium) and is a key indicator of site fertility and species composition. The amount of organic matter in the soil largely determines water retention, carbon storage, and the composition of soil biota. Loss of soil organic matter as a result of management practices can alter the vitality of forest ecosystems through diminished regeneration capacity of trees, lower growth rates, and changes in species composition. Finally, increased soil acidity resulting from deposition of atmospheric pollutants has the capacity to reduce nutrient availability, decrease rates of decomposition, promote the release of toxic elements into the soil solution (e.g., aluminum), and alter patterns and rates of microbial transformations.

Nutrient and water availability to forest vegetation is also dependent on the physical capacity of roots to grow and access nutrients, water, and oxygen from the soil. In addition to playing an important role in plant nutrition, the physical properties of the soil largely determine forest hydrology, particularly with regards to surface and ground water flow. Human activities that result in the destruction of soil aggregates, loss of pore space (compaction), and erosion may increase rates of surface runoff and alter historic patterns of stream flow. In some areas, these changes may result in flooding and/or dewatered streams and can reflect on both the health of aquatic ecosystems and the management and conservation of associated forest and agricultural areas.

11.1 SUMMARY OF METHOD

The soil measurement and sampling procedures are divided into three parts: soil erosion, soil compaction, and soil chemistry. Data collection for soil erosion assessment consists of estimating the percent of bare soil in each subplot. These measurements are combined with data from other sources and used to parameterize established models for erosion potential (RUSLE – Revised Universal Soil Loss Equation , WEPP – Water Erosion Prediction Project). Soil compaction measurements consist of an estimate of the percentage of soil compaction on each subplot along with a description of the type of compaction. Data are recorded using a handheld computer (PDR) with a preloaded data input program.

The chemical and physical properties of the soil are assessed through the collection of soil samples, which are then submitted to a regional laboratory for analysis. Soil samples are collected from the forest floor (subplots 2, 3, and 4) and underlying mineral soil layers (subplot 2). The entire forest floor layer is sampled from a known area after measuring the thickness of the duff (humus) and litter layers at four locations in a sampling frame of known area. Once the forest floor has been removed, mineral or organic soils are sampled volumetrically by collecting cores from two depths: 0 to 4 inches and 4 to 8 inches. The texture of each layer is estimated in the field and characterized as organic, loamy, clayey, sandy, or coarse sandy. Following soil sampling, the depth to any restrictive horizon within the top 20 inches is estimated using a soil probe. In the case of organic soils (e.g., wetland soils), samples are collected from the litter layer and the 0-4 inch and 4-8 inch organic layers.

Physical and chemical properties of the soil are determined in the laboratory. Analyses of forest floor samples include bulk density, water content, total carbon, and total nitrogen. Analyses of mineral soil samples include bulk density, water content, coarse fragment content, total organic and inorganic carbon, total nitrogen, plant available (extractable) phosphorus and sulfur, exchangeable cations (calcium, magnesium, sodium, potassium, and aluminum), pH, and trace metals such as manganese. These data are used to provide indexes of nutrient status, acidification, and carbon sequestration.

11.2 DEFINITIONS

Cryptobiotic crusts	A layer of symbiotic lichens and algae on the soil surface (common in arid regions)
Duff <u>(Humus)</u>	A soil layer dominated by organic material derived from the decomposition of plant and animal litter and deposited on either an organic or a mineral surface. This layer is distinguished from the litter layer in that the original organic material has undergone sufficient decomposition that the source of this material (e.g., individual plant parts) can no longer be identified.
Forest floor	The entire thickness of organic material overlying the mineral soil, consisting of the litter and the duff (humus).
Litter	Undecomposed or only partially decomposed organic material that can be readily identified (e.g., plant leaves, twigs, etc.)
Loam	The textural class name for a soil having a moderate amount of sand, silt, and clay.
Mineral soil	A soil consisting predominantly of products derived from the weathering of rocks (e.g., sands, silts, and clays).
Organic soil	For the purposes of FIA, an organic soil is defined as any soil in which the organic horizon is greater than 8 inches in thickness. These soils are prevalent in wetland areas such as bogs and marshes and may be frequently encountered in certain regions of the country (e.g., Maine, northern Minnesota, coastal regions)
Restrictive layer	Any soil condition which increases soil density to the extent that it may limit root growth. This limitation may be physical (hard rock) or chemical (acid layer) or both.
Sampling frame	A frame used to collect forest floor samples from a known area. A bicycle tire 12 inches in diameter has been selected as the national standard.

Soil erosion	The wearing away of the land surface by running water, wind, ice or other geological agents.
Texture	The relative proportion of sand, silt, and clay in a soil.

11.3 EQUIPMENT AND SUPPLIES

Minimum required equipment is listed below. Field personnel may add equipment as needed to improve efficiency in some areas.

11.3.1 Field Gear Unique to the Soil Indicator

- Retractable measuring tape (inch intervals) for measuring soil layer depths.
- Frame for sampling known area of surface litter material. A small bicycle tire (16 x 2.125 in tire size with an internal diameter of 12 in) has been chosen as the standard size.
- Impact-driven soil core (2-in diameter x 8-in depth) sampler with two 2-in diameter by 4-in long stainless steel core liners for obtaining mineral soil samples.
- Additional bulk density sampling equipment: crescent wrench and universal slip wrench for disassembling bulk density sampler if stuck.
- Tile probe (42 in) for measuring depth to a restrictive layer.
- Garden trowel or hand shovel for sampling forest floor and excavating soil sample hole where soil core sampler cannot be used.
- Small knife with sharp blade for sampling the forest floor layers.
- Pruning shears (very useful in cutting through roots and litter).
- Plastic water bottle for use in hand-texturing soil.
- Small plastic tarp (1 yd x 1 yd) to use as a working surface.
- Indelible ink markers (black thin-line) for marking sample bags.
- Cleaning cloths or tissues.
- Soil sample bags (9 x 12 in or quart size) for mineral soil samples.
- Soil sample bags (10 x 18 in or gallon size) for forest floor samples.
- Soil sample labels.

11.3.2 Optional Soils Equipment

- Supplemental soil sampling equipment for organic soils: Dutch auger.
- Supplemental soil sampling equipment for saturated or wetland soils: mud auger or piston-type core sampler.
- Garden gloves.
- 1-in diameter soil tube probe to take soil samples for hand-texturing or where soil core sampler cannot be used.

11.3.3 Required Equipment not Unique to the Soil Indicator:

- Compass for locating sampling points.
- Measuring tape -100 ft loggers tape for measuring distance to sampling locations.
- Flagging for marking soil sample points.
- Back pack for carrying sampling equipment to the field.
- Clear plastic shipping tape to cover labels after they have been filled out.

11.4 LABORATORY ANALYSES

Phase 3 forest floor samples are analyzed in the laboratory for:

- Bulk density.
- Water content.
- Total carbon.
- Total nitrogen.

Phase 3 mineral soil samples are analyzed for:

- Bulk density, water content, and coarse fragment [>0.08-in (>2-mm)] content.
- pH in water and in 0.01 M $CaCl_2$.
- Total carbon.
- Total organic carbon.
- Total inorganic carbon (carbonates) (pH>7.5 soils only).
- Total nitrogen.
- Exchangeable cations (Na, K, Mg, Ca, Al, Mn).
- Extractable sulfur and trace metals.
- Extractable phosphorus (Bray 1 method for pH < 6 soils, Olsen method for pH > 6 soils).

Methods for preparing and analyzing the collected soil samples are available in a separate document.

11.5 QUALITY ASSURANCE (QA)

The QA program for the soils indicator addresses both field and laboratory measurements. For field measurements, QA protocols are the same as those used for all other Phase 3 indicators. Measurement Quality Objectives (MQOs) have been established for each of the measurements. The MQOs are used during training, certification and auditing to assist with the control of data quality. Periodic re-measurements are undertaken to establish data quality attributes such as precision, bias and comparability.

This field guide only addresses aspects of QA related to the field portion of the program. Soil laboratories have another set of guidelines for ensuring data quality and are required to enroll in a national proficiency testing program. Details of the lab QA protocol may be obtained by contacting the regional lab directors.

11.5.1 Training And Certification

Field crews are trained to make field measurements as well as take soil samples. After training, all field crew members are tested and certified for soil indicator measurements. Each trained crew member must demonstrate the ability to conduct soil measurements within established MQOs.

11.5.2 Hot Checks, Cold Checks, and Blind Checks

QA/QC for the field portion of the soil indicator consists of three parts:

Hot Check – an inspection normally done as part of the training process. The inspector is present on the plot with the trainee and provides immediate feedback regarding data quality. Data errors are corrected. Hot checks can be done on training plots or production plots.

Cold Check – an inspection done either as part of the training process, or as part of the ongoing QC program. Normally the installation crew is not present at the time of inspection. The inspector has the completed data in-hand at the time of inspection. The inspection can include the whole plot or a subset of the plot. Data errors are corrected. Discrepancies between the two sets of data may be reconciled. Cold checks are done on production plots only.

Blind Check – a re-installation done by a qualified inspection crew without production crew data on hand; a full re-installation of the plot for the purpose of obtaining a measure of data quality. The two data sets are maintained separately. Discrepancies between the two sets of data are not reconciled. Blind checks are done on production plots only.

11.5.3 Reference Plots

Remeasurements of field observations by regional trainer crews occur on routine plots recently visited by a standard field crew (cold checks or hot checks) or on reference plots. All erosion and soil compaction remeasurements can be taken on the subplots as described in the soil measurement methods. Reference plots should be selected with areas of bare and compacted soil to allow for an evaluation of a crew's ability to make these measurements.

11.5.4 Debriefing

Feedback from the field crews is critical to identifying problems with the soil indicator measurements and improving the program for subsequent field seasons. Crew members conducting soil measurements should fill out a debriefing form and submit it to the regional field coordinator prior to the end of the field season. Crew members should consider it part of their responsibility to report any problems, inconsistencies, or errors in the field guide or the method.

11.6 SOIL EROSION AND COMPACTION

Erosion is defined as the wearing away of the land surface by running water, wind, or ice. Erosion is a natural process that occurs on all non-flat areas of the landscape. However, human activity (such as timber removal or road-building) can result in accelerated rates of erosion that degrade the soil and reduce the productivity of land. Extensive areas of soil erosion can have a major effect on the aquatic ecosystems associated with forests, recreational opportunities, potable water supplies and the life span of river infrastructure (e.g., dams, levees).

On average, the U. S. loses about 5 billion tons of soil annually to water and wind erosion. As this soil is removed from the landscape, it carries with it all of the nutrients and organic matter that took decades to centuries (or longer) to build up. On human time scales, fertile topsoil is not a renewable resource.

On FIA plots, soil erosion potential is estimated using published models, such as the Revised Universal Soil Loss Equation (RUSLE) and the Water Erosion Prediction Project (WEPP). These models are based on factors that represent how climate, soil, topography, and land use affect soil erosion and surface runoff. Generally, these models require the following factors for analysis: percent slope, slope length, precipitation factor, vegetation cover, and litter cover. Some of these factors are collected as part of the P2 mensuration data and other P3 indicators (percent slope and vegetation cover), one factor is obtained from outside sources (precipitation factor), and the remaining factors (% cover, which is given by 100 minus % BARE SOIL, and SOIL TEXTURE) are measured on each subplot as part of the soil indicator.

Estimates of bare soil are made on all four subplots. Soil texture is measured at the soil sampling site adjacent to subplot 2 during the collection of mineral and organic soil samples.

Compaction refers to a reduction in soil pore space and can be caused by heavy equipment or by repeated passes of light equipment that compress the soil and break down soil aggregates. This compression increases the bulk density and reduces the ability of air and water to move through the soil. These conditions also make it more difficult for plant roots to penetrate the soil and obtain necessary nutrients, oxygen, and water.

In general, compaction tends to be a greater problem on moist soils and on fine-textured soils (clays). These effects can persist for long periods of time and may result in stunted tree growth.

Information about compaction is collected on all subplots that are in a forested condition. Compaction data collected as part of the soil indicator include an estimate of the percent of each subplot affected by compaction and the type(s) of compaction present.

11.6.1 PERCENT COVER OF BARE SOIL

Record a two-digit code indicating the percentage of the subplot that is covered by bare soil (mineral or organic). Fine gravel [0.08-0.20 inch (2-5 mm)] should be considered part of the bare soil. However, do not include large rocks protruding through the soil (e.g., bedrock outcrops) in this category because these are not erodible surfaces. For the purposes of the soil indicator, cryptobiotic crusts are not considered bare soil.

If the subplot includes non-forested areas, multiply the % COVER OF BARE SOIL in the forested part of the subplot by the % of the subplot that is in forested area. For example, if 50% of the subplot is forested and the % COVER OF BARE SOIL of the forested part is 30%, then the % COVER OF BARE SOIL for the entire subplot is 15 %.

When Collected: When any portion of the subplot contains at least one accessible forested condition class
Field Width: 2 digits
Tolerance: +/- 10%
MQO: 75% of the time
Values:

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

11.6.2 PERCENT COMPACTED AREA ON THE SUBPLOT

Record a two-digit code indicating the percentage of the subplot that exhibits evidence of compaction. Soil compaction is assessed relative to the conditions of adjacent undisturbed soil. Do not include improved roads in your evaluation.

When Collected: When any portion of the subplot contains at least one accessible forested condition class
Field Width: 2 digits
Tolerance: +/- 15%
MQO: 75% of the time
Values:

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

11.6.3 TYPE OF COMPACTION - RUTTED TRAIL

Type of compaction is a rutted trail. Ruts must be at least 2 inches deep into mineral soil or 6 inches deep from the undisturbed forest litter surface. Record a “1” if this type of compaction is present; record a “0” if it is not present.

When Collected: When PERCENT COMPACTED AREA ON THE SUBPLOT > 00
Field Width: 1 digit
Tolerance: No errors
MQO: 75% of the time
Values:

1	Present
0	Not present

11.6.4 TYPE OF COMPACTION – COMPACTED TRAIL

Type of compaction is a compacted trail (usually the result of many passes of heavy machinery, vehicles, or large animals). Record a “1” if this type of compaction is present; record a “0” if it is not present.

When Collected: When PERCENT COMPACTED AREA ON THE SUBPLOT > 00
Field Width: 1 digit
Tolerance: No errors
MQO: 75% of the time
Values:

1	Present
0	Not present

11.6.5 TYPE OF COMPACTION – COMPACTED AREA

Type of compaction is a compacted area. Examples include the junction areas of skid trails, landing areas, work areas, animal bedding areas, heavily grazed areas, etc. Record a “1” if this type of compaction is present; record a “0” if it is not present.

When Collected: When PERCENT COMPACTED AREA ON THE SUBPLOT > 00
Field Width: 1 digit
Tolerance: No errors
MQO: 75% of the time

Values:

1 Present
0 Not present

11.6.6 TYPE OF COMPACTION – OTHER

Type of compaction is some other form. Record a “1” if this type of compaction is present; record a “0” if it is not present. (An explanation must be entered in the plot notes).

When Collected: When PERCENT COMPACTED AREA ON THE SUBPLOT > 00
Field Width: 1 digit
Tolerance: No errors
MQO: 75% of the time
Values:

1 Present
0 Not present

11.7 SOIL SAMPLE COLLECTION

The chemical and physical properties of the soil are assessed through the collection of soil samples, which are then submitted to a regional laboratory for analysis. Soil samples are collected from the forest floor (subplots 2, 3, and 4) and underlying mineral soil layers (subplot 2). The entire forest floor layer is sampled from a known area after measuring the thickness at the north, south, east, and west edges of a sampling frame of known area. Once the forest floor has been removed, mineral and organic soils are sampled volumetrically by collecting cores from two depths: 0 to 4 inches and 4 to 8 inches. The texture of each layer is estimated in the field and characterized as organic, loamy, clayey, sandy, or coarse sandy. Following soil sampling, the depth to any restrictive horizon within the top 20 inches is estimated using a soil probe. In the case of organic soils, samples are collected from the litter layer and the 0 to 4 inch and 4 to 8 inch organic layers.

Soil samples are collected within the annular plot along soil sampling lines adjacent to subplots 2, 3, and 4 (Figure 11-1). During the first visit to a plot for soil sampling, soil samples will be collected at the point denoted as Soil Visit #1. On subsequent visits to a plot, soil sampling sites visit #2 or larger will be sampled. The soil sampling sites are spaced at 10-foot intervals alternating on opposite sides of soil sampling site number 1.

The initial sampling points (Soil Visit #1) are located:

- Subplot 2 soil measurement site: 30 feet due south (180^o) from the center of subplot 2.
- Subplot 3 soil measurement site: 30 feet northwest (300^o) from the center of subplot 3.
- Subplot 4 soil measurement site: 30 feet northeast (60^o) from the center of subplot 4.

If the soil cannot be sampled at the designated sampling point due to trampling or an obstruction (e.g., boulder, tree, standing water), the sampling point may be relocated to any location within a radius of 5 feet.

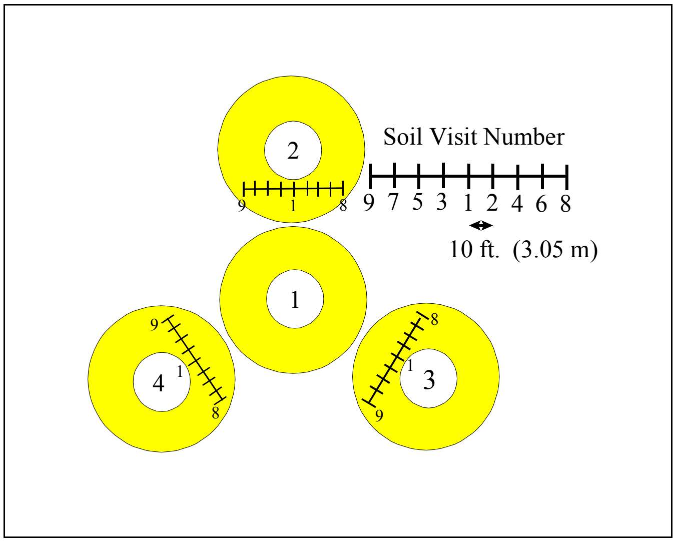

Figure 11-1. Location of soil sampling sites

11.7.1 Forest Floor

Forest floor samples are collected from soil sampling sites adjacent to subplots 2, 3, and 4. Samples are collected if, and only if, the soil sampling sites are forested. The forest floor is sampled as a complete unit using a sampling frame (Figure 11-2).

1 Place the sampling frame over the sampling point taking care not to compact the litter layer.Locate the points due north, due east, due south and due west on the inside of the soil sampling frame and mark these with small vinyl stake flags. Carefully remove the sampling frame.

2. Measure the thickness of the entire forest floor to the nearest centimeter at the four flagged locations. At each sampling point, also measure the thickness of the litter layer.

3. Replace the soil sampling frame. Using a pair of clippers, carefully remove all live vegetation from the sample area. Living mosses should be clipped at the base of the green, photosynthetic material.

4. Using a sharp knife or a pair of clippers, carefully cut through the forest floor along the inner surface of the frame to separate it from the surrounding soil.

5. Using inward scooping motions, carefully remove the entire volume of the forest floor from within the confines of the sampling frame. Discard all woody debris (including pine cones, large pieces of bark, and decomposed wood) above 0.25 inches in diameter (approximately the diameter of a pencil). Discard any rocks or pebbles collected with the forest floor material.

6. Working over the tarp, place the entire forest floor layer sample into a pre-labeled gallon sample bag. In some areas more than one bag might be required to hold the sample. If so, label the bags with identical information, then add "1 of 2" and "2 of 2" respectively.

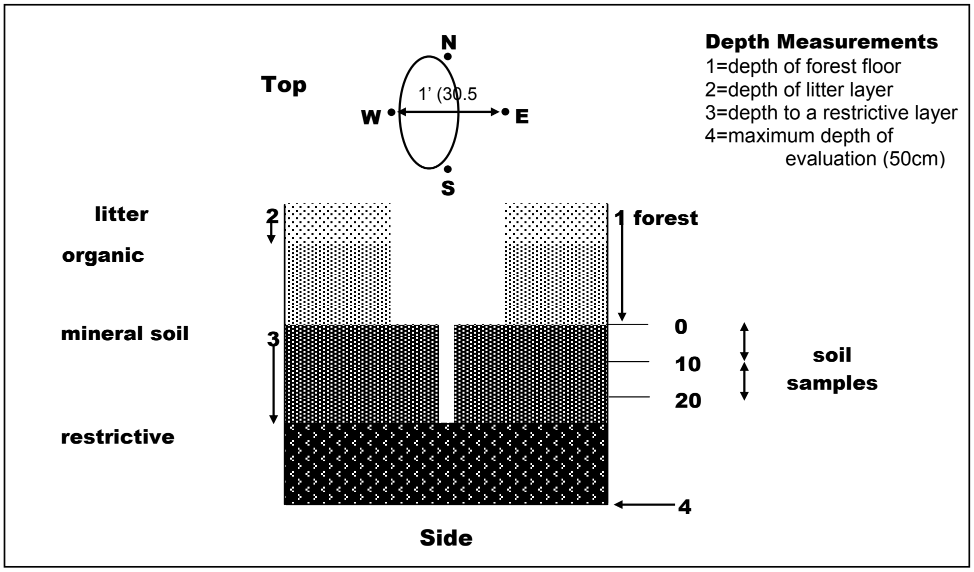

Figure 11-2. Cross-sectional views of sampling sites (top view and side view).

11.7.2 Mineral Soil

Two mineral soil samples 0-4 inch and 4-8 inch are collected from the soil sampling site adjacent to **subplot 2 only**, and are collected if, and only if, the soil sampling site is forested (Figure 11-2).

1. Mineral soil samples are collected from within the area of the sampling frame after the forest floor has been removed.

2. Place the core sampler in a vertical position and drive the sampler into the soil until the top of the coring head is about 1 inch above the mineral soil surface. At this point, the soil should be even with the top of the liner.

3. With the handle of the slide hammer down, rotate the sampler in a circular motion. This motion breaks the soil loose at the bottom of the sampler and makes it easier to remove the core. Do not extend the sliding part of the slide hammer upwards to gain additional leverage as this may bend the attachment. Remove the core sampler from the ground by pulling the slide hammer upwards in a smooth vertical motion.

4. If a complete and intact core has been collected, unscrew the coring head from the top cap and carefully slide the core liners onto the tarp (see section 11.5. for techniques used in handling problem soils). If necessary, use the crescent and slip wrenches to separate the parts. Trim the top and bottom of the core even with the liner rims. Take care to avoid any loss of soil from the cores; if any material spills, you must resample.

5. Using a knife, slice through the soil core at the interface between the two liners (the 4-inch depth). Remove the soil from the 0-4 inch stainless steel liner and place it into a pre-labeled soil sample bag. Repeat for the 4-8 inch core. Be sure to place all of the material in the liner (including coarse fragments, roots, soil, etc.) into the sample bags.

6. For each plot, you should have a maximum of five samples:

   - Three labeled gallon bags containing the forest floor samples from the sampling sites adjacent to subplots 2, 3, and 4. Additional bags may be needed for deep soils.
   - One labeled quart bag containing the 0 - 4 inch mineral soil sample from the soil sampling site adjacent to subplot 2.
   - One labeled quart bag containing the 4 - 8 inch mineral soil sample from the soil sampling site adjacent to subplot 2.

7. Clean all soil sampling equipment thoroughly before sampling soil at the next plot.

11.7.3 Assembly and Operation of Impact Driven Soil Corer (Bulk Density Sampler)

The impact driven core sampler (Figure 11-3) is used to collect a known volume of soil with a minimum of compaction and disturbance. The weight of this core is then used to determine bulk density (the mass of soil per unit volume), an important physical property of the soil. Although we usually think about the soil in terms of the mineral fraction, soils are actually a matrix of solids (mineral and organic), water, and air. The ratio between these fractions (pore space) determines the capacity of the soil to provide nutrients, air, and water to plant roots. In addition, bulk density is used to convert the chemical concentrations obtained in the lab to a volumetric basis, which is more meaningful in terms of plant nutrition.

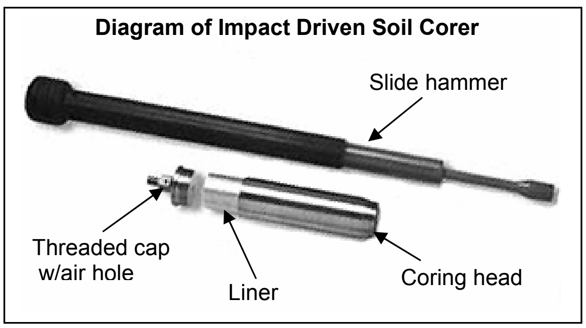

Figure 11-3. Diagram of Impact Driven Soil Corer

Assembly

- Thread the top cap of the soil coring head onto the slide hammer attachment and tighten. This connection must be tight; if not, this connection may be sheared off during use.

- Insert two 2-in diameter x 4-in long stainless steel soil core liners into the soil coring head. It may be helpful to number the core liners with an indelible marker in order to tell them apart after the sample has been collected.

- Thread the soil coring head onto the top cap and slide hammer attachment until the top rim of the coring head just contacts the top cap. Make sure that the vent hole in the top cap is kept open, so that air displaced while the coring head is driven into the soil can escape from inside the coring head.

Maintenance

- Take care to clean and dry the inside and outside of the soil coring head after each sample. Moisture can cause rust build-up on the inside of the core head and make it difficult to insert and remove the liners.

- Use a brush and rag to clean both the inside and outside of the core liners as well. Grit on the outside of the liner can cause damage to the inside of the coring head and make it difficult to collect samples.

- Never twist, pull, or put pressure on the core sampler while the hammer attachment is extended. This can cause the attachment to break or bend.

11.7.4 Regulations Governing Sample Collection (National Historic Preservation Act)

The National Historic Preservation Act of 1966 (as amended) provides for the protection of historical and cultural artifacts. Due to the random placement of the Phase 3 monitoring design, a possibility exists that a Phase 3 plot may be located on a site of prehistoric or historical significance.

If cultural artifacts are encountered on a Phase 3 plot, do **not** take soil samples. Code the site as not sampled on the PDR and record a plot note explaining why soil samples were not taken.

If needed, archeologists or cultural resource specialists in these land management agencies will assist in obtaining permission to sample. Assistance is also available from State Historic Preservation Programs for state and private lands.

11.7.5 Alternate Sampling Methods for "Problem" Soils

In some cases, the soil coring procedure outlined above will not work. For example, in saturated organic soils, use of the core sampler may cause significant compaction of the sample. Very sandy soils or dry soils may tend to fall out of the liners, while in soils with a high rock content or a shallow depth to bedrock, it may not be possible to drive the core sampler into the ground. Approaches to handling these specific problems are addressed in section 11.7.6.

In general, make at least three attempts to collect a sample using the core sampler. If these attempts are unsuccessful, then use one of the following techniques to collect a sample.

1. Excavation method (hand shovel) – Dig a shallow hole whose width is at least 1.5 times the length of your knife. Starting at the top of the mineral soil, measure down 8 inches. Make a mark on the side of the hole at 4 and 8 inches. Use your hand shovel to collect material from the 0-4 and 4-8 inch depth increments. Collect a sufficient volume of soil from the sides of the hole at each depth increment to approximately equal the volume of a soil core liner and place each depth increment sample in separate soil sample bags. Be sure to collect material from throughout the entire depth increment to avoid biasing the sample.

2. Tube probe – Remove the forest floor from an area and use the tube probe to collect samples from the 0-4 inch depth at a number of locations. Composite these samples until you have a sample volume approximately equal to that of the soil core liner. Repeat the sub-sampling and compositing for the 4-8 inch layer by returning to the points sampled previously and pushing the tube probe into the soil an additional 4 inches.

3. Dutch auger – Dutch augers can be very useful in wetland or saturated soils. In an area where the forest floor has been removed, drill into the soil with the auger and use a tape measure to help you collect material from the 0-4 and 4-8 inch depth increments.

For all of these methods, make sure to collect approximately the same amount of soil material [< 0.08 inch (< 2 mm)] that would have been needed to fill the core liner. Completion of the laboratory analyses requires at least 5 ounces (150 g) of mineral soil.

In soils with a large number of small rocks and pebbles, this means that you will need to collect a larger amount of sample so that the lab will have enough material to analyze once the rocks have been removed. In these soils, collect enough material to fill two core liners.

Be certain to circle "Other" on the label under sampler type.

11.7.6 Commonly Encountered Problems

It may not always be possible to obtain soil core samples using the soil core sampler. The following section provides some suggestions on how to overcome these problems.

1. Rocky soils

   In soils containing a high percentage of rocks, it may not be possible to drive the core sampler in to the required 8 inches. If this occurs, remove any soil within the sampler, test for the presence of an obstruction using a plot stake pin or the tile probe, and make a second attempt either within the area where the forest floor has been removed or within the available soil sampling area (within a 5-foot radius of the original soil sampling location). Make a maximum of five attempts. If a complete sample from the 0-4 inch depth can be obtained, collect that sample. Otherwise, use the excavation or soil tube probe approaches outlined above (Section 11.7.5).

2. Very sandy soils (or very dry soils) – sample falls out of the core

   If the soil will not stay in the core liner, use the shovel to dig around the soil coring head while it is still in place. Tilt the soil corer to one side and insert the blade of the shovel underneath the base of the core. Use the base of the shovel to hold the sample in place as you remove the corer from the soil. Depending on the soil type, this technique may require some practice and/or the use of a partner.

3. Saturated or wetland soils.

   Attempt to collect a sample using the soil corer. If this is not possible, or if compaction occurs, use one of the three alternate methods outlined in Section 11.7.5.

4. Buried Soils

   In areas located adjacent to rivers or other bodies of water, sediment transport and periodic flooding may result in the formation of buried soils. Buried soils may be identified by alternating layers of mineral soil and forest floor material. To confirm the presence of a buried soil, excavate a small hole near the soil sampling site with a shovel and look for the presence of forest floor and litter materials buried between layers of mineral soil.

   Collect only the litter and organic matter currently on the soil surface as a forest floor sample following the standard protocol. Attempt to collect 0-4 and 4-8 inch samples using the bulk density corer. If this is not possible, or if the cores do not fill completely, collect a sample using a shovel following the excavation method outlined in 11.7.5. Place a star on the upper right corner of the sampling label, circle "Other" for sampler type, and make a clear note on the shipping form to indicate that this sample represents a buried soil.

5. Other situations in which a complete 8 inch core cannot be collected

If a complete core cannot be obtained in one sample, but is cohesive enough to collect a second sample from the same hole, try the following. Collect a partial sample and measure the length of the collected core. Reinsert the sampler and drive it into the soil to an additional depth close to the length of the collected core. Remove the new core from the sampler. When placed together, the two cores should exceed 8 inches in length. With a knife, cut the cores at the 4-inch and 8-inch lengths. Replace the additional soil into the soil hole.

In some soil types, the 0-4 inch core may not fill completely, although the 4-8 inch core appears to be full. In this instance, attempt to collect a second core by driving the core deeper into the soil. In terms of the soil chemistry, it is better to *slightly* overcompact the sample than to under fill the core. Make three attempts to completely fill the core, driving the corer deeper each time. If you are still unable to obtain a complete 0-4 inch core, collect the 0-4 inch sample and mark "Other" under sampler type. An under filled core cannot be used a bulk density sample. If the 4-8 inch sample is full, it should be collected as a bulk density sample (mark "Bulk Density" under sampler type)

11.7.7 Organic soils

These soils are prevalent in certain regions of the country (e.g., Maine, northern Minnesota, coastal regions) and proper sampling requires modification of the above procedures.

- Due to the large thickness of the underlying organic soil, sampling is restricted to the litter layer. Measure the entire thickness of the forest floor to a maximum depth of 20 inches. However, only collect a sample of the litter layer (see section 11.7.1).

- Attempt to collect a soil sample using the impact driven corer. In many cases, this will not be possible without severe compaction of the sample. If compaction occurs, or if you have difficulty in obtaining a complete core, samples may be collected at the 0 - 4 inch and 4 - 8 inch depth increments using a Dutch auger or shovel (see section 11.7.5).

11.7.8 SUBPLOT NUMBER

Record the number of the subplot adjacent to the soil sampling site.

When Collected: All soil sample locations
Field Width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 2 to 4

11.7.9 CONDITION CLASS

Record the condition class for the soil sampling site. If the condition class for the soil sample is different from any recorded on the 4 subplots, enter "0".

When Collected: All soil sample locations
Field Width: 1 digit
Tolerance: No errors
MQO: At least 95% of the time
Values: 0 to 9

11.7.10 VISIT NUMBER

Record the number of the soil sampling location (Figure 11-1) at which the soil sample was collected.

When Collected: All soil sample locations
Field Width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

11.7.11 SOIL SAMPLE STATUS

Record whether or not a forest floor or mineral soil sample was collected at the soil sampling location. For both forest floor and mineral samples, it is the condition of the soil sampling sites in the annular plot that determines whether soil samples are collected. Samples are collected if, and only if, the soil sampling site is in a forested condition (regardless of the condition class of the subplot). For example, in cases where the subplot has at least one forested condition class and the soil sampling site is not in a forested condition class, soil samples are not collected. Similarly, in cases where the soil sampling site is in a forested condition class and the subplot does not have at least one forested condition class, soil samples are collected.

When Collected: Mineral soil on subplot 2 and forest floor on subplots 2, 3, and 4
Field Width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1 Sampled
2 Not sampled: non-forest

The following are for forest conditions:

3 Not sampled: too rocky to sample
4 Not sampled: water or boggy
5 Not sampled: access denied
6 Not sampled: too dangerous to sample
7 Not sampled: obstruction in sampling area
8 Not sampled: broken or lost equipment
9 Not sampled: other - enter reason in plot notes

11.7.12 FOREST FLOOR THICKNESS – NORTH

Record the thickness (to the nearest 0.1inch) of the forest floor measured from the top of the litter layer to the boundary between the forest floor and mineral soil

Measure to a maximum depth of 20.0 inches. If the thickness of the forest floor is greater than 20.0 inches, then code “20.0”. For locations where bare soil or bedrock material is exposed, enter “00.0" inches depth. On organic soils, measure the entire thickness of the forest floor (to 20.0 inches) even though you will only sample the litter layer.

When Collected: When SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

11.7.13 FOREST FLOOR THICKNESS – EAST

Record the thickness (to the nearest 0.1 inch) of the forest floor measured from the top of the litter layer to the boundary between the forest floor and mineral soil.

Measure to a maximum depth of 20.0 inches. If the thickness of the forest floor is greater than 20.0 inches, then code "20.0". For locations where bare soil or bedrock material is exposed, enter "00.0" inches depth. On organic soils, measure the entire thickness of the forest floor (to 20 inches) even though you will only sample the litter layer.

When Collected: When SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 inches
MQO: 90% of the time
Values: 00.0 to 20.0

11.7.14 FOREST FLOOR THICKNESS – SOUTH

Record the thickness (to the nearest 0.1 inch) of the forest floor measured from the top of the litter layer to the boundary between the forest floor and mineral soil.

Measure to a maximum depth of 20.0 inches. If the thickness of the forest floor is greater than 20.0 inches, then code "20.0". For locations where bare soil or bedrock material is exposed, enter "00.0" inches depth. On organic soils, measure the entire thickness of the forest floor (to 20.0 inches) even though you will only sample the litter layer.

When Collected: When SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

11.7.15 FOREST FLOOR THICKNESS – WEST

Record the thickness (to the nearest 0.1 inch) of the forest floor measured from the top of the litter layer to the boundary between the forest floor and mineral soil.

Measure to a maximum depth of 20.0 inches. If the thickness of the forest floor is greater than 20.0 inches, then code "20.0". For locations where bare soil or bedrock material is exposed, enter "00.0" inches depth. On organic soils, measure the entire thickness of the forest floor (to 20.0 inches) even though you will only sample the litter layer.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

11.7.16 THICKNESS OF THE LITTER LAYER - NORTH

Record the thickness of the litter layer (to the nearest 0.1 inch) at the north location within the sampling frame. The bottom of the litter layer can be distinguished as the boundary where plant parts (such as leaves or needles) are no longer recognizable as such because of decomposition. Another criterion is that the organic layer may contain plant roots, but the litter layer will probably not. At some locations, the depth of the forest floor and the litter layer may be the same. For locations where bare soil or bedrock material is exposed, enter "00.0" inches depth.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

11.7.17 THICKNESS OF THE LITTER LAYER - EAST

Record the thickness of the litter layer (to the nearest 0.1 inch) at the east location within the sampling frame. The bottom of the litter layer can be distinguished as the boundary where plant parts (such as leaves or needles) are no longer recognizable as such because of decomposition. Another criterion is that the organic layer may contain plant roots, but the litter layer will probably not. At some locations, the depth of the forest floor and the litter layer may be the same. For locations where bare soil or bedrock material is exposed, enter "00.0" inches depth.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

11.7.18 THICKNESS OF THE LITTER LAYER - SOUTH

Record the thickness of the litter layer (to the nearest 0.1 inch) at the south location within the sampling frame. The bottom of the litter layer can be distinguished as the boundary where plant parts (such as leaves or needles) are no longer recognizable as such because of decomposition. Another criterion is that the organic layer may contain plant roots, but the litter layer will probably not. At some locations, the depth of the forest floor and the litter layer may be the same. For locations where bare soil or bedrock material is exposed, enter "00.0" inches depth.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

11.7.19 THICKNESS OF THE LITTER LAYER - WEST

Record the thickness of the litter layer (to the nearest 0.1 inch) at the west location within the sampling frame. The bottom of the litter layer can be distinguished as the boundary where plant parts (such as leaves or needles) are no longer recognizable as such because of decomposition. Another criterion is that the organic layer may contain plant roots, but the litter layer will probably not. At some locations, the depth of the forest floor and the litter layer may be the same. For locations where bare soil or bedrock material is exposed, enter "00.0" inches depth.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

11.7.20 DEPTH TO RESTRICTIVE HORIZON

Insert the tile probe into five locations within the soil sampling area (center, north, east, south and west edges) to identify if a restrictive horizon exists. Record the median depth to a restrictive layer (to the nearest 0.1 inch). The maximum depth for testing for a restrictive horizon is 20.0 inches. If a restrictive layer is encountered within the 20.0 inches, record the median depth (to the nearest 0.1 inch) to the restrictive horizon of the five locations probed. Record:

20.0 if a restrictive horizon is not encountered.
00.0 if superficial bedrock is present.
999 if too many rock fragments or cobbles prevent inserting soil probe.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 6 in
MQO: 90% of the time
Values: 00.0 to 20.0, 999

11.7.21 SOIL TEXTURE IN THE 0-4 INCH LAYER

Record the code for the soil texture of the 0-4 inch layer. To estimate texture in the field, collect a sample of the soil from the appropriate horizon and moisten it with water to the consistency of modeling clay/wet newspaper; the sample should be wet enough that all of the particles are saturated but excess water does not freely flow from the sample when squeezed. Attempt to roll the sample into a ball. If the soil will not stay in a ball and has a grainy texture, the texture is either sandy or coarse sandy. If the soil does form a ball, squeeze the sample between your fingers and attempt to form a self-supporting ribbon. Samples which form both a ball and a ribbon should be coded as clayey; samples which form a ball but not a ribbon should be coded as loamy.

In some soils, telling the difference between the bottom of the forest floor and the top of an organic-rich mineral horizon can be difficult. If uncertain:

- Look for evidence of plant parts (e.g., leaves, needles). If you can see them decomposing in place, you’re still in the forest floor.

- Rub the soil between your finger. Does it crumble (organic forest floor) or feel more like modeling clay (try pinching into a ribbon).

- Look for shiny flecks of mica or quartz (won’t help in all soils).

- Look for a subtle change in color. Organic horizons tend to be black; a mineral horizon will tend to be more brownish.

- Wet a sample of the material and press it between your fingers. Note the color of the liquid that runs out. The blacker the color, the higher the organic content.

- Check for a change in density (mineral soils are denser).

When Collected: SOIL SAMPLE STATUS = 1 and SUBPLOT NUMBER = 2
Field Width: 1 digit
Tolerance: +/- 1 class

MQO: 80% of the time
Values:

0 Organic
1 Loamy
2 Clayey
3 Sandy
4 Coarse Sand

11.7.22 SOIL TEXTURE IN THE 4-8 INCH LAYER

Record the code for the soil texture of the 4-8 inch layer (see the directions for SOIL TEXTURE IN THE 0-4 INCH LAYER).

When Collected: SOIL SAMPLE STATUS = 1 and SUBPLOT NUMBER = 2
Field Width: 1 digit
Tolerance: +/- 1 class
MQO: 80% of the time
Values:

0 Organic
1 Loamy
2 Clayey
3 Sandy
4 Coarse Sand

11.8 SAMPLE LABELS

Pre-printed labels will be provided to each field crew. Completion of all items on the soil label is essential for proper processing of the sample by the laboratories. In past years, numerous samples have had to be discarded due to mistakes or inconsistencies on the labels. If you encounter a situation where you need to make additional notes on the sample (e.g., a sample which was particularly unusual or required significant deviation from the standard methods), place a star on the upper right corner of the label and make a note on the sample shipping form. An example label is presented in Figure 11-4.

Soil Sample Collected by
Regular Field Crew

State: «State» County: «county»

P2 Plot: «FIAHex» P3 Hex: «FHMHex»

P3 Plot #: _ Soil Visit #: _ Crew **#:** ___________

Date: ____/____/____ Subplot#: 2 3 4

Layer: Forest Floor 0–4 in 4–8 in

Sampler: Bulk density Other

Figure 11-4. Example soil label

STATE

The 2-digit FIPS (Federal Information Processing Standard) code for the State (see Appendix 1 in the P2 field guide). This will be used by the soil analysis laboratory for batching of samples (should be pre-printed on labels).

COUNTY

The 3-digit FIPS (Federal Information Processing Standard) code identifying the county, parish, or borough (or unit in AK). See Appendix 1 in the P2 field guide. This will be used by the soil analysis laboratory for batching of samples (should be pre-printed on labels).

PLOT NUMBER

The P2 plot number (should be pre-printed on label)

P3 HEXAGON NUMBER

The seven digit P3 hexagon number for the plot. This must be the same as that entered on the PDR (should be pre-printed on label).

P3 PLOT NUMBER:

This number will usually be “1.” However, if more than one Phase 3 plot is located within a hexagon, then enter the number of the plot. Since most labels are preprinted, the number “1” may already be printed on the label. If incorrect, cross through this value and write the correct plot number above. If uncertain, check with your field supervisor.

SOIL VISIT NUMBER:

Record the soil visit number as described in Figure 11-1. For the first soil sample collected along a soil sampling line, this number will be “1". All subsequent visits to a plot will have higher numbers.

DATE SAMPLED:

Enter the date that soils were sampled on this plot.

CREW NUMBER

Enter your field crew identification number. If you have not been assigned a number, enter your last name.

LAYER TYPE:

Circle the type of sample collected and the depth increment of the sample.

SUBPLOT NUMBER:
Circle the subplot adjacent to the soil sampling site.

Subplot 2	Soil sample is from a soil sampling site adjacent to subplot 2
Subplot 3	Soil sample is from a soil sampling site adjacent to subplot 3
Subplot 4	Soil sample is from a soil sampling site adjacent to subplot 4

SAMPLER:
For mineral or organic soils, circle the method used to collect the sample

Bulk density	Impact-driven soil core sampler
Other	Soil tube probe, excavation method, mud auger, or Dutch auger

11.9 SAMPLE SHIPPING

After samples have been collected, changes in the oxygen and moisture content within the bag can cause significant alteration of sample chemistry. To prevent this from occurring, samples are to be shipped on a weekly basis to the regional soil lab designated for your state. Do not keep soil samples longer than a week unless they can be stored in a refrigerated area. Ship samples using the most economical rate. There is no need to ship soil samples using expensive overnight delivery rates.

11.9.1 Shipping Forms

All crews will be provided with shipping forms for forwarding soil samples to a regional laboratory that has been approved to receive soil samples from regulated areas. The addresses for the regional labs are listed at the bottom of the shipping form. An example shipping form is provided in Figure 11-5.

Forms may be submitted either in hard copy or electronically. Electronic versions are preferred by the lab since this greatly increases the efficiency of sample inventory.

The hard copy version of the shipping form consists of a triplicate copy. Prior to shipping samples, crews should completely fill out the shipping form and:

- **Send the original with the soil samples to the laboratory.**
- **Mail one copy immediately to the laboratory in a separate envelope along with a copy of the shipping (tracking) information from the shipping service. The separate mailing of shipping forms will serve to notify the laboratory if a shipment of samples has been misplaced during transport.**
- **Send the third copy to the regional field supervisor for their records.**

Electronic versions may be filled out on a computer and electronic copies sent to the lab and your regional field supervisor. Lab email addresses are provided at the bottom of the shipping form. Print out a hard copy of the form and enclose this in the box prior to shipping. The hard copy is required as a QA check on sample inventory.

A separate line must be completed for each sample collected. Information on the sample shipping form is used by the laboratory to create an inventory of samples, to assign lab numbers, and to help resolve inconsistencies on the sample label. A complete and accurate inventory of samples is critical to efficient and cost-effective processing of samples.

FIA Phase 3 Soil Samples Shipping Form

Name: _________________________ Shipped Via: _________________________
Signature: ______________________ Tracking Number: _____________________
Date: ___________________________
Crew #: ______________ QA Status: ☐ Standard ☐ Audit

State	County	P2 Plot Number	P3 Hexagon Number	Date Sampled	Layer Type (Forest Floor, 0-4 in, or 4-8 in)	Subplot Number (2, 3, or 4)	Bags/Sample (note if more than 1 such as for large forest floor samples)

Total Number of Bags Sent __________

Please provide all information and ship samples WEEKLY to the appropriate lab for the region in which the samples were collected.

Southern states:
Russ Dresbach
MU Soil Characterization Laboratory
41 Mumford Hall
University of Missouri, Columbia
Columbia, MO 65211
Phone: (573) 882-3704

Northeast and North Central states:
Don Nagel
Forestry Sciences Lab
1831 Highway 169 East
Grand Rapids, MN 55744
Phone: 218-326-7101

Western states:
Soil & Water Analysis
Forestry Sciences Lab
860 N. 1200 E.
Logan, UT 84321
Phone: 435-755-3560

Instructions:
1) Fill out form completely. Make certain all soil sample bag labels are correct and complete.
2) Send white copy with soil samples.
3) Mail yellow copy in separate envelope to lab.
4) Keep pink copy.
5) Regular field crews: Please check "Standard" box at top of form.
6) QA crews: Please use a separate form for QA audit samples and check "Audit" box above.

Figure 11-5 FIA Phase 3 soil samples shipping form.

NAME:
Enter your name here.

SHIPPED VIA:
Enter the method used to ship the sample (e.g., UPS, Priority mail, regular mail).

SIGNATURE:
Sign your name here.

TRACKING NUMBER:
Enter the tracking number assigned to the shipment. This information is used by regional supervisors and the laboratories to locate lost or missing shipments.

STATE CODE:
Enter the two-digit FIPS code for the state in which the samples were collected.

DATE:
Enter the date on which samples were shipped.

CREW NUMBER:
If you have been assigned a crew number, enter it here.

QA STATUS:
Indicate whether this sample was collected as part of a standard plot or as part of an audit/QA plot. Unless you are conducting a hot, cold, or blind check, the option for “standard” should be checked.

P3 HEXAGON NUMBER:
Enter the seven digit P3 hexagon number for the plot. This must be the same as that entered on the PDR (should be pre-printed on sample label).

STATE
The 2-digit FIPS (Federal Information Processing Standard) code for the State (see Appendix 1 in the P2 field guide). This will be used by the soil analysis laboratory for batching of samples (should be pre-printed on labels).

COUNTY
The 3-digit FIPS (Federal Information Processing Standard) code identifying the county, parish, or borough (or unit in AK). See Appendix 1 in the P2 field guide. This will be used by the soil analysis laboratory for batching of samples (should be pre-printed on labels).

PLOT NUMBER
The P2 plot number (should be pre-printed on label).

DATE SAMPLED:
Enter the date that the soil sample was collected.

LAYER TYPE:
Indicate the soil layer from which this sample was collected. Choices are: forest floor, 0-4 inches, and 4-8 inches.

SUBPLOT NUMBER:

Enter the subplot adjacent to the soil sampling line from which this sample was collected.

BAGS/SAMPLE

Enter the number of bags associated with a sample. For some forest floor samples, more than 1 bag may be needed to collect all of the material. The lab uses this information to make certain that samples consisting of multiple bags are processed together.

TOTAL NUMBER OF BAGS SENT:

Enter the total number of bags contained in the shipment. The laboratory staff will compare the number on this shipping form to the number of bags that they receive in order to make sure that no samples are missing.

11.9.2 Government Regulations For Pest-Regulated States (Southern Region, NY, AZ, NM, CA, and HI)

In order to limit the movement of agricultural pests (e.g., fire ant, corn cyst nematode, golden nematode, witchweed, and Mexican fruit fly), the shipment of soil samples across state boundaries is strictly regulated by the USDA. States with these pests are primarily located in the southern United States and include AL, AR, FL, GA, LA, MD, MS, NC, OK, SC, TN, and TX); soil shipments are also regulated in AZ, NM, CA, HI, and NY. In order to receive a permit to accept soil samples from these areas, the soil labs have had to sign a compliance agreement with the Plant Protection and Quarantine program of the USDA Animal and Plant Health Inspection Service (APHIS) and pass an inspection.

The burden for meeting APHIS shipping regulations falls on the field crews. Crews must:

- Double bag or enclose all samples from a shipment within a larger plastic bag (i.e., trash bag).
- Attach a shipping label to the outside of the box .
- Attach a regulated soils label showing the regional lab's APHIS permit number to the box.

After analysis, all soil samples must be stored or disposed of in the prescribed manner.

11.10 TASKS THAT CAN BE PERFORMED BY OTHER CREW MEMBERS

In order to maximize efficiency on the plot, crew members not trained in the soil indicator may be asked to assist with certain tasks related to sample collection. These tasks include:

- Locating the sampling site (with instruction from trained crew member).
- Assembling the impact driven corer.
- Filling in bag labels and sample shipping forms (Note: these should be checked by trained crew member prior to leaving the plot to ensure completeness and accuracy).
- Cleaning the core liners and the coring head.
- Disassembling the impact driven corer.

11.11 REFERENCES

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11.12 ACKNOWLEDGEMENTS

The National Advisor for this indicator may be contacted at: Michael Amacher, USDA Forest Service, Rocky Mountain Research Station, 860 N. 1200 E, Logan UT 84321, via phone at (435) 755-3560 or via email at mamacher@fs.fed.us .

11.13 EXAMPLE DATA SHEETS

Soil Data Sheet 1
FIA Phase 3 Soil Sampling Site Measurements

State: ___ ___ County: ___ ___ ___ P2 Plot #: ___ ___ ___ ___
P3 Hexagon #: ___ ___ ___ ___ ___ ___ ___ Plot #: ___ Soil Visit #: ___
Date: ___/___/_____ Crew Member(s): ____

Soil Sampling Site Information

Soil Sampling Site Adjacent To:	Condition Class	Sampling Code	Sampler Min 1	Sampler Min 2
Subplot 2:	______	______	____	____
Subplot 3:	______	______	____	____
Subplot 4:	______	______	____	____

Sampling Codes
1 = Sampled
2 = Not sampled: non-forest
3 = Not sampled: too rocky
4 = Not sampled: water
5 = Not sampled: access denied
6 = Not sampled: too dangerous
7 = Not sampled: obstruction in sample area
8 = Not sampled: broken or lost equipment
9 = Not sampled: other (enter reason in plot notes)

Sampler
1 = Bulk density
2 = Other

Forest Floor Thickness (cm)

	N	E	S	W
Subplot 2 Soil Sampling Site:	_____	_____	_____	_____
Subplot 3 Soil Sampling Site:	_____	_____	_____	_____
Subplot 4 Soil Sampling Site:	_____	_____	_____	_____

Litter Layer Thickness (cm)

	N	E	S	W
Subplot 2 Soil Sampling Site:	_____	_____	_____	_____
Subplot 3 Soil Sampling Site:	_____	_____	_____	_____
Subplot 4 Soil Sampling Site:	_____	_____	_____	_____

Depth to Subsoil Restrictive Layer (cm)

Subplot 2 Soil Sampling Site: _____
Subplot 3 Soil Sampling Site: _____
Subplot 4 Soil Sampling Site: _____

Field Texture Determination

Subplot 2 Soil Sampling Site:	Mineral 1 (0-4 in)	_____
	Mineral 2 (4-8 in)	_____
Subplot 3 Soil Sampling Site:	Mineral 1 (0-4 in)	_____
	Mineral 2 (4-8 in)	_____
Subplot 4 Soil Sampling Site:	Mineral 1 (0-4 in)	_____
	Mineral 2 (4-8 in)	_____

Soil Texture Codes
0 = Organic
1 = Loamy
2 = Clayey
3 = Sandy
4 = Coarse sandy

Note to regular field crews: Collect mineral 1 and mineral 2 samples from forested sampling sites adjacent to subplot 2 only

Soil Data Sheet 2
FIA Phase 3 Soil Erosion and Compaction Measurements

State: ___ ___ County: ___ ___ ___ P2 Plot #: ___ ___ ___ ___

P3 Hexagon #: ___ ___ ___ ___ ___ ___ ___ Plot #: ___ Soil Visit #: ___

Date: ___/___/_____ Crew Member(s): ____

____

Soil Erosion Measurements:

Subplot	Bare Soil[a] (%)
1	
2	
3	
4	

[a] Percent area estimate for forested portion of subplot

Soil Compaction Measurements:

Measurement	Subplot 1	Subplot 2	Subplot 3	Subplot 4
% Forested Area Compacted				
Type - Rutted Trail				
Type - Compacted Trail				
Type - Compacted Area				
Type - Other (Explain)*				

*Explanations: ____

____

____

Section 12. Crowns: Measurements and Sampling

12.1 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.

VIGOR CLASS, UNCOMPACTED LIVE CROWN RATIO, CROWN LIGHT EXPOSURE and CROWN POSITION are determined for each sapling. Foliage below the point used for UNCOMPACTED LIVE CROWN RATIO is not considered in VIGOR CLASS determination. All sapling measurements are done during plot establishment and whenever plot remeasurement occurs.

Crown evaluations, including UNCOMPACTED LIVE CROWN RATIO, LIGHT EXPOSURE, POSITION, DENSITY, DIEBACK, and TRANSPARENCY are made on all trees with DBH/DRC (DRC in the West) 5.0 inches or larger. Trees with high scores for UNCOMPACTED LIVE CROWN RATIO and DENSITY, and low scores for DIEBACK and FOLIAGE TRANSPARENCY have increased potential for carbon fixation, nutrient storage and increased potential for survival and reproduction. 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 (Figure 12.3). 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: (1) taking an average, if the numbers differ by 10 percent (2 classes) or less; (2) changing positions, if the numbers differ by 15 percent or more and attempting to narrow the range to 10 percent or less if crew members cannot agree; or (3) 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).

12.2 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. Normally, silhouettes are derived from vigorous, open grown trees and tend to be species-specific. For Phase 3 purposes, 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 tree.

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

Live Branch
A live branch is any woody lateral growth supporting foliage, and is 1.0 inch 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 5.0 inches DBH/DRC may have only live twigs which have not yet reached 1.0 inch 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 for these smaller branched trees until the tree matures to a point where twigs have attained 1.0 inch or larger in diameter at the base above the swelling where it joins a main stem or larger branch.

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 5.0 inches DBH/DRC or greater, if any live branch is within 5 feet 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 feet of the foliage of the lowest qualifying branch (Figure 12-1).

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-foot 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.

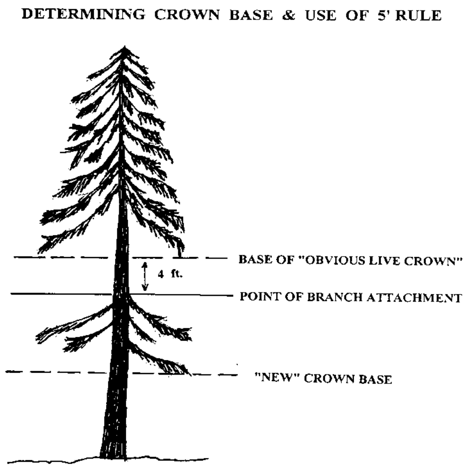


Figure 12-1. Determining the base of the live crown.

Overstory Canopy Zone
The area delineated by the average live crown height determined from the UNCOMPACTED LIVE CROWN RATIO of 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.

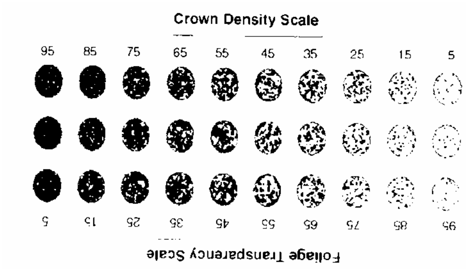
Snag Branch
A dead upper crown branch without twigs or sprigs attached to it. A lower branch on woodland trees such as juniper is not considered a snag branch unless the branch reaches into the upper crown, or reached into the upper crown when the branch was alive. A branch that died due to shading in any crown is not a snag branch.

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.

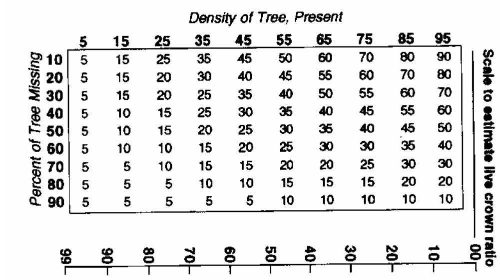
Twig
Any woody lateral growth, with secondary branching, less than 1.0 inch in diameter at the base above the swelling at the point of attachment to a branch or crown stem.

12.3 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

Figure 12-2. Density-Transparency card

The crown density - foliage transparency card (Figure 12-2) 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.

12.4 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 evaluating trees from the down slope side should be avoided.

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 12-3). 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.

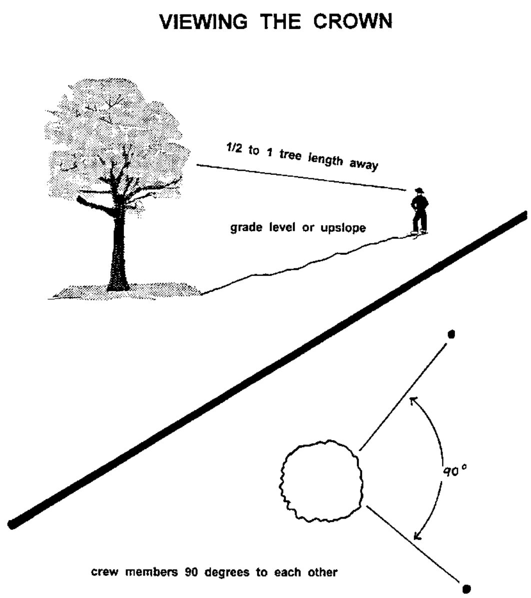


Figure 12-3. Crew positions for viewing crowns.

Climatic conditions -
Cloudy or overcast skies, fog, rain and poor sun angles may affect the accuracy of crown estimates. Crews need to be especially careful during poor lighting conditions to obtain the best possible view of the crown for the given climate conditions.

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 PDR tree note field that it is leaning (Figure 12-5). 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: UNCOMPACTED LIVE CROWN RATIO = 00, CROWN LIGHT EXPOSURE = 0, CROWN POSITION = 3, CROWN DENSITY = 00, CROWN DIEBACK = 99, FOLIAGE TRANSPARENCY = 99. This combination of codes is a flag for trees with no crowns.

After a sudden release or damage, a sapling may have very dense foliage, but no crown as it only has sprigs. These situations are coded as follows: UNCOMPACTED LIVE CROWN RATIO = 00, CROWN LIGHT EXPOSURE = 0, CROWN POSITION = 3, sapling VIGOR = 3. This combination of codes is a flag for saplings with no crowns.

12.5 UNCOMPACTED LIVE CROWN RATIO (UCRC)

UNCOMPACTED LIVE CROWN RATIO is a percentage determined by dividing the live crown height by the total live tree height (Figure 12-5).

Saplings

Determine sapling UNCOMPACTED LIVE CROWN RATIO by dividing the live crown height by total tree height to the live crown top, then enter the appropriate code into the PDR. Live crown height is the distance between the top live foliage (dieback and dead branches are not included) and the lowest live foliage on the lowest live twig for saplings. Be sure to eliminate vine foliage as best you can when determining the live crown. The live crown base for saplings is different from trees 5.0 inches DBH/DRC and larger. The 5-foot/1-inch rule does not apply in this case. Do not include sprigs or leaves on the main stem below the lowest live twig (Figure 12-4).

When the two estimates do not agree, follow the guidelines listed at the end of section 12.1 *Overview*. The estimate is placed into one of 21 percentage classes.

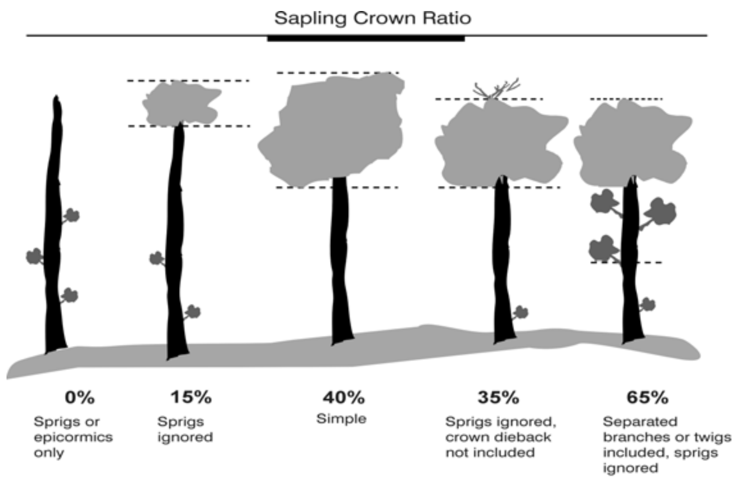


Figure12-4. Sapling UNCOMPACTED LIVE CROWN RATIO determination examples.

Measure leaning saplings as they are (Figure 12-5).

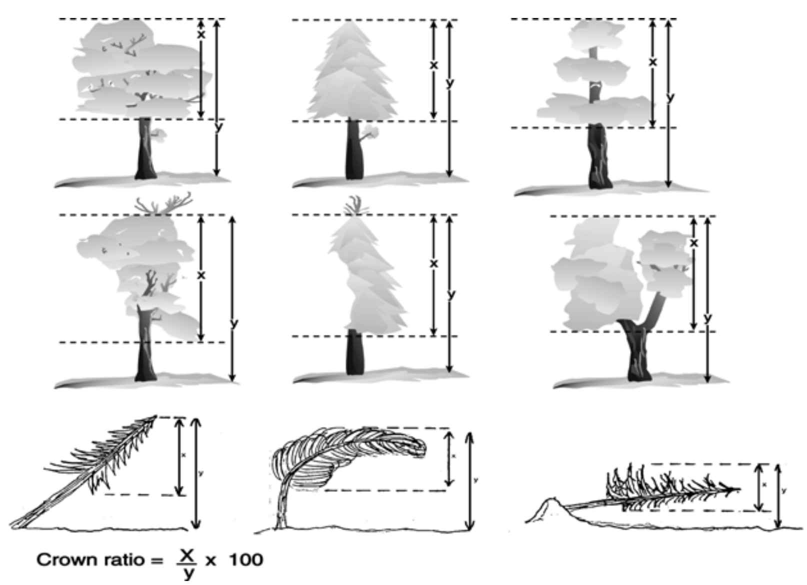


Figure 12-5. UNCOMPACTED LIVE CROWN RATIO examples.

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 (Figure 12-6). 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 inch and are within 5.0 feet of the base of the obvious live crown (Figure 12-1). 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-inch diameter branches. If this occurs, use the 5.0-foot rule, and apply it to branches that you feel contribute significantly to tree growth.

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 12-2). 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 12.1 *Overview*. The estimate is placed into one of 21 percentage classes.

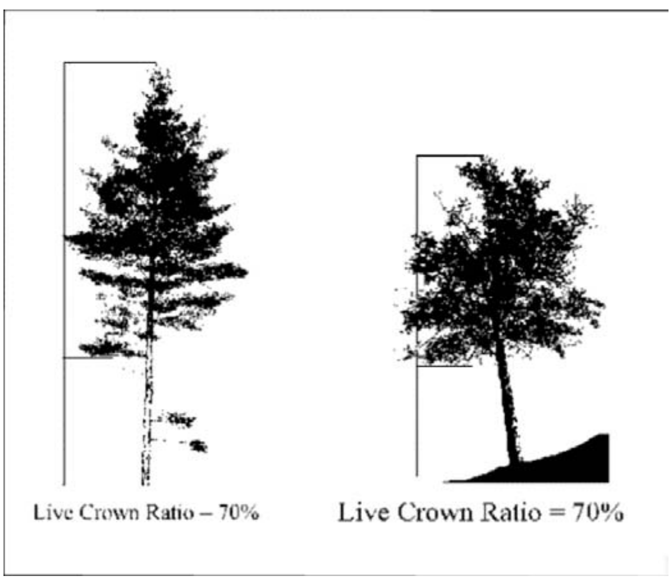


Figure 12-6. UNCOMPACTED LIVE CROWN RATIO outline and rating examples

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

MQO: At least 90% of the time
Values:

Code	Definition	Code	Definition	Code	Definition
00	No crown	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.

12.6 CROWN LIGHT EXPOSURE (CRLE)

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 12-7).

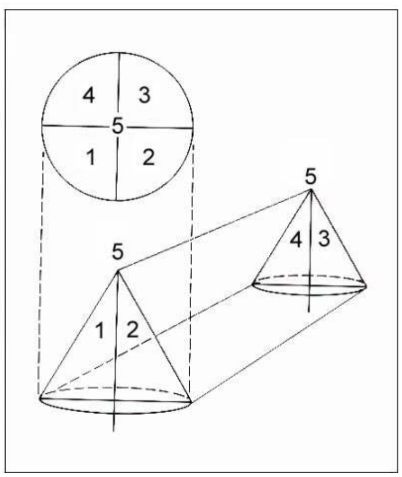


Figure 12-7. Dividing the crown.

Note: The entire side (25 percent 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 percent UNCOMPACTED LIVE CROWN RATIO can have a maximum crown exposure of one. Individual sides with less than 35 percent UNCOMPACTED LIVE CROWN RATIO should not be counted (Figure 12-8).

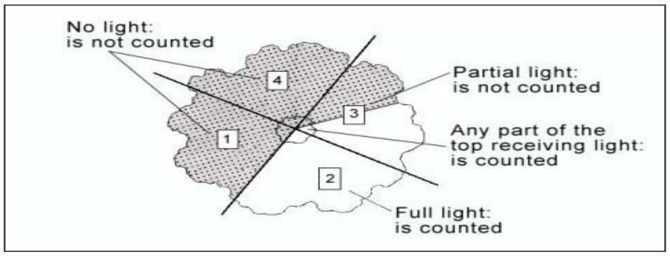


Figure 12-8. CROWN LIGHT EXPOSURE.

When collected: All live trees $\geq$ 1.0 in DBH/DRC
Field width: 1 digit
Tolerance: within 1 if > 0
MQO: At least 85% of the time
Values:

Code	Definition
0	The tree receives no full light because it is shaded by trees, vines, or other vegetation; the tree has no crown by definition.
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.

12.7 CROWN POSITION (CRPO)

Determine the relative position of each tree in relation to the overstory canopy zone (Figure 12-9). 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 acre in size, then assign code 4. When code 4 is used, it is assigned to all trees in the stand except trees with no crown by definition. Code 4 is typically used in the following cases:

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

Code 1 is not used for saplings.

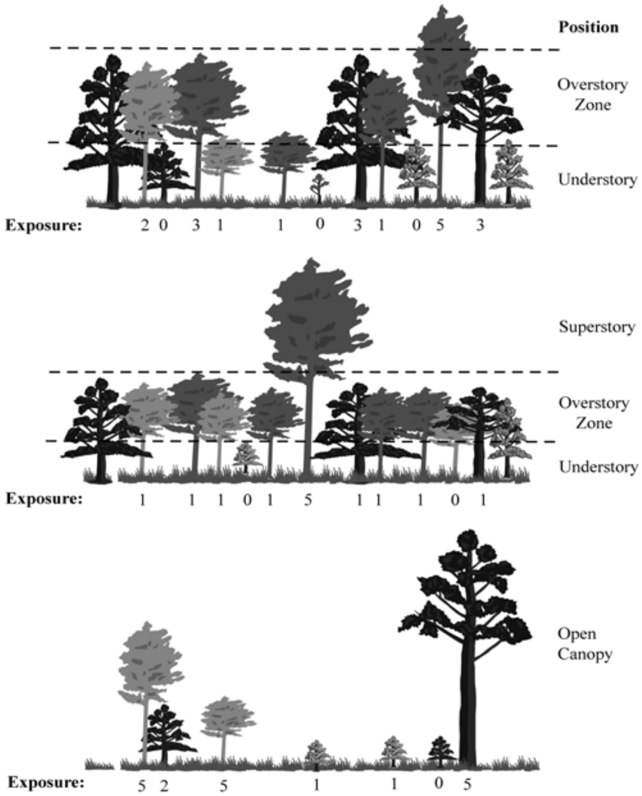


Figure 12-9. CROWN LIGHT EXPOSURE and CROWN POSITION.

When collected: All live trees ≥ 1.0 in DBH/DRC
Field width: 1 digit
Tolerance: No errors
MQO: At least 85% of the time
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.). NOT USED FOR SAPLINGS.
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, or tree has no crown by definition.
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.

12.8 CROWN VIGOR CLASS (CRVC)

See Figure 12-10 for a visual description of the sapling CROWN VIGOR classes.

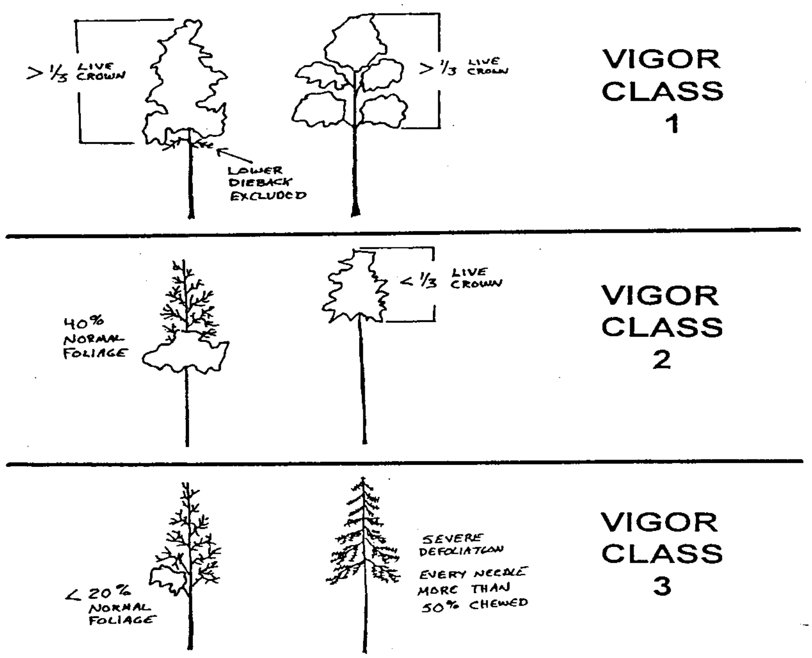


Figure 12-10. Sapling CROWN VIGOR classes.

When collected: All live trees $\geq$ 1.0 in DBH/DRC and < 5.0 in DBH/DRC
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

Class/Code	Definition
1	Saplings must have an UNCOMPACTED LIVE CROWN RATIO of 35 or higher, have less than 5 percent DIEBACK (deer/rabbit browse is not considered as dieback but is considered missing foliage) and 80 percent or more of the foliage present is normal or at least 50 percent of each leaf is not damaged or missing. Twigs and branches that are dead because of normal shading are not included.
2	Saplings do not meet Class 1 or 3 criteria. They may have any UNCOMPACTED LIVE CROWN RATIO, may or may not have DIEBACK and may have between 21 and 100 percent of the foliage classified as normal.
3	Saplings may have any UNCOMPACTED LIVE CROWN RATIO and have 1 to 20 percent

normal foliage or the percent of foliage missing combined with the percent of leaves that are over 50 percent damaged or missing should equal 80 percent or more of the live crown. Twigs and branches that are dead because of normal shading are not included. Code is also used for saplings that have no crown by definition.

12.9 CROWN DENSITY (CRDN)

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.

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. Include missing or dead tops. Project half-sided trees as full crowns by using the "mirror image" of the existing half of the crown. Foliage below the crown base is not included (Figure 12-1). Include CROWN DIEBACK and open areas in this outline (Figures 12-11 and 12-12).

After determining the crown shape, each person should use the crown density - foliage transparency card (Figure 12-2). 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 12.1 *Overview*. The estimate is placed into one of 21 percentage classes.

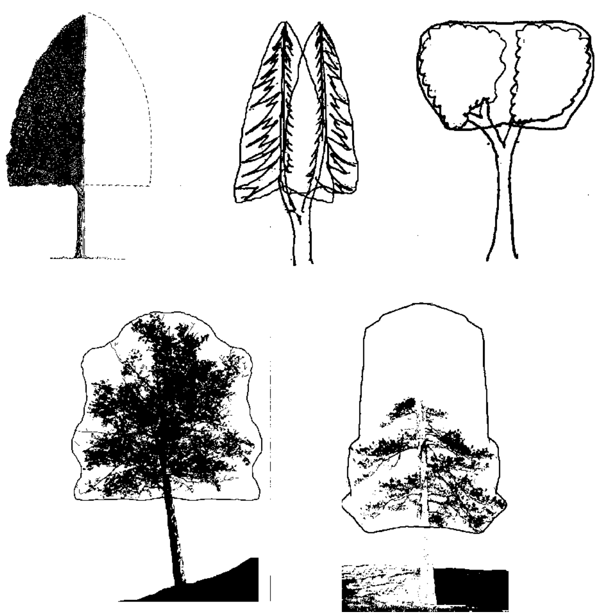


Figure 12-11. CROWN DENSITY rating outline examples.

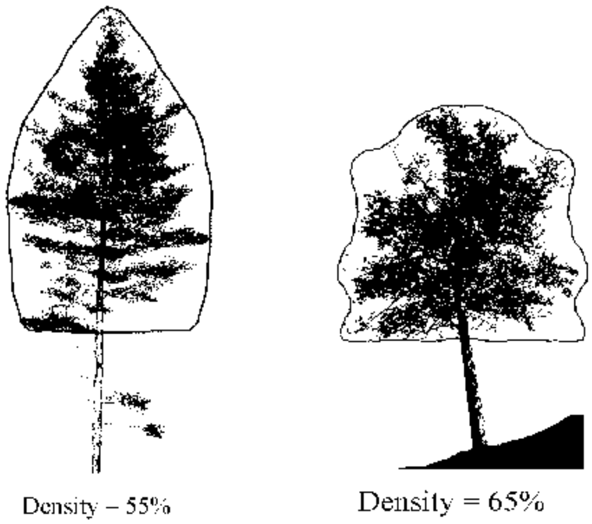


Figure 12-12. Crown density outline and rating examples

When collected: All live trees ≥ 5.0 in DBH/DRC
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: At least 90% of the time
Values:

Code	Definition	Code	Definition	Code	Definition
00	No crown	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

12.10 CROWN DIEBACK (CRDB)

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, excluding snag branches and large holes or gaps in the crown (Figures 12-13 and 12-14).

Project 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 12.1 *Overview*. The estimate is placed into one of 21 percentage classes.

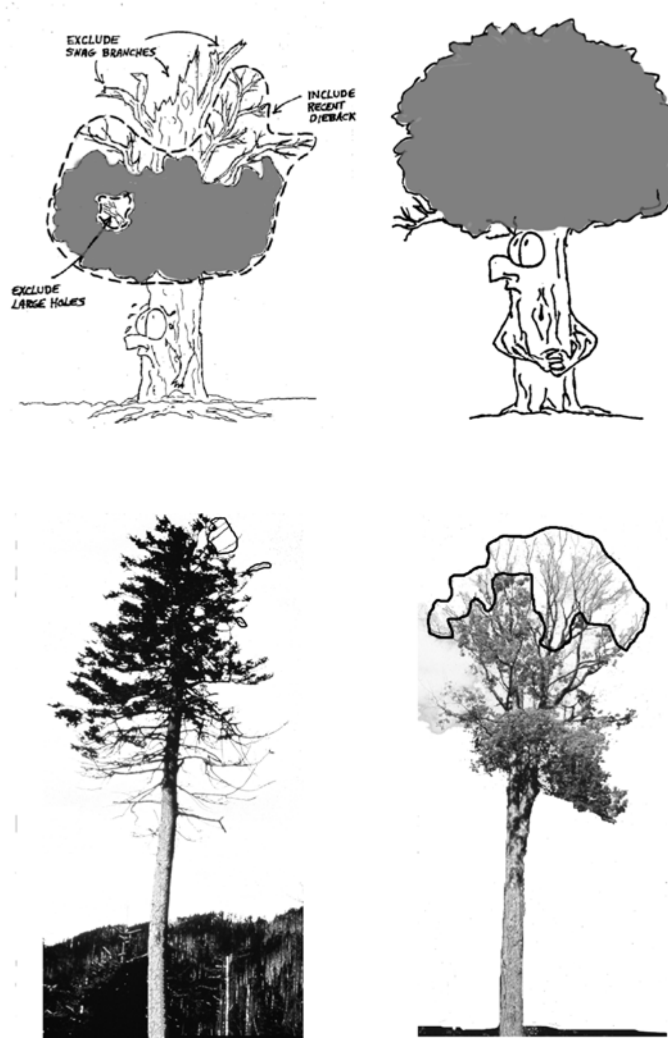


Figure 12-13. CROWN DIEBACK rating outline examples.

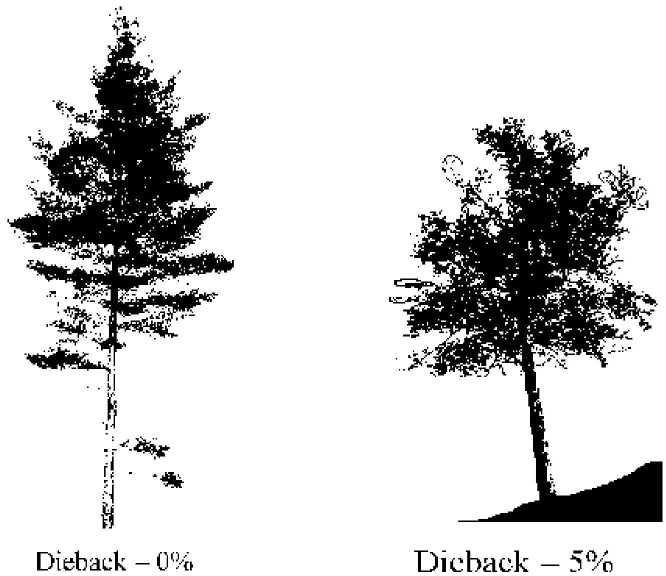


Figure 12-14. Dieback outline and rating examples.

When collected: All live trees ≥ 5.0 in DBH/DRC
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: At least 90% of the time
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.

12.11 FOLIAGE TRANSPARENCY (CRTR)

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 defoliation or stresses during the current or preceding years.

Estimate FOLIAGE TRANSPARENCY using the crown density - foliage transparency card (Figure 12-2). 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 12-15).

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 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.

Project a two-dimensional crown outline. Determine the foliated area within the crown outline and estimate the transparency of the normally foliated area.

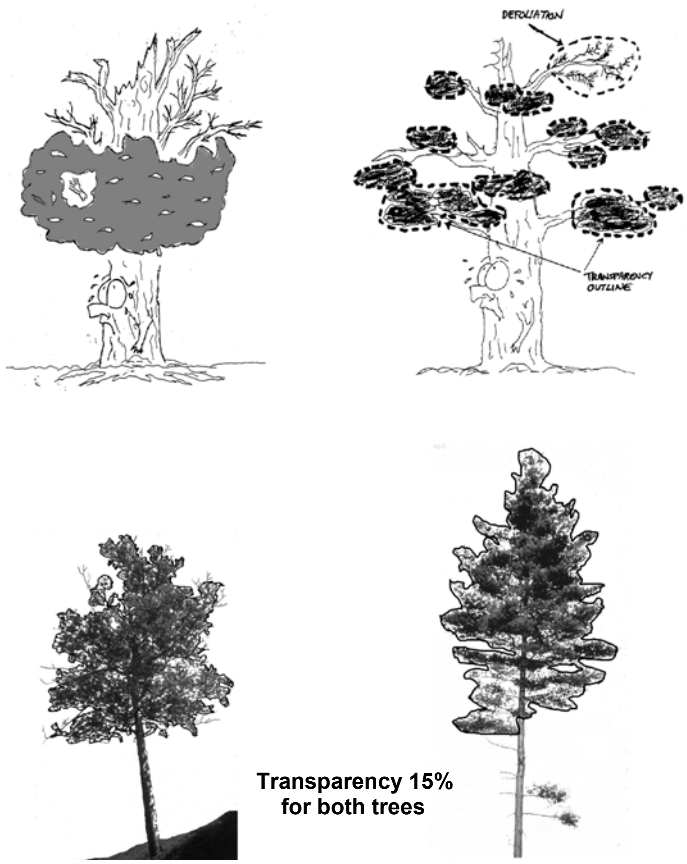


Figure 12-15. FOLIAGE TRANSPARENCY rating outline examples.

When collected: All live trees $\geq$ 5.0 in DBH/DRC
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: At least 90% of the time
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.

12.12 ACKNOWLEDGEMENTS

Contact information for the National Advisor for this indicator is: Michael Schomaker, 5400 Vardon Way, Fort Collins, CO 80528-9114 or email mschomak@lamar.colostate.edu .

Section 14. Down Woody Materials

14.0 INTRODUCTION

Down woody materials (DWM) are an important component of forest ecosystems across the country. DWM is dead material on the ground in various stages of decay. Wildlife biologists, ecologists, mycologists, foresters, and fuels specialists are some of the people interested in DWM because it helps describe the:

- Quality and status of wildlife habitats.
- Structural diversity within a forest.
- Fuel loading and fire behavior.
- Carbon sequestration – the amount of carbon tied up in dead wood.
- Storage and cycling of nutrients and water – important for site productivity.

Down woody components and fuels estimated by the FIA program are: coarse woody, fine woody, litter, herb/shrubs, slash, duff, and fuelbed depth. Any crew member can learn to collect down woody materials data. If untrained members of the crew are available to help, they can locate, measure, and flag transect lines and record the condition class information for the transect segments.

DWM is only sampled in accessible forest conditions intersected by the transect. If a transect crosses a nonforest condition, the boundaries of the condition are recorded (see section 14.3) but no DWM or fuels measurements are taken along this portion of the transect. The majority of DWM in the inventory is sampled using the line intersect sampling method (also called planar intercept method). In this method, transects are established, and individual pieces of CWD or FWD are tallied if the central axis of the piece is intersected by the plane of the transect. In addition, each piece must meet specified dimensions and other criteria before being selected for tally. Special procedures apply when a CWD piece lays across a condition class boundary (section 14.2). Transects will always be used to sample FWD. Transects will be used to sample CWD when crews are able to see and measure individual pieces.

The line intersect method is not practical for sampling CWD when it is part of machine-piled windrows or slash piles, or part of log "jumbles" at the bottom of steep-sided ravines. In these situations, individual pieces are impractical to tally separately and are labeled as “residue piles”. A different sampling method is used to tally and measure CWD residue piles (see section 14.8, Sampling Residue Piles).

14.1 DEFINITION OF DOWN WOODY MATERIALS

CWD – In this inventory, CWD includes downed, dead tree and shrub boles, large limbs, and other woody pieces that are severed from their original source of growth and on the ground. CWD also includes dead trees (either self-supported by roots, severed from roots, or uprooted) that are leaning > 45 degrees from vertical. Also included are non-machine processed round wood such as fence posts and cabin logs. For multi-stemmed woodland trees such as juniper, only tally stems that are dead, detached, and on the ground; or dead and leaning > 45 degrees from vertical.

CWD does not include:

1. Woody pieces < 3.0 inches in diameter at the point of intersection with the transect.
2. Dead trees leaning 0 to 45 degrees from vertical.
3. Dead shrubs, self-supported by their roots.
4. Trees showing any sign of life.
5. Stumps that are rooted in the ground (i.e., not uprooted).
6. Dead foliage, bark or other non-woody pieces that are not an integral part of a bole or limb. (Bark attached to a portion of a piece is an integral part).
7. Roots or main bole below the root collar.

FWD – In this inventory, FWD includes downed, dead branches, twigs, and small tree or shrub boles that are not attached to a living or standing dead source. FWD can be connected to a larger branch, as long as this branch is on the ground and not connected to a standing dead or live tree. Only the woody branches, twigs, and fragments that intersect the transect are counted. FWD can be connected to a down, dead tree bole or down, dead shrub. FWD can be twigs from shrubs and vines. FWD must be no higher than 6 feet above the ground to be counted.

FWD does not include:

1) Woody pieces ≥ 3.0 inches in diameter at the point of intersection with the transect.
2) Dead branches connected to a live tree or shrub; or to a standing dead tree or dead shrub.
3) Dead foliage (i.e., pine or fir needles, or leaf petioles).
4) Bark fragments or other non-woody pieces that are not an integral part of a branch, twig, or small bole.
5) Small pieces of decomposed wood (i.e., chunks of cubical rot)

14.2 LOCATING AND ESTABLISHING LINE TRANSECTS

Transects are established on each subplot if the subplot center is accessible (i.e., not census water, access denied, or hazardous), and there is at least one forest land condition class mapped within the 24.0-foot radius subplot (CONDITION CLASS STATUS = 1). Transects begin at the subplot center and extend 24.0 feet to the edge of the subplot. The location of condition class boundaries are recorded along the transect. It is extremely important to lay out the transect in a straight line to avoid biasing the selection of pieces and to allow the remeasurement of transect lines and tally pieces for future change detection.

Transect lines should be marked with a pin or small piece of flagging at the end of the line (24.0 feet, horizontal distance) to help the QA staff identify the path of the transect during the check-plot procedure. Because the tolerance for the transect azimuth is +/- 2 degrees, the line might have been laid down in a slightly different direction from the check-plot crew. This could affect the location of diameter measurements for CWD pieces as well as identifying whether a CWD piece is a valid tally piece. It is also helpful to mark the point where the FWD transect begins (14 feet, slope distance).

14.2.1 CWD transects

Three transects are established that originate at the subplot center and extend out 24.0 feet horizontal distance (the radius of the subplot) at azimuths of 30, 150, 270 degrees (Figure 14-1). This transect configuration was chosen to avoid sampling bias on sloped land, where it is possible that CWD may be oriented in one direction. This configuration of transects should pick up CWD logs that are lying parallel to the slope, perpendicular to the slope, and across slope.

14.2.2 FWD transects

One transect is established on each subplot, along the 150 degree azimuth. FWD is tallied within 3 size classes. Because FWD is generally present in higher densities, a shorter transect will pick up an acceptable amount of tally. The transect begins at 14 feet (slope distance) from the subplot center and extends out either 6 or 10 feet (slope distance) depending on the FWD size class, as follows:

Category of FWD	Size Class	Diameter range	Transect length (slope distance)	Transect location (slope distance)
Small FWD	1	0 in to 0.24 in	6 feet	14 to 20 feet
Medium FWD	2	0.25 in to 0.9 in	6 feet	14 to 20 feet
Large FWD	3	1.0 in to 2.9 in	10 feet	14 to 24 feet

Note that the FWD transects are slope distance not horizontal distance. The formulas used to estimate biomass from the data contain an adjustment for slope. It is helpful to have a size gauge available until your eye is 'trained' to recognize the 3 size classes. Examples include a plastic or cardboard card with 3 notches cut for each size class, or a set of 3 dowels representing each size class.

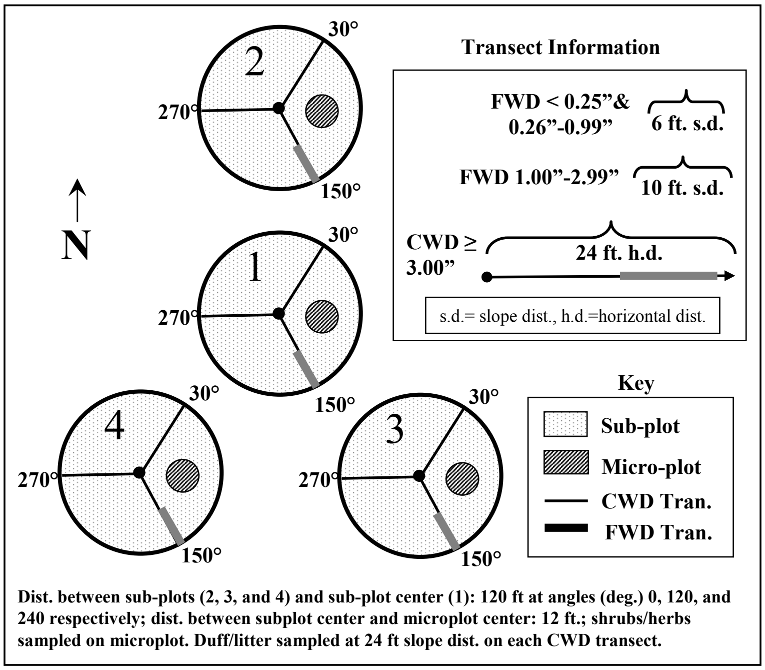


Figure 14-1. Plot layout for sampling CWD, FWD, and fuels.

14.3 TRANSECT LINE SEGMENTING

Transect lines are segmented to determine the length of transect that occurs within each mapped condition class intersecting the line. A segment is a length of transect that is in one condition. Segments are identified by recording the BEGINNING DISTANCE and ENDING DISTANCE of the slope from subplot center out to the end of the subplot. In the office, the segmenting data will be combined with CWD distances to determine which condition class each piece falls in (condition classes are not assigned to CWD pieces in the field). If more than one condition is found on the FWD transects, the segmenting information recorded here will provide the length of transect in each condition.

Starting at the subplot center and working towards the fixed radius plot boundary, each segment of transect line in a different condition class is delineated and recorded as a separate record. On each record, the BEGINNING DISTANCE and ENDING DISTANCE of the slope are recorded for each condition class encountered. The first record for each transect will have a BEGINNING DISTANCE of 0 feet. If only one condition class occurs on the transect line, only one segment is recorded. The transect must extend a total of 24.0 feet horizontal distance. If the entire 24.0-foot subplot is nonforest, enter codes for SUBPLOT NUMBER, TRANSECT, CONDITION CLASS NUMBER, followed by zeros in the remaining fields.

On subplots where a transect intersects a boundary between condition classes, the transect continues across the boundary into the adjacent class (Figure 14-2). Although DWM is only sampled in accessible forest conditions, all CONDITION CLASS BOUNDARIES (BEGINNING DISTANCE and ENDING DISTANCE) are recorded on each transect.

Individual pieces of DWM intersected by a transect are tallied or counted if they meet the tally rules for CWD or FWD specified in the sections that follow. It is expected that the majority of FWD transects will be in one condition, but if the condition class changes along the transect, a count is recorded for each condition. Again, the segmenting data recorded here will identify which condition class is associated with each count.

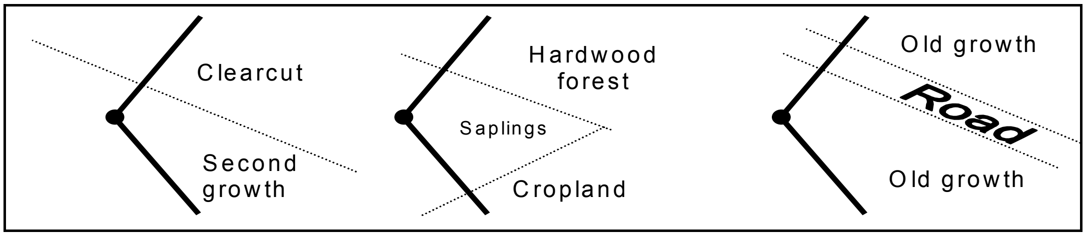


Figure 14-2. Transects are installed across condition class boundaries.

14.3.1 SUBPLOT NUMBER

Record the code indicating the subplot center from which the transect originates.

When collected: All tally segments
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 4

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

14.3.2 TRANSECT

Record the code indicating the transect on which a condition class is being delineated. The three transects used are 30 degrees, 150 degrees, and 270 degrees. These transects, when being installed, have a tolerance of +/- 2 degrees.

When Collected: All tally segments
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

030	Transect extends 30 degrees from subplot center
150	Transect extends 150 degrees from subplot center
270	Transect extends 270 degrees from subplot center

14.3.3 CONDITION CLASS NUMBER

Record the code indicating the number of the condition class for the transect segment. Use the same code assigned to the condition class on the subplot or elsewhere on the plot. The first segment recorded for each transect will have the same CONDITION CLASS NUMBER as assigned to the subplot center.

When collected: All tally segments
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

14.3.4 BEGINNING DISTANCE

Record the location (using slope distance) on the transect line where the transect intersects the boundary with the adjacent condition class nearer to the subplot center. The first record for each transect will have a BEGINNING DISTANCE of 00.0 ft. Each subsequent record will have a BEGINNING DISTANCE equal to the ENDING DISTANCE of the previous record. Measure to the nearest 0.1 ft.

When collected: All tally segments
Field width: 3 digits
Tolerance: +/- 1.0 ft
MQO: At least 95% of the time
Values: 00.0 to 99.9

14.3.5 SLOPE PERCENT

Record the code indicating the average slope percent along the transect within the condition class being segmented. When only one condition class is present on a transect, slope percent is the average slope percent along the entire transect. Measure to the nearest 5%.

When collected: All tally segments
Field width: 3 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 005 to 155

14.3.6 ENDING DISTANCE

Record the location (using slope distance) on the transect line where the transect exits the condition class being delineated and intersects the boundary with a different condition class further away from the subplot center. If no other condition classes are encountered, record the location (using slope distance) of the end of the transect line. Measure to the nearest 0.1 foot.

When collected: All tally segments
Field width: 3 digits
Tolerance: +/- 1.0 ft
MQO: At least 95% of the time
Values: 00.1 to 99.9

14.4 Sampling Methods for COARSE WOODY DEBRIS (CWD)

14.4.1 Tally Rules for Coarse Woody Debris (CWD)

1. Coarse woody debris (CWD) is sampled in accessible forest land conditions only.
   Tally a piece if its central longitudinal axis intersects the transect, and the condition class is accessible forest land at the point of intersection (Figure 14-3). The entire piece is assigned to this condition.

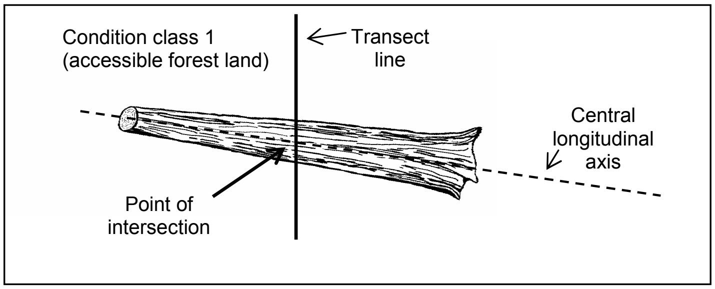


Figure 14-3. Tally rules for CWD.

2. Tally dead trees and tall stumps that are leaning > 45 degrees from vertical. Do not tally live trees or standing dead trees and stumps that are still upright and leaning < 45 degrees from vertical. Follow the same rules for down trees as outlined in section 5.0 'Tree and Sapling Data' from the P2 field guide. Most CWD will be laying on the ground.

3. The minimum length of any tally piece is 3.0 feet. When CWD pieces are close to 3 feet, measure the length to the nearest 0.1 f00t to determine if it is ≥3.0 feet.

4. Decay class of the piece determines whether or not the piece is tallied (see section 14.4.3.4).

   For decay classes 1 to 4: tally a piece if it is ≥ 3.0 inches in diameter at the point of intersection with the transect. The piece must be ≥ 3.0 feet in length and ≥ 3.0 inches or more in diameter along that length. If the intersect diameter is close to 3.0 inches, measure the diameter to the nearest 0.1 inch to determine if the piece qualifies (Figure 14-4).

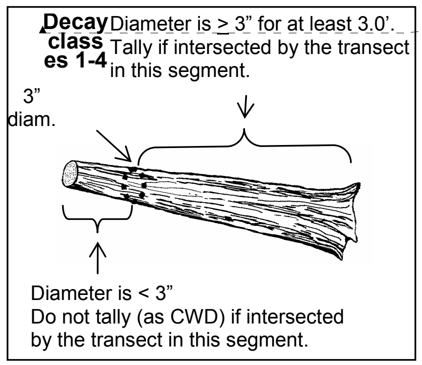


Figure 14-4. CWD tally rules for decay classes 1-4.

   For decay class 5: tally a piece if it is ≥ 5.0 inches in diameter at the point of intersection and ≥ 5.0 inches high from the ground. The piece must be ≥ 3.0 feet in length and ≥ 5.0 inches or more in diameter along that length. The reason for treating decay class 5 pieces differently is because they are difficult to identify, especially when heavily decomposed. Only pieces that still have some shape and log form are tallied—humps of decomposed wood that are becoming part of the duff layer are not tallied.

5. Tally pieces created by natural causes (examples: natural breakage or uprooting) or by human activities such as cutting only if not systematically machine-piled. Do not record pieces that are part of machine-piled slash piles or windrows, or that are part of a log "jumble" at the bottom of a steep-sided ravine in which individual pieces are impractical to tally separately. Instead, sample these piles according to instructions in section 14.8 'Sampling Residue Piles'. A slash pile or windrow consists of broken logs, limbs, and other vegetative debris.

6. Tally a piece only if the point of intersection occurs above the ground. If one end of a piece is buried in the litter, duff, or mineral soil, the piece ends at the point where it is no longer visible. Measure the diameter and length at this point.

7. If the central longitudinal axis of a piece is intersected more than once on a transect line or if it is intersected by two transect lines, tally the piece each time it is intersected (uncommon situation, see Figure 14-5).

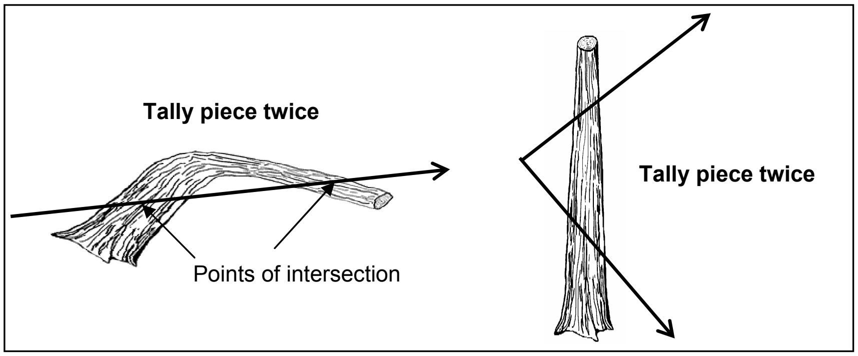


Figure 14-5. CWD tally rules: intersections.

8. Tally a piece only once if the subplot center falls directly on the central longitudinal axis of the piece. Tally the piece on the 30 degree transect and record the CWD Distance as 001.

9. If a piece is fractured across its diameter or length, and would pull apart at the fracture if pulled from either end or sides, treat it as two separate pieces. If judged that it would not pull apart, tally as one piece. Tally only the piece intersected by the transect line.

10. Do not tally a piece if it intersects the transect on the root side of the root collar. Do not tally roots.

11. When the transect crosses a forked down tree bole or large branch connected to a down tree, tally each qualifying piece separately. To be tallied, each individual piece must meet the minimum diameter and length requirements.

12. In the case of forked trees, consider the "main bole" to be the piece with the largest diameter at the fork. Variables for this fork such as TOTAL LENGTH and DECAY CLASS should pertain to the entire main bole. For smaller forks or branches connected to a main bole (even if the main bole is not a tally piece), variables pertain only to that portion of the piece up to the point where it attaches to the main bole (see Figure 14-6).

13. If a transect intersects a nonforest condition (e.g., a road), no CWD is tallied.

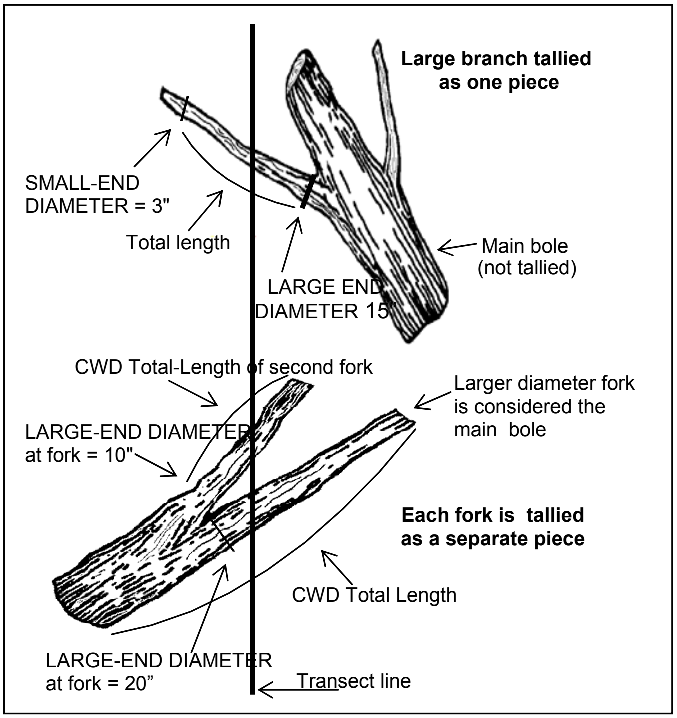


Figure 14-6. CWD tally rules for forked trees.

14.4.2 Marking CWD

Marking CWD is optional. Marked CWD is an aid to future crews returning to the plot for a QA check or to remeasure the plot at the next remeasurement period. Nails can be used to mark the location of the point of intersection, if the piece is in decay class 1, 2, or 3. Position the nail on top of the piece, and if possible, drive the nail into the piece so that about 1 inch of the nail is left exposed. Stop driving the nail if the next blow means breaking the piece or seriously disturbing the location of the piece. Please see section 14.3 Transect Line Segmenting, for information on the required marking of the transect line.

14.4.3 Recording Procedures for CWD

The tolerance for the total number of pieces ($\geq$ 3 inches, transect diameter) tallied across all transects on the plot is : +/- 2 piece or +/- 5%, whichever is greater for the plot. Note: always round up to a whole piece count when using the 5% option.

14.4.3.1 SUBPLOT NUMBER

Record the code indicating the number of the subplot center from which the transect originates.

When collected: All tally pieces
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 4

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

14.4.3.2 TRANSECT

Record the code indicating the azimuth of the transect on which the piece is sampled.

When Collected: All tally pieces
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

030	Transect extends 30 degrees from subplot center
150	Transect extends 150 degrees from subplot center
270	Transect extends 270 degrees from subplot center

14.4.3.3 CWD SLOPE DISTANCE

Record the code indicating the slope distance from the subplot center to the point where the transect intersects the longitudinal center of the piece. If two or more pieces have the same slope distances, record the top piece first. Measure and record to the nearest 0.1 feet. CWD SLOPE DISTANCE is an important item because it will be used to assign the CWD piece to a condition class by comparing the recorded distance to the piece with the recorded BEGINNING DISTANCE and ENDING DISTANCE to the condition class boundary. CWD SLOPE DISTANCE is also used to locate the piece for QA and remeasurement in future inventories.

When Collected: All tally pieces
Field width: 3 digits
Tolerance: +/- 1.0 ft
MQO: At least 90% of the time
Values: 00.1 to 99.9

14.4.3.4 CWD DECAY CLASS

Record a 1-digit code indicating the decay class of the piece. Code the decay class which predominates along the recorded CWD TOTAL LENGTH (14.4.3.7) of the piece. Use the guide below to determine CWD DECAY CLASS.

When Collected: All tally pieces
Field width: 1 digit
Tolerance: +/- 1 class
MQO: At least 90% of the time
Values:

Decay Class	Structural Integrity	Texture of Rotten Portions	Color of Wood	Invading Roots	Branches and Twigs
1	Sound, freshly fallen, intact logs	Intact, no rot; conks of stem decay absent	Original color	Absent	If branches are present, fine twigs are still attached and have tight bark
2	Sound	Mostly intact; sapwood partly soft (starting to decay) but can't be pulled apart by hand	Original color	Absent	If branches are present, many fine twigs are gone and remaining fine twigs have peeling bark
3	Heartwood sound; piece supports its own weight	Hard, large pieces; sapwood can be pulled apart by hand or sapwood absent	Reddish-brown or original color	Sapwood only	Branch stubs will not pull out
4	Heartwood rotten; piece does not support its own weight, but maintains its shape	Soft, small blocky pieces; a metal pin can be pushed into heartwood	Reddish or light brown	Through-out	Branch stubs pull out
5	None, piece no longer maintains its shape, it spreads out on ground	Soft; powdery when dry	Red-brown to dark brown	Through-out	Branch stubs and pitch pockets have usually rotted down

Note: CWD DECAY CLASS 5 pieces can be difficult to identify because they often blend into the duff and litter layers. They must still resemble a log, therefore, the first tally rule is that they must be > 5.0 inches in diameter, > 5.0 inches from the surface of the ground, and at least 3.0 feet long. Decomposed logs that are slightly elevated 'humps' on the ground are not tallied.

CWD DECAY CLASS: The chart above was developed primarily for Douglas-fir in the Pacific Northwest. At the present time, there are no other charts available to use to describe decay classes for other species or locations. Concentrate on the structural integrity and texture when estimating a decay class for CWD logs.

If a log is case hardened (hard, intact outer sapwood shell) but the heartwood is rotten, code this log as a CWD DECAY CLASS 2 with a HOLLOW PIECE code of 1. CWD DECAY CLASS 1 should be reserved for 'freshly fallen' logs that are completely intact (i.e., recent windfalls, or harvest).

14.4.3.5 SPECIES

Record the code indicating the species of the piece. Species codes are the same as those used in P2 (see Appendix 3 of the P2 field guide). Because CWD includes the tally of large shrub boles and woody vines, enter a code of '0001' for SPECIES if the tally piece is a shrub or vine.

Species identification may be uncertain for some pieces. The piece's bark (either attached or sloughed and laying beside the piece), branching pattern (if the branches are still present), or heartwood smell (particularly if cedars, Douglas-fir, or western hemlock) may provide clues. On remeasurement plots, see what tree species were tallied in past inventories. One way to distinguish hardwoods from softwoods is by the type of decay present. Hardwoods usually have a white or grayish stringy rot, while softwoods usually have a reddish-brown blocky rot. If it is not possible to identify the species, attempt to estimate if it is softwood or hardwood. Enter code 0299 for unknown conifer or 0998 for unknown hardwood. If all else fails, enter the unknown SPECIES code (0999).

When Collected: CWD DECAY CLASS = 1 to 4
Field width: 4 digits
Tolerance: No errors
MQO: At least 80% of the time
Values: See species codes in Appendix 3 of the P2 field guide.

14.4.3.6 Diameters
The diameter is most commonly measured by holding a tape above the log, at a position perpendicular to the length (Figure 14-7). It is useful to carry a steel carpenters retracting tape to measure diameters. Other methods include wrapping a tape around the bole if possible, holding a straight-edge ruler above the piece, or using calipers.

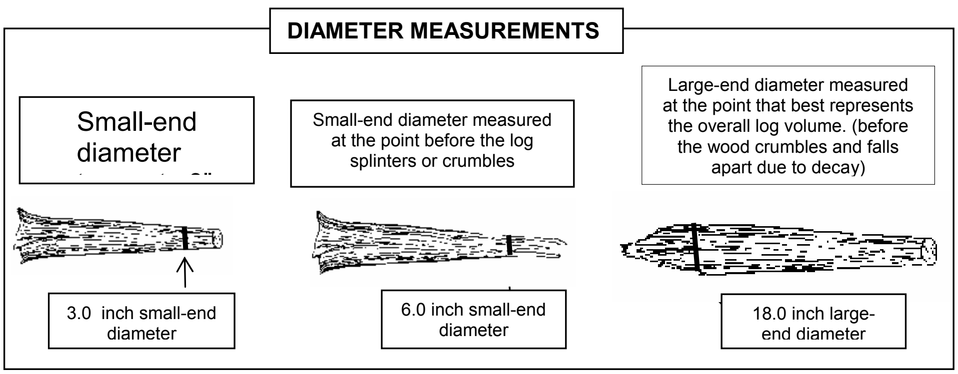


Figure 14-7. Diameter measurements

For pieces that are not round in cross-section because of missing chunks of wood or "settling" due to decay, measure the diameter in two directions and take an average. Estimate the longest and shortest axis of the cross-section ("A" and "B" in Figure 14-8), and enter the average in the diameter field. This technique applies to intersect, small-end, and large-end diameters.

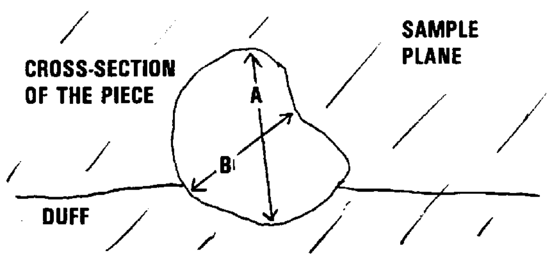


Figure 14-8. Estimating the diameter of pieces that are not round in cross-section.

If the transect intersects the log at the decayed or splintered end (Figure 14-9) (i.e., the portion where we do not consider it part of the log because it is falling apart), record the diameter at this location as the intersect diameter, but record the large end and small end diameter according to our established rules (i.e., at the points where they best represent the log volume). If the splintered end appears to be two separate pieces (i.e., a major split located just at the end) – in this situation treat it as one log and take a diameter around the end (take two measurements if it is odd shaped). Length would be measured between the large and small end diameters.

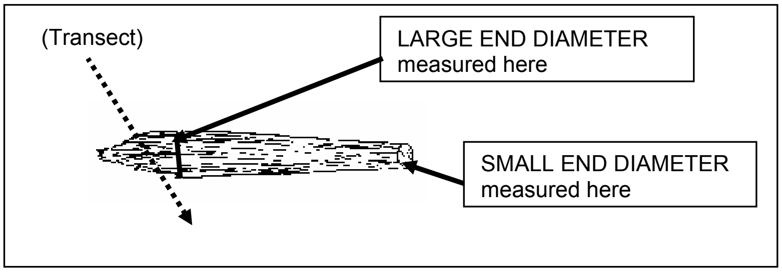


Figure 14-9. Example of decayed end intersecting the transect

14.4.3.6.1 DIAMETER AT POINT OF INTERSECTION

Record the code indicating the piece's diameter at the point where the transect intersects the longitudinal center of the piece. If the diameter is close to 3 inches, measure the diameter to the nearest 0.1 inch to determine if the piece is actually ≥3.0 inches and a valid tally piece. The diameter is recorded to the nearest inch.

When Collected: All tally pieces
Field width: 3 digits
Tolerance: Pieces < 20.0 in diameter: +/- 3 in
Pieces ≥ 20.0 in diameter: +/- 20%
MQO: At least 90% of the time
Values: 003 to 200

14.4.3.6.2 DIAMETER AT THE SMALL END

Record the code indicating the diameter at the piece's small end. The diameter is recorded to the nearest inch. The DIAMETER AT THE SMALL END occurs either at (1) the actual end of the piece, if the end has a diameter ≥ 3.0 inches, or (2) at the point where the piece tapers down to 3.0 inches in diameter. If the end is splintered or decomposing (sloughing off), measure the diameter at the point where it best represents the overall log volume. Use the same measuring procedures described in 14.4.3.6.1 (see Figure 14-7).

When Collected: CWD DECAY CLASS = 1 to 4
Field width: 3 digits
Tolerance Pieces < 20.0 in diameter: +/- 2 in
Pieces ≥ 20.0 in diameter: +/- 10%
MQO: At least 90% of the time
Values: 003 to 200

14.4.3.6.3 DIAMETER AT THE LARGE END

Record the code indicating the diameter at the piece's large end. The diameter is recorded to the nearest inch. The large end will occur either at a broken or sawn end, at a fracture, or at the root collar. If the end is splintered or decomposing (sloughing off), measure the diameter at the point where it best represents the overall log volume. Use the same measuring procedures used for 14.4.3.6.1.

When Collected: CWD DECAY CLASS = 1 to 4
Field width: 3 digits
Tolerance: Pieces < 20.0 in diameter: +/- 2 in
Pieces $\geq$ 20.0 in diameter: +/- 15%
MQO: At least 90% of the time
Values: 003 to 200

14.4.3.7 CWD TOTAL LENGTH

Record the code indicating the total length of the piece. CWD TOTAL LENGTH is the length of the piece that lies between the piece's recorded DIAMETER AT THE SMALL END AND DIAMETER AT THE LARGE END (14.4.3.6.2 & 14.4.3.6.3). For DECAY CLASS = 5, DIAMETER AT THE SMALL END AND DIAMETER AT THE LARGE END are not recorded for a log, therefore the length is measured between the two physical ends of the log. For curved logs, measure along the curve. The minimum log length is 3.0 feet before it is a valid tally log. When the length is close to 3.0 feet, measure the length to determine if the piece is actually $\geq$3.0 feet. CWD TOTAL LENGTH is recorded to the nearest foot.

When Collected: All tally pieces
Field width: 3 digits
Tolerance: + / - 20%
MQO: At least 90% of the time
Values: 003 to 250

14.4.3.8 IS THE PIECE HOLLOW?

Record the code indicating whether or not the piece is hollow (see Figure 14-10).

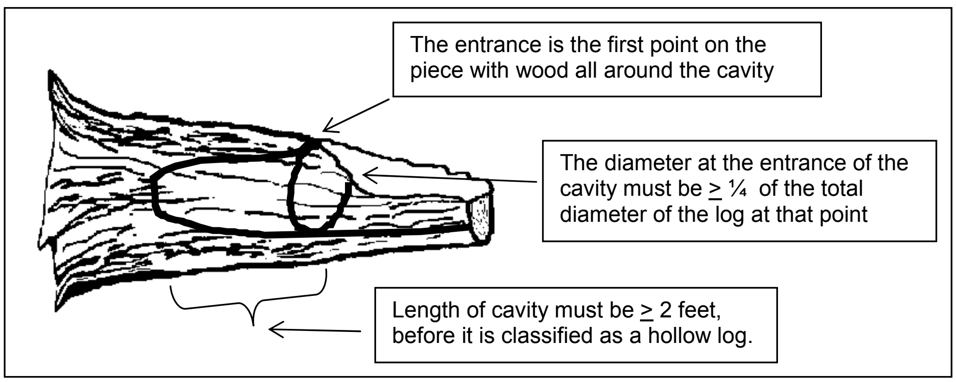


Figure 14-10. Determining if the piece is hollow.

When Collected: CWD DECAY CLASS = 1 to 4
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

- Y A piece is considered hollow if a cavity extends at least 2 feet along the central longitudinal axis of the piece, and the diameter of the entrance to the cavity is at least 1/4 of the diameter of the piece where the entrance occurs. The entrance occurs at the point where the circumference of the cavity is whole -- the point where wood is present completely around the circumference of the cavity. The length of the cavity begins at this point.
- N Does not meet criteria for being a hollow log

14.4.3.9 CWD HISTORY

Record the code that indicates whether or not the piece of CWD is on the ground as a result of harvesting operations or as a result of natural circumstances. One objective of this item is to identify those pieces that are considered logging residue. If the piece appears to have fallen to the ground as a result of natural causes such as decomposition or windfall, enter a code of 1. This category would include blown out tops, snapped off boles, wind-fallen trees on clearcut edges, and trees that basically collapsed and fell over due to decomposition.

If the piece is on the ground as a result of recent (since last annual remeasurement; if the plot is new, the time between the panel remeasurements) harvesting activity, either because the tree was cut down with a chainsaw (or other device) or pushed over by harvesting equipment (bulldozer), enter a code of 2. A code of 2 would be considered logging residue (usually you are in the middle of a recent clearcut).

If the piece is on the ground as a result of older (more than 15 years) harvesting activity, enter a code of 3. This would be a situation where you tally an old decomposing log that has a sawn end – if it appears that the log was cut and left on site, then enter a code of “3”.

If a piece is on the ground as a result of incidental harvest (such as a standing tree was cut for firewood or small clearing), enter a code of “4”. Incidental harvest involves a few trees and is not a part of a major organized harvesting operation.

If the crew cannot decide the history of the CWD log, classify it as “unknown”, and give it a code of “5”.

When Collected: CWD DECAY CLASS = 1 to 4
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

1	CWD piece is on the ground as a result of natural causes
2	CWD piece is on the ground as a result of major recent harvest activity (<= 15 yrs old)
3	CWD piece is on the ground as a result of older harvest activity (> 15 yrs old)
4	CWD piece is on the ground as a result of an incidental harvest (such as firewood cutting)
5	Exact Reason Unknown

14.5 SAMPLING METHODS FOR FINE WOODY DEBRIS (FWD)

1. Fine Woody Debris (FWD) is sampled in accessible forest land conditions. The length of FWD transects are measured in slope distance--no correction is applied to obtain a horizontal distance. The FWD transects start at 14.0 feet slope distance and extend for 6.0 or 10.0 feet slope distance. Estimates of FWD biomass calculated in the office, will include a slope correction factor obtained from the transect segmenting data on the subplot.

2. Only sample FWD that intersects a plane from the ground to a height of 6 feet.

3. FWD is sampled in three size classes, on the 150 degree azimuth transect. Two of the FWD size classes (0.01 to 0.24 inches and 0.25 to 0.9 inches) are counted on a 6-foot transect, from 14 to 20 feet. Pieces in the third size class (1.0 to 2.9 inches) are counted on a 10-foot transect, from 14 to 24 feet (see section 14.2 for details on transects). These transects overlap. Note: individual diameters are not recorded for FWD.

4. Count a piece of FWD if it intersects the transect, and the condition class is accessible forest land at the point of intersection. Only count a piece if the twig, branch, wood fragment, or shrub/tree bole are woody. Do not count pine or fir needles or non-woody parts of a tree or shrub.

5. Accumulate the number of pieces counted within each size class and enter the total count on one record for the subplot (unless there are >1 condition classes). If there is no tally on a transect, enter zeros for the count.

6. Accurate counts of FWD can be conducted efficiently up to about 50 pieces for small and medium size classes, and up to 20 pieces for the large size class. After that, crews can begin estimating counts in a systematic fashion. Transects that fall on very dense FWD where counting is nearly impossible, can be subsampled and calculated. For example, an accurate count can be conducted on a 2.0-foot section of the transect and then multiplied by 3 to provide an estimate for the 6 foot transect, as long as the crew feels that the remaining transect has a similar density of FWD pieces.

7. If a transect intersects a large pile of material such as a wood rat's nest or a recently fallen tree (with many attached fine branches), crews should estimate a count based on #6 above, but also enter a code indicating that this is an unusual situation (see section 14.5.6).

8. If rocks, logs, or other obstructions are present along the transect (14- to 24-foot section) include any FWD that is present on top of these obstructions in the respective FWD counts. If the obstructions are so large (huge boulder) that the top surface cannot be seen, assume the count is zero in this area, and continue counting if there is transect line beyond the boulder.

9. If a residue pile intersects the FWD transect at any point along the 14- to 24-foot section, do not measure FWD on this transect. It is too subjective determining exact boundaries of the pile, and how they relate to the exact point on the transect line. To identify this situation, code 1 in RESIDUE PILE ON TRANSECT which indicates that a residue pile has intersected the transect line.

10. If a transect crosses a condition class boundary, record the CONDITION CLASS NUMBER and enter a count for each condition on separate records. Transect lengths within each condition class will be obtained from the transect segmenting data entered for the subplot.

14.5.1 SUBPLOT NUMBER

Record the code indicating the subplot center from which the transect originates.

When collected: All tally segments
Field width: 1 digit
Tolerance: No errors

MQO: At least 99% of the time
Values: 1 to 4

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

14.5.2 CONDITION CLASS NUMBER

Record the code indicating the number of the condition class that pertains to the FWD count.

When collected: All tally segments
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

14.5.3 SMALL FWD COUNT

Record the number of pieces counted in this size class (0.01 to 0.24-inch diameter) along the transect segment. An accurate count should be conducted up to 50 pieces. If the count exceeds 50, the transect can be subsampled to estimate a total count for the transect segment (see 14.5, #6)

When collected: On the 150 degree transect in CONDITION CLASS STATUS = 1
Field width: 3 digits
Tolerance:0 to 50 = +/- 20% of the total count for the transect
51 to 100 = +/- 25% of the total count for the transect
100 + = +/- 50% of the total count for the transect
MQO: At least 90% of the time
Values: 000 to 999

14.5.4 MEDIUM FWD COUNT

Record the number of pieces counted in this size class (0.25 to 0.9-inch diameter) along the transect segment. An accurate count should be conducted up to 50 pieces. If the count exceeds 50, the transect can be subsampled to estimate a total count for the transect segment (see 14.5, #6)

When collected: On the 150 degree transect in CONDITION CLASS STATUS = 1
Field width: 3 digits
Tolerance: +/- 20% of the total count for the transect
MQO: At least 90% of the time
Values: 000 to 999

14.5.5 LARGE FWD COUNT

Record the number of pieces counted in this size class (1.0 to 2.9 inch diameter) along the transect segment. An accurate count should be conducted up to 20 pieces. If the count exceeds 20, the transect can be subsampled to estimate a total count for the transect segment (see section 14.5, #6).

When collected: On the 150 degree transect in CONDITION CLASS STATUS = 1
Field width: 3 digits
Tolerance: +/- 20% of the total count for the transect
MQO: At least 90% of the time
Values: 000 to 500

14.5.6 HIGH COUNT REASON

Enter a code that applies to the situation encountered on the transect. Enter a code if any of the counts on a transect are greater than 100 pieces.

When Collected: When any count on the transect ≥100
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

0	FWD is not unusually high
1	High count is due to an overall high density of FWD across the transect
2	Wood Rat's nest located on transect
3	Tree or shrub laying across transect
4	Other reason

14.5.7 RESIDUE PILE ON TRANSECT

Enter a code that indicates whether a residue pile intersects the FWD transect segment. The default is always 0; crews will enter a 1 if the situation is encountered on the transect.

When Collected: On all FWD transects (between 14 and 24 ft)
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

0	No
1	Yes

14.6 DUFF, LITTER, AND FUELBED DEPTH MEASUREMENTS

Depth measurements are sampled in accessible forest land conditions. The depth of the duff layer, litter layer, and overall fuelbed are important components of fire models used to estimate fire behavior, fire spread, fire effects, and smoke production. These measurements are taken at the 24-foot location on each transect. An average depth will be calculated in the office and stored with other information about the condition class on the plot. If a residue pile, log, rock, or other obstruction intersects the transect at the 24-ft location, do not measure the duff or litter depth. But, do measure the fuelbed depth if the obstruction is a log or residue pile.

14.6.1 Definitions

1. Litter is the layer of freshly fallen leaves, needles, twigs (< 0.25 inch in diameter), cones, detached bark chunks, dead moss, dead lichens, detached small chunks of rotted wood, dead herbaceous stems, and flower parts (detached and not upright). Litter is the loose plant material found on the top surface of the forest floor. Little decomposition has begun in this layer.

   Litter is flash fuel – so think about it as the loose material that is exposed to the air, capable of igniting quickly and carrying a fire across the surface of the forest floor.

   Litter does not include bark that is still attached to a down log, or rotten chunks of wood that are still inside a decaying log or log end (i.e., if a decayed log end has a lot of rotten cubes or pieces laying on a log surface and exposed to air, they are considered part of the log and not litter – fire would burn differently if it hit a pile of rotten punky wood chips, cradled by the unrotted sapwood shell). If these rotten chunks have spilled out to the ground and are actually on the ground surface, then they would be included in the litter layer.

   Litter does not include animal manure.

   Microplot estimates: As you look down on the microplot, litter is the material that you see covering the surface area of the 6.8-foot radius plot.

2. Duff is the layer just below litter. It consists of decomposing leaves and other organic material. You should see no recognizable plant parts, the duff layer is usually dark decomposed organic matter. When moss is present, the top of the duff layer is just below the green portion of the moss. The bottom of this layer is the point where mineral soil (A horizon) begins.

3. The fuelbed is the accumulated mass of dead, woody material on the surface of the forest floor. It begins at the top of the duff layer, and includes litter, FWD, CWD, and dead woody shrubs. In this definition, the fuelbed does not include dead hanging branches from standing trees.

14.6.2 Overview of Measurements

Depth measurements will be taken at the 24-foot (slope distance) location on each transect. If a log, rock or other obstruction occurs at the sample location, do not measure duff or litter depth, regardless of what is on top of the obstruction. However, if the obstruction is a log, proceed with the fuelbed depth estimate.

The DUFF, LITTER, AND FUELBED SAMPLE variable has three options for indicating if duff, litter, and/or fuelbed were measured at each sample location. The default value for this variable is 1, indicating that all three variables were measured (duff, litter, and fuelbed). A value of 0 is entered if duff and litter were not sampled (obstruction), but fuelbed was sampled. A value of 2 is entered if none of the three (duff, litter, and the fuelbed) were sampled (i.e., submerged part of plot).

14.6.2.1 Duff and Litter

The duff layer is the organic material layer between the A-horizon (or uppermost soil mineral horizon) and the litter layer. The duff is a soil layer dominated by organic material derived from the decomposition of plant and animal litter (pine straw, leaves, twigs, etc) and deposited on either an organic or a mineral surface. This layer is distinguished from the litter layer in that the original organic material has undergone sufficient decomposition that the source of this material (e.g., individual plant parts) can no longer be identified. Litter is defined as undecomposed or only partially decomposed organic material that can be readily identified (e.g., plant leaves, twigs, etc.). As a general rule, duff depth should rarely exceed a few inches. Crews should be absolutely sure they are measuring deep duff depths, instead of mineral soil layers or parts of the litter layer. Duff can easily weigh more than 6 times that of litter. If unsure of the bottom of the duff layer, crews should feel the texture of the suspect material in their hand. Rub the soil between your fingers. Does it crumble (duff) or feel more like modeling clay (mineral).

Carefully expose a shallow profile of the forest floor by digging out an area at the sample point using a knife, hatchet, or other tool. Estimate the depth of each layer with a ruler to the nearest 0.1 inch. If there is a log, rock, or other obstruction on the surface at the sample point, do not measure the litter or duff depth (record DUFF, LITTER, AND FUELBED SAMPLE = 0 or 2, depending if fuelbed can be sampled) ; a value of 99.9 will be entered by the TALLY program for each depth.

As you dig the hole for this measurement, if you encounter a rock, root, or buried log – stop the depth measurement at this point.

The height of the litter should be measured at the top of the loose material located at the sample point on the transect. Try to preserve the conditions of this location by walking around this point, so the QA staff will measure the same height as the original crew.

14.6.2.2 Fuelbed

Measure the height of the fuelbed from the top of the duff layer (just below the litter) to the highest piece of woody debris found at the transect point. Round to the nearest 0.1 foot. If a rock or other obstruction (other than a log) occurs at the 24.0-foot sample location, do not measure fuelbed depth.

14.6.3 SUBPLOT NUMBER

Record the code indicating the number of the subplot center from which the transect originates.

When collected: All tally segments
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 4

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

14.6.4 TRANSECT

Record the code indicating the azimuth of the transect.

When collected: All tally segments
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

030 Transect extends 30 degrees from subplot center
150 Transect extends 150 degrees from subplot center
270 Transect extends 270 degrees from subplot center

14.6.5 DUFF, LITTER, AND FUELBED SAMPLE

Record the code indicating if the depth of the duff and litter layer was measured.

When collected: At 24.0 ft on each transect
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0 Duff and litter depth not sampled; Fuelbed is sampled
1 All sampled: Duff, litter, and fuelbed
2 Nothing sampled; Duff, litter, fuelbed are not sampled

14.6.6 DUFF DEPTH

Record the code indicating the depth of the duff layer to the nearest 0.1 inch.

When collected: At 24.0 ft on each transect
Field width: 3 digits
Tolerance: +/- 0.5 inch
MQO: At least 90% of the time
Values: 00.0 to 99.9

14.6.7 LITTER DEPTH

Record the code indicating the depth of the litter layer to the nearest 0.1 inch.

When collected: At 24.0 ft on each transect
Field width: 3 digits
Tolerance: +/- 0.5 inch
MQO: At least 90% of the time
Values: 00.0 to 99.9

14.6.8 FUELBED DEPTH

Record the code indicating the depth of the fuelbed layer, to the nearest 0.1 foot. If the fuelbed depth is >0 and ≤ 0.1 foot enter 0.1foot. In this situation finer depth resolution will be obtained from the duff and litter measurements.

When collected: At 24.0 ft on each transect
Field width: 3 digits
Tolerance: +/- 20%
MQO: At least 90% of the time
Values: 00.0 to 99.9

14.7 FUEL LOADING ON THE MICROPLOT

Another component of the total fuel loading on a plot is the biomass of live and dead understory material. The 6.8-foot radius microplot will be used to estimate the percent cover and height of live and dead shrubs, live and dead herbs (includes grasses) and litter. Fuel loading is estimated in accessible forest land conditions on the microplot. Enter one value for all forested conditions combined.

Shrubs are plants with woody stems, including woody vines. Herbs are non-woody herbaceous plants, but also include ferns, mosses, lichens, sedges, and grasses. Although many forbs and grasses will die by the end of the growing season, an estimate of live and dead biomass on a given date will help fire modelers predict the phenology of herbaceous material during the year, allowing them to estimate fire danger patterns across the landscape.

Percent cover is estimated for each of the five fuel categories (live shrubs, dead shrubs, live herbs, dead herbs, and litter) in 10-percent classes for the accessible forested conditions of the microplot. For live fuels, estimate the percent of the microplot area that is covered by live plant material. Include whole plants that are entirely green (or alive) and the live branches on plants that are a mixture of live and dead plant parts. Include live branches or leaves that extend into the microplot area from a plant that is actually rooted outside of the microplot. Do not include herbaceous material above 6 feet (i.e., moss, ferns, lichens, epiphytes that are growing in tree branches above 6 feet).

For dead fuels, estimate the percent cover using the same procedures as live fuels, but include plants that are entirely dead and branches or leaves that are dead but still attached to a live plant. Dead plant material must be clearly visible. Do not include dead material that has fallen to the ground. Cover estimates are made by visualizing an outline around the dead material (with all ‘air’ space included) and accumulating this across the forested microplot area.

An estimate of the total height of the shrub and herbaceous layers is also needed to calculate biomass and fuel loadings. Record a height estimate for each fuel category, except litter. Height is estimated for the tallest shrub on the microplot.

Microplot Cover Estimation Guide (Hint: 8.5” x 11” = about 0.5% coverage)

%	area (sq ft)	radius (ft)	square (ft)
1	1.45	0.68	1.20
10	14.52	2.15	3.81
20	29.04	3.04	5.39
30	43.56	3.72	6.60
40	58.08	4.30	7.62
50	72.60	4.81	8.52
60	87.12	5.27	9.33
70	101.64	5.69	10.08
80	116.16	6.08	10.78
90	130.68	6.45	11.43
100	145.2	6.80	12.05

14.7.1 SUBPLOT NUMBER

Record the code indicating the number of the subplot center from which the transect originates.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 4

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

14.7.2 LIVE SHRUB PERCENT COVER

Record the code for the cover class that indicates the percent cover of the forested microplot area covered with live shrubs.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 2 digits
Tolerance: +/- 1 class
MQO: At least 85% of the time
Values:

00	Absent
01	Trace (< 1% cover)
10	1 – 10%
20	11-20%
30	21-30%
….	
90	81-90%
99	91-100%

14.7.3 LIVE SHRUB HEIGHT

Record the code indicating the height of the tallest shrub to the nearest 0.1 foot. Measure heights < 6 feet and estimate heights $\geq$ 6 feet.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 3 digits
Tolerance: +/- 0.5 ft
MQO: At least 90% of the time
Values: 00.0 to 99.9

14.7.4 DEAD SHRUBS PERCENT COVER

Record the code for the cover class that indicates the percent cover of the forested microplot area covered with dead shrubs and dead branches attached to live shrubs if visible from above.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 2 digits
Tolerance: +/- 1 class
MQO: At least 85% of the time
Values:

00	Absent
01	Trace (< 1% cover)
10	1 – 10%
20	11-20%
30	21-30%
….	
90	81-90%
99	91-100%

14.7.5 DEAD SHRUB HEIGHT

Record the code indicating the height of the tallest dead shrub to the nearest 0.1 foot. Measure heights < 6 feet and estimate heights ≥ 6 feet.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 3 digits
Tolerance: +/- 0.5 ft
MQO: At least 90% of the time
Values: 00.0 to 99.9

14.7.6 LIVE HERBS PERCENT COVER

Record the code for the cover class that indicates the percent cover of the forested microplot area covered with live herbaceous plants.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 2 digits
Tolerance: +/- 1 class
MQO: At least 85% of the time
Values:

00	Absent
01	Trace (< 1% cover)
10	1 – 10%
20	11-20%
30	21-30%
….	
90	81-90%
99	91-100%

14.7.7 LIVE HERBS HEIGHT

Record the code indicating the height (at the tallest point) of the live herbaceous layer to the nearest 0.1 foot. Maximum height is 6 feet.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 2 digits
Tolerance: +/- 0.2 ft
MQO: At least 90% of the time
Values: 0.0 to 6.0

14.7.8 DEAD HERBS PERCENT COVER

Record the code for the cover class that indicates the percent cover of the forested microplot area covered with dead herbaceous plants and dead leaves attached to live plants if visible from above.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 2 digits
Tolerance: +/- 1 class

MQO: At least 85% of the time
Values:

00	Absent
01	Trace (< 1% cover)
10	1 – 10%
20	11-20%
30	21-30%
….	
90	81-90%
99	91-100%

14.7.9 DEAD HERBS HEIGHT

Record the code indicating the height (at the tallest point) of the dead herbaceous layer to the nearest 0.1 foot. Maximum height is 6 feet.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 2 digits
Tolerance: +/- 0.2 ft
MQO: At least 90% of the time
Values: 0.0 to 6.0

14.7.10 LITTER PERCENT COVER

Record the code for the cover class that indicates the percent cover of the forested microplot area covered with litter. Litter is the layer of freshly fallen leaves, twigs, dead moss, dead lichens, and other fine particles of organic matter found on the surface of the forest floor. Decomposition is minimal.

When collected: All microplots with at least one CONDITION CLASS STATUS = 1
Field width: 2 digits
Tolerance: +/- 1 class
MQO: At least 85% of the time
Values:

00	Absent
01	Trace (< 1% cover)
10	1 – 10%
20	11-20%
30	21-30%
….	
90	81-90%
99	91-100%

14.8 SAMPLING RESIDUE PILES

The line transect method is not practical when sampling CWD within piles and windrows. Piles and windrows will be located and sampled on the subplot plot, regardless of whether they intersect a transect.

Piles and windrows created directly by human activity and log piles at the bottom of steep-sided ravines in which individual pieces are impossible to tally separately, are more efficiently sampled by using the following instructions. However, loose CWD in piles created by wind throw, landslides, fires, and other natural causes should be tallied using line transects unless it is physically impossible to measure the pieces in the natural pile.

For a pile to be tallied on a subplot that contains forest land, all of the following criteria must be met (Figure 14-11):

- The pile's center must be within 24.0 horizontal feet of subplot center,
- The pile's center must be in an accessible forest land condition class, and
- The pile contains pieces of CWD $\geq$ 3 inches diameter that would be impossible to tally separately.

Use the PILE DENSITY variable to estimate the percent of the pile that contains woody material $\geq$ 3 inches.
The pile is assigned to the condition class in which the pile center lies.

Apply the following steps to determine the center of a pile or windrow:

1. Determine the longest axis of a pile.
2. Determine the midpoint of this axis.
3. Project a line through this midpoint that is perpendicular to the axis determined in step 1.
4. Determine the midpoint of the segment of this projected line that crosses the pile.
5. This is the center of the pile.

Piles that cross the 24.0-foot fixed-radius subplot boundary: If the center of a pile is within 24.0 horizontal feet of subplot center, tally the pile, recording the dimensions of the entire pile even if part of the pile is beyond 24.0 feet. If the center of a pile is more than 24.0 horizontal feet of subplot center, do not tally the pile or any portion of the pile.

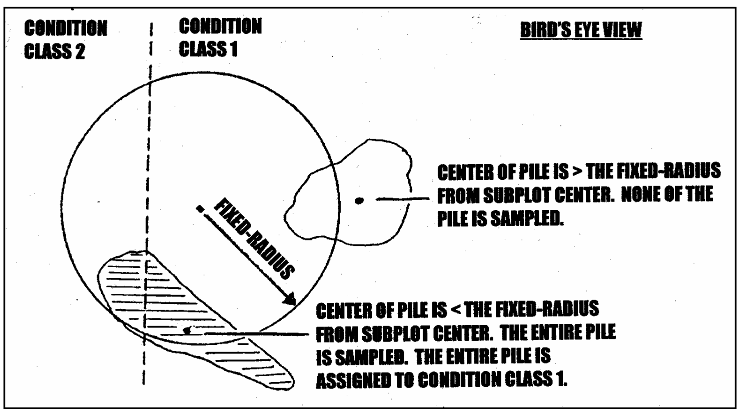


Figure 14-11. Residue pile selection examples.

14.8 SUBPLOT NUMBER

Record the code indicating the subplot number.

When collected: Record for all sampled residue piles
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 4

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

14.8.2 CONDITION CLASS
Record the code indicating the number of the condition class to which the pile is assigned.

When collected: Record for all sampled residue piles
Field Width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

14.8.3 PILE AZIMUTH
Record the code indicating the azimuth from the subplot center to the pile. This azimuth centers on the pile so that it can be relocated. Use 360 for north.

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

14.8.4 PILE SHAPE
Record the code indicating the shape of the pile. Determine which of the four shapes diagrammed in Figure 14-12 most resembles the pile and record the dimensions. Pile dimensions should be ocularly smoothed out when making estimates. Average the unevenness of protruding pieces.

When collected: All sampled residue piles
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values: 1 to 4

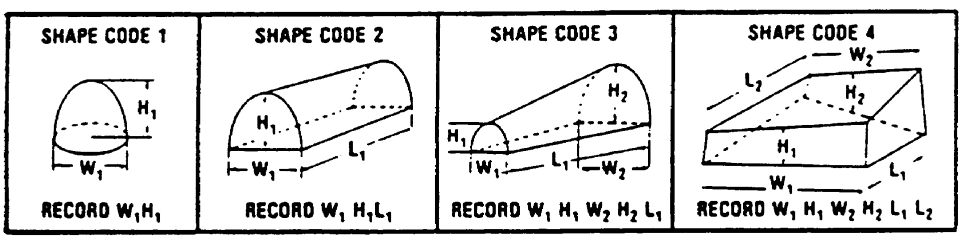


Figure 14-12. PILE SHAPE codes.

14.8.5 PILE LENGTH 1
Record the code indicating the length of the sides of the pile. Estimate to the nearest foot. PILE LENGTH 1 may often equal PILE LENGTH 2.

When collected: All sampled residue piles and PILE SHAPE = 2, 3, 4
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 01 to 99

14.8.6 PILE LENGTH 2

Record the code indicating the length of the sides of the pile. Estimate to the nearest foot. PILE LENGTH 1 may often equal PILE LENGTH 2.

When collected: All sampled residue piles and PILE SHAPE = 4
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 01 to 99

14.8.7 PILE WIDTH 1

Record the code indicating the width of the sides of the pile. Estimate to the nearest foot. PILE WIDTH 1 may often equal PILE WIDTH 2.

When collected: All sampled residue piles, and PILE SHAPE = 1, 2, 3, 4
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 01 to 99

14.8.8 PILE WIDTH 2

Record the code indicating the width of the sides of the pile. Estimate to the nearest foot. PILE WIDTH 1 may often equal PILE WIDTH 2.

When collected: All sampled residue piles, and PILE SHAPE = 3, 4
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 01 to 99

14.8.9 PILE HEIGHT 1

Record the code indicating the height of either end of the pile. Estimate to the nearest foot. PILE HEIGHT 1 may often equal PILE HEIGHT 2.

When collected: All sampled residue piles, and PILE SHAPE = 1, 2, 3, 4
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 01 to 99

14.8.10 PILE HEIGHT 2

Record the code indicating the height of either end of the pile. Estimate to the nearest foot. PILE HEIGHT 1 may often equal PILE HEIGHT 2.

When collected: All sampled residue piles, and PILE SHAPE = 3, 4
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 01 to 99

14.8.11 PILE DENSITY

Record the code estimating the percent of the pile that consists of wood. Air, soil, rock, plants, etc, should be factored out of the estimate. Estimate to the nearest 10 percent.

When collected: All sampled residue piles
Field width: 2 digits
Tolerance: +/- 20%

MQO: At least 75% of the time
Values:

00	Absent
01	Trace (< 1% cover)
10	1 – 10%
20	11-20%
30	21-30%
….	
90	81-90%
99	91-100%

14.9 ACKNOWLEDGEMENTS
Contact information for the National Advisor for this indicator is: Chris Woodall, USDA Forest Service, North Central Research Station, 1992 Folwell Ave, St. Paul, MN 55108, cwoodall@fs.fed.us, http:\\ncrs2.fs.fed.us\4801\DWM .

DWM APPENDIX. DATA SHEETS

DOWN WOODY MATERIALS – TRANSECT SEGMENT DATA FORM

HEX # ________________ DATE ____/____/____

CWD TRANSECT SEGMENTS

SUB PL	T	CC	SLP DIST1 (0.1ft)	SLP DIST2 (0.1ft)	SLP PCT	HOR DIST (0.1ft)
xx	Xxx	x	xxx.y	xxx.y	xxx	xxx.y

FWD DATA FORM

HEX # ________________ DATE ____/____/____

FINE WOODY DEBRIS COUNT

SUBPLOT	CONDITION CLASS	SMALL FWD 0.1" TO 0.25"	MED FWD 0.25" TO 1"	LARGE FWD 1" TO 3"	REASON FOR HIGH COUNT	RESIDUE PILE ON TRANSECT?
x	X	xxx	Xxx	xxx	x	x

COARSE WOODY DEBRIS DATA FORM

HEX # ________________ DATE ____/____/____ PAGE ____ OF____

SUB PLT	TRAN	CWD DIST	SPC	TRAN DIAM	SML DIAM	LRG DIAM	TOTAL LENGTH	DECAY CLASS	HOL?	CWD HIST
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
x	xxx	xx.y	xxx	xxx	xxx	xxx	xx	x	x	x

FUELS ASSESSMENT DATA FORM

HEX # ________________ DATE ____/____/____

MICROPLOT FUEL LOADING

SUBPLOT	LIVE SHRUB %	LIVE SHRUB HT	DEAD SHRUB %	DEAD SHRUB HT	LIVE HERB %	LIVE HERB HT	DEAD HERB %	DEAD HERB HT	LITTER %
	xx	xx.y	xx	xx.y	xx	xx.y	xx	xx.y	xx
1									
2									
2									
4									

DUFF, LITTER, FUELBED ASSESSMENT DATA FORM

HEX # ________________   DATE ____/____/____

DUFF, LITTER, & FUELBED DEPTHS

SUBPLOT	TRANSECT	DL_SAMP	DUFFLITTER DEPTH	LITTER DEPTH	FUELBED DEPTH
x	xxx	X	xx.y	xx.y	xx.y

RESIDUE PILE DATA FORM

HEX # ________________ DATE ____/____/____

RESIDUE PILES

SUB PL	CC	PILE AZM	SHP	LNG1 (ft)	LNG2 (ft)	WID1 (ft)	WID2 (ft)	HT1 (ft)	HT2 (ft)	PILE DENS
xx	x	xxx	X	xx	xx	xx	xx	xx	xx	Xx

DWM Combined Data Form

Date **Hexagon #** **FIA Plot #** **P-3 Plot #**

Transect Segment Data

Sub plot xx	Transect xxx	Condition x	Dist Start xxx.y (ft)	Dist End xxx.y (ft)	Slope xxx (%)

Duff, Litter and Fuelbed Depths

Transect	Sampled x	Duff xx.y (in)	Litter xx.y (in)	Fuelbed xx.y (ft)
1 30				
1 150				
1 270				
2 30				
2 150				
2 270				
3 30				
3 150				
3 270				
4 30				
4 150				
4 270				

CWD Form

Sub Plot xx	Transect xxx	Dist xx.y (ft)	Species xxx	Tran. Dia xxx (in)	Sm. End xxx (in)	Lg. End xxx (in)	Length xxx (ft)	Decay x	Hollow x	History x

FWD		**0.00 - .25**	**.25 - 1.00**	**1.00 -**	**H. Count**	**Residue**	**History**	**Microplot Cover**

Form			3.00							
Sub Plot	Condition	Small	Med	Large	Reason	Pile				
	x	xxx	xxx	xxx	x	x	1	Natural	0	None
1							2	<=15 yrs.	1	Trace
2							3	>15 yrs.	10	1-10
3							4	Firewood	20	11 - 20
4							5	Unknown	99	91 - 100

Microplot Fuel Loading									
Sub Plot	Live Shrub	Height	Dead Shrub	Height	Live Herb	Height	Dead Herb	Height	Litter %
	xx (%)	xx.y (ft)	xx (%)	xx.y (ft)	xx (%)	xx.y (ft)	xx (%)	xx.y (ft)	xx (%)
1									
2									
3									
4									

Residue Pile										
Sub Plot	Condition	Azimuth	PILE Shape	Length 1	Length 2	Width 1	Width 2	Height 1	Height 2	Density
xx	xx (%)	xxx (deg)	x	xx (ft)	xx (ft)	xx (ft)	xx (ft)	xx (ft)	xx (ft)	xx (%)

Appendix 1. State and County FIPS Codes

Illinois	**(17)**
Unit 1	
Alexander	3
Franklin	55
Gallatin	59
Hamilton	65
Hardin	69
Jackson	77
Johnson	87
Massac	127
Perry	145
Pope	151
Pulaski	153
Randolph	157
Saline	165
Union	181
White	193
Williamson	199
Unit 2	
Bond	5
Calhoun	13
Clark	23
Clay	25
Clinton	27
Crawford	33
Cumberland	35
Edwards	47
Effingham	49
Fayette	51
Greene	61
Jasper	79
Jefferson	81
Jersey	83
Lawrence	101
Macoupin	117
Madison	119
Marion	121
Monroe	133
Montgomery	135
Richland	159
St.Clair	163
Shelby	173
Wabash	185
Washington	189
Wayne	191
Unit 3	
Adams	1
Boone	7
Brown	9
Bureau	11
Carroll	15
Cass	17
Champaign	19
Christian	21
Coles	29
Cook	31
DeKalb	37
De Witt	39
Douglas	41
DuPage	43
Edgar	45
Ford	53
Fulton	57
Grundy	63
Hancock	67
Henderson	71
Henry	73
Iroquois	75
JoDaviess	85
Kane	89
Kankakee	91
Kendall	93
Knox	95
Lake	97
La Salle	99
Lee	103
Livingston	105
Logan	107
Macon	115
Marshall	123
Mason	125
McDonough	109
McHenry	111
McLean	113
Menard	129
Mercer	131
Morgan	137
Moultrie	139
Ogle	141
Peoria	143
Piatt	147
Pike	149
Putnam	155
Rock Island	161
Sangamon	167
Schuyler	169
Scott	171
Stark	175
Stephenson	177
Tazewell	179
Vermilion	183
Warren	187
Whiteside	195
Will	197
Winnebago	201
Woodford	203

Indiana	**(18)**
Unit 1	
Clay	21
Daviess	27
Gibson	51
Greene	55
Knox	83
Martin	101
Parke	121
Pike	125
Posey	129
Putnam	133
Sullivan	153
Vanderburg	163
Vermillion	165
Vigo	167
Unit 2	
Brown	13
Clark	19
Crawford	25
Dubois	37
Floyd	43
Harrison	61
Jackson	71
Lawrence	93
Monroe	105
Morgan	109
Orange	117
Owen	119
Perry	123
Scott	143
Spencer	147
Warrick	173
Washington	175
Unit 3	
Dearborn	29
Fayette	41
Franklin	47
Jefferson	77
Jennings	79
Ohio	115
Ripley	137
Switzerland	155
Union	161
Unit 4	
Adams	1
Allen	3
Bartholome	5
Benton	7
Blackford	9
Boone	11

Indiana	**(18)**
Unit 4-continued	
Carroll	15
Cass	17
Clinton	23
Decatur	31
De Kalb	33
Delaware	35
Elkhart	39
Fountain	45
Fulton	49
Grant	53
Hamilton	57
Hancock	59
Hendricks	63
Henry	65
Howard	67
Huntington	69
Jasper	73
Jay	75
Johnson	81
Kosciusko	85
Lagrange	87
Lake	89
La Porte	91
Madison	95
Marion	97
Marshall	99
Miami	103
Montgomery	107
Newton	111
Noble	113
Porter	127
Pulaski	131
Randolph	135
Rush	139
St. Joseph	141
Shelby	145
Starke	149
Steuben	151
Tippecanoe	157
Tipton	159
Wabash	169
Warren	171
Wayne	177
Wells	179
White	181
Whitley	183

Iowa	**(19)**
Unit 1	
Allamakee	5
Benton	11
Black Hawk	13
Bremer	17
Buchanan	19
Butler	23
Cedar	31
Chickasaw	37
Clayton	43
Clinton	45
Delaware	55
Dubuque	61
Fayette	65
Floyd	67
Grundy	75
Howard	89
Jackson	97
Johnson	103
Jones	105
Linn	113
Mitchell	131
Scott	163
Tama	171
Winneshiek	191
Unit 2	
Appanoose	7
Boone	15
Clarke	39
Dallas	49
Davis	51
Decatur	53
DesMoines	57
Guthrie	77
Hamilton	79
Hardin	83
Henry	87
Iowa	95
Jasper	99
Jefferson	101
Keokuk	107
Lee	111
Louisa	115
Lucas	117
Madison	121
Mahaska	123
Marion	125
Marshall	127
Monroe	135
Muscatine	139
Polk	153
Poweshiek	157
Story	169
Van Buren	177
Wapello	179
Warren	181
Washington	183
Wayne	185
Webster	187
Unit 3	
Adair	1
Adams	3
Audubon	9
Carroll	27
Cass	29
Crawford	47
Fremont	71
Greene	73
Harrison	85
Mills	129
Monona	133
Montgomery	137
Page	145
Pottawatta	155
Ringgold	159
Shelby	165
Taylor	173
Union	175
Woodbury	193
Unit 4	
Buena Vist	21
Calhoun	25
Cerro Gord	33
Cherokee	35
Clay	41
Dickinson	59
Emmet	63
Franklin	69
Hancock	81
Humboldt	91
Ida	93
Kossuth	109
Lyon	119
O'Brien	141
Osceola	143
Palo Alto	147
Plymouth	149
Pocahontas	151
Sac	161
Sioux	167
Winnebago	189
Worth	195
Wright	197

Kansas	**(20)**
Unit1	
Atchison	5
Brown	13
Clay	27
Dickinson	41
Doniphan	43
Douglas	45
Franklin	59
Geary	61
Jackson	85
Jefferson	87
Johnson	91

Kansas (20)

Unit1-continued

Leavenworth	103
Marshall	117
Miami	121
Nemaha	131
Osage	139
Pottawatomie	149
Riley	161
Shawnee	177
Wabaunsee	197
Washington	201
Wyandotte	209

Unit 2

Allen	1
Anderson	3
Bourbon	11
Butler	15
Chase	17
Chautauqua	19
Cherokee	21
Coffey	31
Cowley	35
Crawford	37
Elk	49
Greenwood	73
Labette	99
Linn	107
Lyon	111
Marion	115
Montgomery	125
Morris	127
Neosho	133
Wilson	205
Woodson	207

Unit 3

Barber	7
Barton	9
Cheyenne	23
Clark	25
Cloud	29
Comanche	33
Decatur	39
Edwards	47
Ellis	51
Ellsworth	53
Finney	55
Ford	57
Gove	63
Graham	65
Grant	67
Gray	69
Greeley	71
Hamilton	75
Harper	77
Harvey	79
Haskell	81
Hodgeman	83
Jewell	89
Kearny	93
Kingman	95
Kiowa	97
Lane	101
Lincoln	105
Logan	109
McPherson	113
Meade	119
Mitchell	123
Morton	129
Ness	135
Norton	137
Osborne	141
Ottawa	143
Pawnee	145
Phillips	147
Pratt	151
Rawlins	153
Reno	155
Republic	157
Rice	159
Rooks	163
Rush	165
Russell	167
Saline	169
Scott	171
Sedgwick	173
Seward	175
Sheridan	179
Sherman	181
Smith	183
Stafford	185
Stanton	187
Stevens	189
Sumner	191
Thomas	193
Trego	195
Wallace	199
Wichita	203

Michigan (26)

Unit 1

Alger	3
Chippewa	33
Delta	41
Luce	95
Mackinac	97
Menominee	109
Schoolcraft	153

Unit 2

Baraga	13
Dickinson	43
Gogebic	53
Houghton	61
Iron	71
Keweenaw	83
Marquette	103
Ontonagon	131

Unit 3

Alcona	1
Alpena	7
Antrim	9
Arenac	11
Bay	17
Benzie	19
Charlevoix	29
Cheboygan	31
Clare	35
Crawford	39
Emmet	47
Gladwin	51
Grand Traverse	55
Iosco	69
Isabella	73
Kalkaska	79
Lake	85
Leelanau	89
Manistee	101
Mason	105
Mecosta	107
Midland	111
Missaukee	113
Montmorenc	119
Newaygo	123
Oceana	127
Ogemaw	129
Osceola	133
Oscoda	135
Otsego	137
Presque Isle	141
Roscommon	143
Wexford	165

Unit 4

Allegan	5
Barry	15
Berrien	21
Branch	23
Calhoun	25
Cass	27
Clinton	37
Eaton	45
Genesee	49
Gratiot	57
Hillsdale	59
Huron	63
Ingham	65
Ionia	67

Michigan	**(26)**
Unit 4	
Jackson	75
Kalamazoo	77
Kent	81
Lapeer	87
Lenawee	91
Livingston	93
Macomb	99
Monroe	115
Montcalm	117
Muskegon	121
Oakland	125
Ottawa	139
Saginaw	145
St. Clair	147
St. Joseph	149
Sanilac	151
Shiawassee	155
Tuscola	157
Van Buren	159
Washtenaw	161
Wayne	163

Minnesota	**(27)**
Unit 1	
Carlton	17
Cook	31
Koochiching	71
Lake	75
St. Louis	137
Unit 2	
Aitkin	1
Becker	5
Beltrami	7
Cass	21
Clearwater	29
Crow Wing	35
Hubbard	57
Itasca	61
Lake of the Woods	77
Mahnomen	87
Roseau	135
Wadena	159
Unit 3	
Anoka	3
Benton	9
Carver	19
Chisago	25
Dakota	37
Douglas	41
Fillmore	45
Goodhue	49
Hennepin	53
Houston	55
Isanti	59
Kanabec	65
Le Sueur	79
Mille Lacs	95
Morrison	97
Olmsted	109
Otter Tail	111
Pine	115
Ramsey	123
Rice	131
Scott	139
Sherburne	141
Stearns	145
Todd	153
Wabasha	157
Washington	163
Winona	169
Wright	171
Unit 4	
Big Stone	11
Blue Earth	13
Brown	15
Chippewa	23
Clay	27
Cottonwood	33
Dodge	39
Faribault	43
Freeborn	47
Grant	51
Jackson	63
Kandiyohi	67
Kittson	69
Lac qui Parle	73
Lincoln	81
Lyon	83
McLeod	85
Marshall	89
Martin	91
Meeker	93
Mower	99
Murray	101
Nicollet	103
Nobles	105
Norman	107
Pennington	113
Pipestone	117
Polk	119
Pope	121
Red Lake	125
Redwood	127
Renville	129
Rock	133
Sibley	143
Steele	147
Stevens	149
Swift	151
Traverse	155
Waseca	161
Watonwan	165
Wilkin	167
Yellow Medicine	173

Missouri	**(29)**
Unit 1	
Bollinger	17
Butler	23
Carter	35
Crawford	55
Dent	65
Iron	93
Madison	123
Oregon	149
Reynolds	179
Ripley	181
St. Francois	187
Shannon	203
Washington	221
Wayne	223
Unit 2	
Barry	9
Christian	43
Douglas	67
Howell	91
McDonald	119
Newton	145
Ozark	153
Stone	209
Taney	213
Texas	215
Webster	225
Wright	229
Unit 3	
Benton	15
Camden	29
Cedar	39
Dallas	59
Hickory	85
Laclede	105
Maries	125
Miller	131
Morgan	141
Phelps	161
Polk	167
Pulaski	169
St. Clair	185
Unit 4	
Adair	1
Andrew	3
Atchison	5
Audrain	7
Barton	11
Bates	13

Missouri	**(29)**
Unit 4	
Buchanan	21
Caldwell	25
Carroll	33
Cass	37
Chariton	41
Clark	45
Clay	47
Clinton	49
Cooper	53
Dade	57
Daviess	61
DeKalb	63
Gentry	75
Greene	77
Grundy	79
Harrison	81
Henry	83
Holt	87
Jackson	95
Jasper	97
Johnson	101
Knox	103
Lafayette	107
Lawrence	109
Lewis	111
Lincoln	113
Linn	115
Livingston	117
Macon	121
Marion	127
Mercer	129
Monroe	137
Nodaway	147
Pettis	159
Pike	163
Platte	165
Putnam	171
Ralls	173
Randolph	175
Ray	177
Saline	195
Schuyler	197
Scotland	199
Shelby	205
Sullivan	211
Vernon	217
Worth	227
Unit 5	
Boone	19
Callaway	27
Cape Girar	31
Cole	51
Dunklin	69
Franklin	71
Gasconade	73
Howard	89
Jefferson	99
Mississippi	133
Moniteau	135
Montgomery	139
New Madrid	143
Osage	151
Pemiscot	155
Perry	157
St. Charle	183
St. Louis	189
Ste. Genev	186
Scott	201
Stoddard	207
Warren	219
St. Louis	510

Nebraska	**(31)**
Unit 1	
Adams	1
Boone	11
Buffalo	19
Burt	21
Butler	23
Cass	25
Cedar	27
Clay	35
Colfax	37
Cuming	39
Custer	41
Dakota	43
Dawson	47
Dixon	51
Dodge	53
Douglas	55
Fillmore	59
Franklin	61
Frontier	63
Furnas	65
Gage	67
Gosper	73
Greeley	77
Hall	79
Hamilton	81
Harlan	83
Hitchcock	87
Howard	93
Jefferson	95
Johnson	97
Kearney	99
Lancaster	109
Madison	119
Merrick	121
Nance	125
Nemaha	127
Nuckolls	129
Otoe	131
Pawnee	133
Phelps	137
Pierce	139
Platte	141
Polk	143
Red Willow	145
Richardson	147
Saline	151
Sarpy	153
Saunders	155
Seward	159
Sherman	163
Stanton	167
Thayer	169
Thurston	173
Valley	175
Washington	177
Wayne	179
Webster	181
York	185
Unit 2	
Antelope	3
Arthur	5
Banner	7
Blaine	9
Box Butte	13
Boyd	15
Brown	17
Chase	29
Cherry	31
Cheyenne	33
Dawes	45
Deuel	49
Dundy	57
Garden	69
Garfield	71
Grant	75
Hayes	85
Holt	89
Hooker	91
Keith	101
Keya Paha	103
Kimball	105
Knox	107
Lincoln	111
Logan	113
Loup	115
McPherson	117
Morrill	123
Perkins	135
Rock	149
Scotts Bluff	157
Sheridan	161
Sioux	165

N.Dakota	**(38)**
Unit 1	
Thomas	171
Wheeler	183
Adams	1
Barnes	3
Benson	5
Billings	7
Bottineau	9
Bowman	11
Burke	13
Burleigh	15
Cass	17
Cavalier	19
Dickey	21
Divide	23
Dunn	25
Eddy	27
Emmons	29
Foster	31
Golden Valley	33
Grand Fork	35
Grant	37
Griggs	39
Hettinger	41
Kidder	43
LaMoure	45
Logan	47
McHenry	49
McIntosh	51
McKenzie	53
McLean	55
Mercer	57
Morton	59
Mountrail	61
Nelson	63
Oliver	65
Pembina	67
Pierce	69
Ramsey	71
Ransom	73
Renville	75
Richland	77
Rolette	79
Sargent	81
Slope	87
Sheridan	83
Sioux	85
Stark	89
Steele	91
Stutsman	93
Towner	95
Traill	97
Walsh	99
Ward	101
Wells	103
Williams	105

S.Dakota	**(46)**
Unit 1	
Aurora	3
Beadle	5
Bennett	7
Bon Homme	9
Brookings	11
Brown	13
Brule	15
Buffalo	17
Campbell	21
Charles Mi	23
Clark	25
Clay	27
Codington	29
Corson	31
Davison	35
Day	37
Deuel	39
Dewey	41
Douglas	43
Edmunds	45
Faulk	49
Grant	51
Gregory	53
Haakon	55
Hamlin	57
Hand	59
Hanson	61
Hughes	65
Hutchinson	67
Hyde	69
Jackson	71
Jerauld	73
Jones	75
Kingsbury	77
Lake	79
Lincoln	83
Lyman	85
Marshall	91
McCook	87
McPherson	89
Mellette	95
Miner	97
Minnehaha	99
Moody	101
Perkins	105
Potter	107
Roberts	109
Sanborn	111
Spink	115
Stanley	117
Sully	119
Todd	121
Tripp	123
Turner	125
Union	127
Walworth	129
Yankton	135
Ziebach	137
Unit 2	
Butte	19
Custer	33
Fall River	47
Harding	63
Lawrence	81
Meade	93
Pennington	103
Shannon	113

Wisconsin	**(55)**
Unit 1	
Florence	37
Forest	41
Langlade	67
Lincoln	69
Menominee	78
Marinette	75
Oconto	83
Oneida	85
Shawano	115
Vilas	125
Unit 2	
Ashland	3
Barron	5
Bayfield	7
Burnett	13
Douglas	31
Iron	51
Polk	95
Price	99
Rusk	107
Sawyer	113
Taylor	119
Washburn	129
Unit 3	
Adams	1
Chippewa	17
Clark	19
Eau Claire	35
Jackson	53
Juneau	57
Marathon	73
Marquette	77
Monroe	81
Portage	97
Waupaca	135
Waushara	137
Wood	141

Wisconsin	**(55)**
Unit 4	
Buffalo	11
Crawford	23
Dunn	33
Grant	43
Iowa	49
La Crosse	63
Lafayette	65
Pepin	91
Pierce	93
Richland	103
St. Croix	109
Sauk	111
Trempealeau	121
Vernon	123
Unit 5	
Brown	9
Calumet	15
Columbia	21
Dane	25
Dodge	27
Door	29
Fond du La	39
Green	45
Green Lake	47
Jefferson	55
Kenosha	59
Kewaunee	61
Manitowoc	71
Milwaukee	79
Outagamie	87
Ozaukee	89
Racine	101
Rock	105
Sheboygan	117
Walworth	127
Washington	131
Waukesha	133
Winnebago	139

Appendix 2. FIA Forest Type Codes

This following list includes all forest types in the Continental U.S. and Alaska Types designated East/West are commonly found in those regions, although types designated for one region may occasionally be found in another.

East	West	Code	Species Type
			White / Red / Jack Pine Group
E		101	Jack pine
E		102	Red pine
E		103	Eastern white pine
E		104	Eastern White pine / Eastern hemlock
E		105	Eastern hemlock
			Spruce / Fir Group
E		121	Balsam fir
E		122	White spruce
E		123	Red spruce
E		124	Red spruce / balsam fir
E		125	Black spruce
E		126	Tamarack
E		127	Northern white-cedar
			Longleaf / Slash Pine Group
E		141	Longleaf pine
E		142	Slash pine
			Loblolly / Shortleaf Pine Group
E		161	Loblolly pine
E		162	Shortleaf pine
E		163	Virginia pine
E		164	Sand pine
E		165	Table-mountain pine
E		166	Pond pine
E		167	Pitch pine
E		168	Spruce pine
			Pinyon / Juniper Group
E		181	Eastern redcedar
E	W	182	Rocky Mountain juniper
	W	183	Western juniper
E	W	184	Juniper woodland
E	W	185	Pinyon juniper woodland
			Douglas-fir Group
E	W	201	Douglas-fir
	W	202	Port-Orford-cedar
			Ponderosa Pine Group
E	W	221	Ponderosa pine
	W	222	Incense cedar
	W	223	Jeffrey pine / Coulter pine / bigcone Douglas-fir
	W	224	Sugar pine

East	West	Code	Species Type
			Western White Pine Group
	W	241	Western white pine
			Fir / Spruce / Mountain Hemlock Group
	W	261	White fir
	W	262	Red fir
	W	263	Noble fir
	W	264	Pacific silver fir
	W	265	Engelmann spruce
	W	266	Engelmann spruce / subalpine fir
	W	267	Grand fir
	W	268	Subalpine fir
	W	269	Blue spruce
	W	270	Mountain hemlock
	W	271	Alaska-yellow-cedar
			Lodgepole Pine Group
	W	281	Lodgepole pine
			Hemlock / Sitka Spruce Group
	W	301	Western hemlock
	W	304	Western redcedar
	W	305	Sitka spruce
			Western Larch Group
	W	321	Western larch
			Redwood Group
	W	341	Redwood
	W	342	Giant sequoia
			Other Western Softwoods Group
	W	361	Knobcone pine
	W	362	Southwest white pine
	W	363	Bishop pine
	W	364	Monterey pine
	W	365	Foxtail pine / bristlecone pine
	W	366	Limber pine
	W	367	Whitebark pine
	W	368	Misc. western softwoods
			California Mixed Conifer Group
	W	371	California mixed conifer
			Exotic Softwoods Group
E		381	Scotch pine
E	W	382	Australian pine
E	W	383	Other exotic softwoods
E		384	Norway Spruce
E		385	Introduced larch
			Oak / Pine Group
E		401	Eastern white pine / N. red oak / white ash
E		402	Eastern redcedar / hardwood

East	West	Code	Species Type
E		403	Longleaf pine / oak
E		404	Shortleaf pine / oak
E		405	Virginia pine / southern red oak
E		406	Loblolly pine / hardwood
E		407	Slash pine / hardwood
E		409	Other pine / hardwood
			Oak / Hickory Group
E		501	Post oak / blackjack oak
E		502	Chestnut oak
E		503	White oak / red oak / hickory
E		504	White oak
E		505	Northern red oak
E		506	Yellow-poplar / white oak / N. red oak
E		507	Sassafras / persimmon
E		508	Sweetgum / yellow-poplar
E		509	Bur oak
E		510	Scarlet oak
E		511	Yellow-poplar
E		512	Black walnut
E		513	Black locust
E		514	Southern scrub oak
E		515	Chestnut oak / black oak / scarlet oak
E		519	Red maple / oak
E		520	Mixed upland hardwoods
			Oak / Gum / Cypress Group
E		601	Swamp chestnut oak / cherrybark oak
E		602	Sweetgum / Nuttall oak / willow oak
E		605	Overcup oak / water hickory
E		606	Atlantic white-cedar
E		607	Baldcypress / water tupelo
E		608	Sweetbay / swamp tupelo / red maple
			Elm / Ash / Cottonwood Group
E		701	Black ash / American elm / red maple
E		702	River birch / sycamore
E	W	703	Cottonwood
E	W	704	Willow
E		705	Sycamore / pecan / American elm
E		706	Sugarberry / hackberry / elm / green ash
E		707	Silver maple / American elm
E		708	Red maple / lowland
E	W	709	Cottonwood / willow
	W	722	Oregon ash
			Maple / Beech / Birch Group
E		801	Sugar maple / beech / yellow birch
E		802	Black cherry
E		803	Cherry / ash / yellow-poplar
E		805	Hard maple / basswood
E		807	Elm / ash / locust
E		809	Red maple / upland

East	West	Code	Species Type
			Aspen / Birch Group
E	W	901	Aspen
E	W	902	Paper birch
E	W	904	Balsam poplar
			Alder / Maple Group
	W	911	Red alder
	W	912	Bigleaf maple
			Western Oak Group
	W	921	Gray pine
	W	922	California black oak
	W	923	Oregon white oak
	W	924	Blue oak
E	W	925	Deciduous oak woodland
	W	926	Evergreen oak woodland
	W	931	Coast live oak
	W	932	Canyon live oak / interior live oak
			Tanoak / Laurel Group
	W	941	Tanoak
	W	942	Califonia laurel
	W	943	Giant chinkapin
			Other Western Hardwoods Group
	W	951	Pacific madrone
E	W	952	Mesquite woodland
	W	953	Cercocarpus woodland
	W	954	Intermountain maple woodland
E	W	955	Misc. western hardwood woodlands
			Tropical Hardwoods Group
E		981	Sabal palm
E		982	Mangrove
E		989	Other tropical
			Exotic Hardwoods Group
E		991	Paulownia
E		992	Melaluca
E	W	993	Eucalyptus
E	W	995	Other exotic hardwoods

For non-stocked stands, see section 2.5.3 for procedures to determine FOREST TYPE.

Eastern Forest Type Descriptions

WHITE/RED/JACK PINE GROUP

101 Jack pine: Associates – red pine, northern pin oak, quaking and bigtooth aspen, paper birch, black spruce, and white spruce. Sites--generally driest, most porous sands but also on more moist, sandy soils near swamps and on rocky hills and lodges.

102 Red pine: Associates – white, jack, or pitch pine; northern pin oak; white oak; red maple; paper birch; quaking and bigtooth aspen, chestnut oak, northern red oak, and hemlock. Sites--spotty distribution in Northeast and sandy and gravelly locations or dry sandy loam soils; often in plantations.

103 Eastern white pine: Associates – pitch pine, gray birch, aspen, red maple, pin cherry, white oak, paper birch, sweet birch, yellow birch, black cherry, white ash, northern red oak, sugar maple, basswood, hemlock, northern white-cedar, yellow-poplar, white oak, chestnut oak, scarlet oak, and shortleaf pine. Sites--wide variety, but best development on well drained sands and sandy loams.

104 Eastern white pine/ Eastern hemlock: Associates – beech, sugar maple, basswood, red maple, yellow birch, black cherry, white ash, paper birch, sweet birch, northern red oak, white oak, chestnut oak, yellow-poplar, and cucumbertree. Sites--wide variety but favors cool locations, moist ravines, and north slopes.

105 Eastern hemlock: Associates – beech, sugar maple, yellow birch, basswood, red maple, black cherry, white ash, white pine, paper birch, sweet birch, northern red oak, and white oak. Sites--cool locations, moist ravines, and north slopes.

SPRUCE/FIR GROUP

121 Balsam fir: Associates – black, white, or red spruce; paper or yellow birch; quaking or bigtooth aspen, beech; red maple; hemlock; tamarack; black ash; or northern white-cedar. Sites--upland sites on low lying moist flats and in swamps.

122 White spruce: Associates – black spruce, balsam fir, quaking aspen, paper birch, jack pine, red spruce, sugar maple, beech, and yellow birch. Sites--moist, sandy loam or alluvial soils--found on many different sites but especially typical of stream banks, lake shores, and adjacent slopes.

123 Red Spruce: Associates – vary widely and may include red maple, yellow birch, eastern hemlock, eastern white pine, white spruce, northern white-cedar, paper birch, pin cherry, gray birch, mountain ash, beech, striped maple, sugar maple, northern red oak, red pine, and aspen. Sites--include moderately well drained to poorly drained flats and thin-slopes and on varying acidic soils in abandoned fields and pastures. This code should be used where red spruce comprises a plurality or majority of the stand's stocking but where balsam fir is either nonexistent or has very little stocking. Otherwise the plot would be coded 124, red spruce/balsam fir.

124 Red spruce/balsam fir: Associates – red maple, paper birch, white pine, hemlock, white spruce, and northern white-cedar. Sites--moderately drained to poorly drained flats or on thin-soiled upper slopes.

125 Black spruce: Associates – white spruce, balsam fir, jack pine, quaking aspen, paper birch, tamarack, northern white-cedar, black ash, or red maple. Sites--acid peat swamps but also on moist flats and uplands.

126 Tamarack (eastern larch): Associates – northern white cedar, red maple, black ash, and quaking aspen. Sites--wet swamps.

127 Northern white-cedar: Associates – tamarack, yellow birch, paperbirch, black ash, red maple, white pine, and hemlock. Sites--slow drainage (not stagnant bogs) areas that are not strongly acid.

LONGLEAF/SLASH PINE GROUP

141 Longleaf pine: Longleaf pine occurs as a pure type or comprises a majority of the trees in the overstory. Associates-slash, loblolly and shortleaf pine, southern red oak, blackjack oak, water oak, persimmon, and sweetgum. Sites--those areas that can and do burn on a periodic basis--usually occurs on middle and upper slopes with a low severity of hardwood and brush competition. Regional distribution--coastal plain and piedmont units.

142 Slash pine: Slash pine is pure or provides a majority of the stocking. Associates--on moist sites; a wide variety of moist-site hardwoods, pond pine, and pondcypress. On dry sites; a wide variety of dry-site hardwoods, longleaf, loblolly, and sand pine. Sites--both moist and well-drained flatwoods, and bays. Regional distribution--coastal plain and piedmont units from North Carolina to Florida.

LOBLOLLY/SHORTLEAF PINE GROUP

161 Loblolly pine: Associates – sweetgum, southern red oak, post oak, blackjack oak, blackgum, yellow-poplar, and pond pine. Sites--in Delaware and Maryland both on upland soils with abundant moisture but good drainage and on poorly drained depressions.

162 Shortleaf pine: Associates – white oak, southern red oak, scarlet oak, black oak, hickory, post oak, blackjack oak, blackgum, red maple, pitch pine, and Virginia pine. Sites--low, well drained ridges to rocky, dry, south slopes and the better drained spur ridges on north slopes and also on old fields.

163 Virginia pine: Associates – shortleaf pine, white oak, chestnut oak, southern red oak, black oak, sweetgum, red maple, blackgum, and pitch pine. Sites--dry sites, often abandoned fields.

164 Sand pine: Sand pine occurs in pure stands or provides a majority of the stocking. Associates--dwarf live oak, dwarf post oak, turkey oak, persimmon, and longleaf pine. Sites--dry, acidic, infertile sands. Regional distribution--found chiefly in the central peninsula and panhandle of Florida, although planted stands extend into the sandhills of Georgia and South Carolina.

165 Table-mountain pine: Associates – chestnut oak, scarlet oak, pitch pine, pine, and black oak. Sites--poor, dry, often rocky slopes.

166 Pond pine: Associates – loblolly pine, sweetgum, baldcypress, and Atlantic white-cedar. Sites--rare, but found in southern New Jersey, Delaware, and Maryland in low, poorly drained acres, swamps, and marshes.

167 Pitch pine: Associates – chestnut oak, scarlet oak, table-mountain pine, black oak, and blackgum. Sites--relatively infertile ridges, dry flats, and slopes.

168 Spruce pine: Spruce pine comprises a majority of the stocking. Associates--any of the moist site softwood or hardwood species. Sites--moist or poorly drained areas. Regional

distribution--this type is rarely encountered and is found almost exclusively in the coastal plain.

PINYON / JUNIPER GROUP

181 Eastern redcedar: Associates – gray birch, red maple, sweetbirch, Virginia Pine, shortleaf pine, oak. Sites--usually dry uplands and abandoned fields on limestone outcrops and other shallow soils but can grow well on good sites.

182 Rocky Mountain juniper

PONDEROSA PINE GROUP

221 Ponderosa pine

EXOTIC SOFTWOODS GROUP

381 Scotch pine: plantation type, not naturally occurring.

382 Australian pine:

383 Other exotic softwoods

384 Norway spruce: plantation type, not naturally occurring

385 Introduced larch: plantation type, usually Japanese larch, European larch, or a hybrid of the two (Dunkeld larch) - not naturally occurring. Sites--well-drained uplands; heavy plantation in New York.

OAK/PINE GROUP

401 Eastern white pine/northern red oak/white ash: Associates – red maple, basswood, yellow birch, bigtooth aspen, sugar maple, beech, paper birch, black cherry, hemlock, and sweet birch. Sites--deep, fertile, well-drained soil.

402 Eastern redcedar/hardwood: Associates – oak, hickory, walnut, ash, locust, dogwood, blackgum, hackberry, winged elm, shortleaf pine, and Virginia pine. Sites--usually dry uplands and abandoned fields.

403 Longleaf pine/oak: Longleaf pine and scrub oaks-primarily turkey, bluejack, blackjack, and dwarf post oak--comprise the type. Associates--southern scrub oaks in the understory. Sites--common on sandhills where soils are dry, infertile, and coarse textured. Regional distribution-- coastal plain and piedmont units.

404 Shortleaf pine/oak: Associates - (oaks generally include white, scarlet, blackjack, black, post, and southern red) hickory, blackgum, sweetgum, Virginia pine, and pitch pine. Sites--generally in dry, low ridges, flats, and south slopes.

405 Virginia pine/southern red oak: Associates – black oak, scarlet oak, white oak, post oak, blackjack oak, shortleaf pine, blackgum, hickory, pitch pine, table-mountain pine, chestnut oak. Sites--dry slopes and ridges.

406 Loblolly pine/hardwood: Associates – wide variety of moist and wet site hardwoods including blackgum, sweetgum, yellow-poplar, red maple, white and green ash, and American elm; on drier sites associates include southern and northern red oak, white

oak, post oak, scarlet oak, persimmon, and hickory. Sites--usually moist to very moist though not wet all year but also on drier sites.

407 Slash pine/hardwood: Slash pine and a variable mixture of hardwoods comprise the type. Associates-- codominant with the slash pine component are sweetbay, blackgum, loblolly-bay, pond cypress, pond pine, Atlantic white-cedar, red maple, ash, and water oak. Sites--undrained or poorly drained depressions such as bays or pocosins and along pond margins. Regional distribution--primarily coastal plain units.

409 Other pine/hardwood:

OAK/HICKORY GROUP

501 Post oak/blackjack oak: Associates – black oak, hickory, southern red oak, white oak, scarlet oak, shingle oak, live oak, shortleaf pine, Virginia pine, blackgum, sourwood, red maple, winged elm, hackberry, chinkapin oak, shumard oak, dogwood, and eastern redcedar. Sites--dry uplands and ridges.

502 Chestnut oak: Associates – scarlet oak, white oak, black oak, post oak, pitch pine, blackgum, sweetgum, red maple, red oak, shortleaf pine, Virginia pine. Sites--rocky outcrops with thin soil, ridge tops.

503 White oak/red oak/hickory: Associates – scarlet oak, bur oak, pinoak, white ash, sugar maple, red maple, walnut, basswood, locust, beech, sweetgum, blackgum, yellow-poplar, and dogwood. Sites--wide variety of well drained upland soils.

504 White oak: Associates – black oak, northern red oak, bur oak, hickory, white ash, yellow-poplar. Sites--scattered patches on upland, loamy soils but on drier sites than type 503.

505 Northern red oak: Associates – black oak, scarlet oak, chestnut oak, and yellow-poplar. Sites--spotty distribution on ridge crests and north slopes in mountains but also found on rolling land, slopes, and benches on loamy soil.

506 Yellow-poplar/white oak/northern red oak: Associates – black oak, hemlock, blackgum, and hickory. Sites--northern slopes, coves, and moist flats.

507 Sassafras/persimmon: Associates – elm, eastern redcedar, hickory, ash, sugar maple, yellow-poplar, and oaks. Sites--abandoned farmlands and old fields.

508 Sweetgum/yellow-poplar: Associates – red maple, white ash, green ash, and other moist site hardwoods. Sites--generally occupies moist, lower slopes.

509 Bur oak: Associates—northern pin oak, black oak, chinkapin oak, and eastern redcedar in northern and dry upland sites; shagbark hickory, black walnut, eastern cottonwood, white ash, American elm, swamp white oak, honey locust, and American basswood in southern and lowland sites. Sites – drier uplands to moist bottomlands with the drier uplands more common in the northern part of the range and the moist bottomlands more common in the southern part of the range.

510 Scarlet oak: Associates – black oak, southern red oak, chestnut oak, white oak, post oak, hickory, pitch pine, blackgum, sweetgum, black locust, sourwood, dogwood, shortleaf pine, and Virginia pine. Sites--dry ridges, south- or west-facing slopes and flats but often moister situations probably as a result of logging or fire.

511 Yellow-poplar: Associates – black locust, red maple, sweet birch, cucumbertree, and other moist-site hardwoods (except sweetgum, see type 562) and white oak and northern red oak (see type 560). Sites--lower slopes, northerly slopes, moist coves, flats, and old fields.

512: Black Walnut: Associates – yellow-poplar, white ash, black cherry, basswood, beech, sugar maple, oaks, and hickory. Sites--coves and well-drained bottoms.

513 Black locust: Associates – many species of hardwoods and hardpines may occur with it in mixture, either having been planted or from natural seeding. Sites--may occur on any well-drained soil but best on dry sites, often in old fields.

514 Southern scrub oak: This forest cover type consists of a mixture of scrub oaks that may include several of the following species: turkey oak, bluejack oak, blackjack oak, dwarf post oak, and dwarf live oak. Sites--dry sandy ridges-the type frequently develops on areas formerly occupied by longleaf pine. Regional distribution--common throughout all coastal plain units and into the lower Piedmont.

515 Chestnut oak/black oak/scarlet oak: Associates—northern and southern red oaks, post oak, white oak, sourwood, shagbark hickory, pignut hickory, yellow-poplar, blackgum, sweetgum, red maple, eastern white pine, pitch pine, Table Mountain pine, shortleaf pine, and Virginia pine. Sites—dry upland sites on thin-soiled rocky outcrops on dry ridges and slopes.

519 Red maple/oak: Associates – the type is dominated by red maple and some of the wide variety of central hardwood associates include upland oak, hickory, yellow-poplar, black locust, sassafras as well as some central softwoods like Virginia and shortleaf pines. Sites -- uplands.

520 Mixed upland hardwoods: Associates – Any mixture of hardwoods of species typical of the upland central hardwood region, should include at least some oak. Sites--wide variety of upland sites.

OAK/GUM/CYPRESS GROUP

601 Swamp chestnut oak/cherrybark oak: Associates – white ash, hickory, white oak, shumard oak, blackgum, sweetgum, southern red oak, post oak, American elm, winged elm, yellow-poplar, and beech. Sites--within alluvial flood plains of major rivers on all ridges in the terraces and on the best fine sandy loam soils on the highest first bottom ridges.

602 Sweetgum/Nuttall oak/willow oak: Associates – green ash, American elm, pecan, cottonwood, red maple, honeylocust, and persimmon. Sites--very wet.

605 Overcup oak/water hickory: Associates – willow oak, American elm, green ash, hackberry, persimmon, and red maple. Sites--in South within alluvial flood plains in low, poorly drained flats with clay soils; also in sloughs and lowest backwater basins and low ridges with heavy soils that are subject to late spring inundation.

606 Atlantic white-cedar: Associates – North includes gray birch, pitch pine, hemlock, blackgum, and red maple. South includes pond pine, baldcypress, and red maple. Sites--usually confined to sandy-bottomed, peaty, interior, and river swamps, wet depressions, and stream banks.

607 Baldcypress/water tupelo: Associates – willow, red maple, American elm, persimmon, overcup oak, and sweetgum. Sites--very low, poorly drained flats, deep sloughs, and swamps wet most all the year.

608 Sweetbay/swamp tupelo/red maple: Associates – blackgum, loblolly and pond pines, American elm, and other moist-site hardwoods. Sites--very moist but seldom wet all year--shallow ponds, muck swamps, along smaller creeks in Coastal Plain (rare in Northeast).

ELM/ASH/COTTONWOOD GROUP

701 Black ash/American elm/red maple: Associates – silver maple, swamp white oak, sycamore, pin oak, blackgum, white ash, and cottonwood. Sites--moist to wet areas, swamps, gullies, and poorly drained flats.

702 River birch/sycamore: Associates – red maple, black willow, and other moist-site hardwoods. Sites--moist soils at edges of creeks and rivers.

703 Cottonwood: Associates – willow, white ash, green ash, and sycamore. Sites--streambanks where bare, moist soil is available.

704 Willow: Associates – cottonwood, green ash, sycamore, pecan, American elm, red maple, and boxelder. Sites--streambanks where bare, moist soil is available.

705 Sycamore/pecan/American elm: Associates – boxelder, green ash, hackberry, silver maple, cottonwood, willow, sweetgum, and river birch. Sites--bottomlands, alluvial flood plains of major rivers.

706 Sugarberry/hackberry/elm/green ash: Associates – pecan, blackgum, persimmon, honeylocust, red maple, hackberry, and boxelder. Sites--low ridges and flats in flood plains.

707 Siver maple/American elm: Associates – sweetgum, pin oak, swamp white oak, eastern cottonwood, sycamore, green ash, and other moist-site hardwoods (depending on region). Sites – well-drained, moist sites along river bottoms and floodplains, and beside lakes and larger streams.

708 Red maple/lowland:

709 Cottonwood/willow: Associates – white ash, green ash sycamore, American elm, red maple and boxelder. Sites – stream banks where bare, moist soil is available.

MAPLE/BEECH/BIRCH GROUP

801 Sugar maple/beech/yellow birch: Associates – basswood, red maple, hemlock, northern red oak, white ash, white pine, black cherry, sweet birch, American elm, rock elm, and eastern hophornbeam. Sites--fertile, moist, well-drained sites.

802 Black cherry: Associates – sugar maple, northern red oak, red maple, white ash, basswood, sweet birch, butternut, American elm, and hemlock. Sites--fertile, moist, well-drained sites.

803 Cherry/ash/yellow-poplar: Associates – sugar maple, American beech, northern red oak, white oak, blackgum, hickory, cucumbertree, and yellow birch. Sites -- fertile, moist, well-drained sites.

805 Hard maple/basswood: Associates – white ash, northern red oak, eastern hophornbeam, American elm, red maple, eastern white pine, eastern hemlock. Sugar maple and basswood occur in different proportions but together comprise the majority of the stocking. Sites -- fertile, moist, well-drained sites.

807 Elm/ash/locust: Associates – locust, silver maple, boxelder, elm, red maple, green ash predominate. Found in North Central region, unknown in Northeast. Sites--upland

809 Red maple/upland: Associates – the type is dominated by red maple and some of the wide variety of northern hardwood associates include sugar maple, beech, birch, aspen, as well as some northern softwoods like white pine, red pine, and hemlock; this type is often man-made and may be the result of repeated cuttings. Sites -- uplands. (See Type 519 under oak/hickory group)

ASPEN/BIRCH GROUP

901 Aspen: Associates – paper birch, pin cherry, bur oak, green ash, American elm, balsam poplar, and boxelder. Sites--all kinds of soils except very driest sands and wettest swamps; found on burns, clearcuts, and abandoned land.

902 Paper birch: Associates – aspen, white pine, yellow birch, hemlock, red maple, northern red oak, and basswood. Sites--wide range of upland site, common on burns or clearcuts.

904 Balsam poplar: Associates – balsam fir, white spruce, black spruce, tamarack, aspen, and paper birch. Sites – uplands and flood plains.

TROPICAL HARDWOODS GROUP

981 Sabal palm:

982 Mangrove: Forests in which mangrove comprises a majority of the stocking. Associates--cabbage palm on some of the higher sites in the area. Sites--predominantly salt marshes; mangrove frequently develops its own island or shoreline made up of a dense mat of root structures. Regional distribution--restricted to South Florida, the Keys, Puerto Rico, and the U.S. Virgin Islands.

989 Other tropical:

EXOTIC HARDWOODS GROUP

991 Paulownia:

992 Melaluca:

993 Eucalyptus:

995 Other exotic hardwoods:

For non-stocked stands, see sections 2.5.3 for procedures to determine FOREST TYPE.

Appendix 3. NC FIA Tree Species Codes

Core	East	West	Woodland	FIA Code	PLANTS Code	Common Name	Genus	Species
	E	W		0010	ABIES	fir spp.	Abies	spp.
X	E	W		0012	ABBA	balsam fir	Abies	balsamea
X	E			0016	ABFR	Fraser fir	Abies	fraseri
X	E			0043	CHTH2	Atlantic white-cedar	Chamaecyparis	thyoides
	E	W		0057	JUNIP	redcedar / juniper spp.	Juniperus	spp.
X	E			0061	JUAS	Ashe juniper	Juniperus	ashei
X	E	W	w	0066*	JUSC2	Rocky Mountain juniper	Juniperus	scopulorum
	E			0067	JUVIS	southern redcedar	Juniperus	virginiana var. silicicola
X	E			0068	JUVI	eastern redcedar	Juniperus	virginiana
X	E	W		0071	LALA	tamarack (native)	Larix	laricina
	E	W		0090	PICEA	spruce spp.	Picea	spp.
X	E			0091	PIAB	Norway spruce	Picea	abies
X		W		0093	PIEN	Engelmann spruce	Picea	engelmannii
X	E	W		0094	PIGL	white spruce	Picea	glauca
X	E	W		0095	PIMA	black spruce	Picea	mariana
X	E	W		0096	PIPU	blue spruce	Picea	pungens
X	E			0097	PIRU	red spruce	Picea	rubens
	E	W		0100	PINUS	pine spp.	Pinus	spp.
X	E			0105	PIBA2	jack pine	Pinus	banksiana
X		W		0108	PICO	lodgepole pine	Pinus	contorta
X	E			0110	PIEC2	shortleaf pine	Pinus	echinata
X		W		0113	PIFL2	limber pine	Pinus	flexilis
X	E			0115	PIGL2	spruce pine	Pinus	glabra
X	E	W		0122	PIPO	ponderosa pine	Pinus	ponderosa
X	E			0123	PIPU5	Table Mountain pine	Pinus	pungens
X	E			0125	PIRE	red pine	Pinus	resinosa
X	E			0126	PIRI	pitch pine	Pinus	rigida
X	E			0129	PIST	eastern white pine	Pinus	strobus
X	E			0130	PISY	Scotch pine	Pinus	sylvestris
X	E			0131	PITA	loblolly pine	Pinus	taeda
X	E			0132	PIVI2	Virginia pine	Pinus	virginiana
X	E			0136	PINI	Austrian pine	Pinus	nigra
X		W		0202	PSME	Douglas-fir	Pseudotsuga	menziesii
	E			0220	TAXOD	cypress spp.	Taxodium	spp.
X	E			0221	TADI2	baldcypress	Taxodium	distichum

Core	East	West	Woodland	FIA Code	PLANTS Code	Common Name	Genus	Species
X	E			0222	TAAS	pondcypress	Taxodium	ascendens
X	E			0241	THOC2	northern white-cedar	Thuja	occidentalis
	E	W		0260	TSUGA	hemlock spp.	Tsuga	spp.
X	E			0261	TSCA	eastern hemlock	Tsuga	canadensis
X	E			0262	TSCA2	Carolina hemlock	Tsuga	caroliniana
X	E	W		0299	2TE	Unknown conifer	Tree	evergreen
	E	W		0310	ACER	maple spp.	Acer	spp.
X	E	W		0313	ACNE2	Boxelder	Acer	negundo
X	E			0314	ACNI5	black maple	Acer	nigrum
X	E			0315*	ACPE	striped maple	Acer	pensylvanicum
X	E			0316	ACRU	red maple	Acer	rubrum
X	E			0317	ACSA2	silver maple	Acer	saccharinum
X	E			0318	ACSA3	sugar maple	Acer	saccharum
	E			0319*	ACSP2	Mountain maple	Acer	spicatum
	E			0320	ACPL	Norway maple	Acer	platanoides
		W	w	0321	ACGL	Rocky Mountain maple	Acer	glabrum
X	E			0323	ACLE	chalk maple	Acer	leucoderme
	E	W		0330	AESCU	buckeye, horsechestnut spp.	Aesculus	spp.
X	E			0331	AEGL	Ohio buckeye	Aesculus	glabra
X	E			0332	AEFL	yellow buckeye	Aesculus	flava
	E			0336	AEPA	red buckeye	Aesculus	pavia
X	E			0337	AESY	painted buckeye	Aesculus	sylvatica
X	E			0341*	AIAL	ailanthus	Ailanthus	altissima
X	E	W		0345*	ALJU	mimosa/silktree	Albizia	julibrissin
X	E			0355	ALGL2	European alder	Alnus	glutinosa
	E	W		0356*	AMELA	serviceberry spp.	Amelanchier	spp.
	E	W		0357*	AMAR3	common serviceberry	Amelanchier	arborea
	E	W		0358*	AMSA	roundleaf serviceberry	Amelanchier	sanguinea
X	E			0367*	ASTR	Pawpaw	Asimina	triloba
	E	W		0370	BETUL	birch spp.	Betula	spp.
X	E			0371	BEAL2	yellow birch	Betula	alleghaniensis
X	E			0372	BELE	sweet birch	Betula	lenta
X	E			0373	BENI	river birch	Betula	nigra
X	E			0374	BEOC2	Water birch	Betula	occidentalis
X	E	W		0375	BEPA	paper birch	Betula	papyrifera
X	E			0377	BEUB	Virginia roundleaf birch	Betula	uber

Core	East	West	Woodland	FIA Code	PLANTS Code	Common Name	Genus	Species
X	E			0379	BEPO	gray birch	Betula	populifolia
	E			0381*	SILAL3	Chittamwood/gum bumelia	Sideroxylon	lanuginosum ssp. lanuginosum
X	E			0391*	CACA18	American hornbeam, musclewood	Carpinus	caroliniana
	E			0400	CARYA	hickory spp.	Carya	spp.
X	E			0401	CAAQ2	water hickory	Carya	aquatica
X	E			0402	CACO15	bitternut hickory	Carya	cordiformis
X	E			0403	CAGL8	pignut hickory	Carya	glabra
X	E			0404	CAIL2	pecan	Carya	illinoinensis
X	E			0405	CALA21	shellbark hickory	Carya	laciniosa
X	E			0406	CAMY	nutmeg hickory	Carya	myristiciformis
X	E			0407	CAOV2	shagbark hickory	Carya	ovata
X	E			0408	CATE9	black hickory	Carya	texana
X	E			0409	CAAL27	mockernut hickory	Carya	alba
X	E			0410	CAPA24	sand hickory	Carya	pallida
X	E			0411	CAFL6	scrub hickory	Carya	floridana
X	E			0412	CAOV3	red hickory	Carya	ovalis
X	E			0413	CACA38	southern shagbark hickory	Carya	carolinae-septentrionalis
	E	W		0420	CASTA	chestnut spp.	Castanea	spp.
	E			0421	CADE12	American chestnut	Castanea	dentata
X	E			0422	CAPU9	Allegheny chinkapin	Castanea	pumila
	E			0423	CAPUO	Ozark chinkapin	Castanea	pumila var. ozarkensis
X	E	W		0424	CAMO83	Chinese chestnut	Castanea	mollissima
	E			0450	CATAL	catalpa spp.	Catalpa	spp.
X	E			0451	CABI8	southern catalpa	Catalpa	bignonioides
X	E			0452	CASP8	northern catalpa	Catalpa	speciosa
	E	W		0460	CELTI	hackberry spp.	Celtis	spp.
X	E	W		0461	CELA	sugarberry	Celtis	laevigata
X	E	W		0462	CEOC	hackberry	Celtis	occidentalis
	E	W		0463	CELAR	netleaf hackberry	Celtis	laevigata var. reticulata
X	E			0471*	CECA4	eastern redbud	Cercis	canadensis
X	E			0481	CLKE	yellowwood	Cladrastis	kentukea
X	E			0491	COFL2	flowering dogwood	Cornus	florida
	E			0500*	CRATA	hawthorn spp.	Crataegus	spp.
	E			0501*	CRCR2	cockspur hawthorn	Crataegus	crus-galli
	E			0502*	CRMO2	downy hawthorn	Crataegus	mollis

Core	East	West	Woodland	FIA Code	PLANTS Code	Common Name	Genus	Species
	E			0503*	CRBR3	Brainerd hawthorn	Crataegus	brainerdii
	E			0504*	CRCA	pear hawthorn	Crataegus	calpodendron
	E			0505*	CRCH	Fireberry hawthorn	Crataegus	chrysocarpa
	E			0506*	CRDI	broadleaf hawthorn	Crataegus	dilatata
	E			0507*	CRFL	fanleaf hawthorn	Crataegus	flabellata
	E			0508*	CRMO3	Oneseed hawthorn	Crataegus	monogyna
	E			0509*	CRPE	scarlet hawthorn	Crataegus	pedicellata
	E			5091*	CRPH	Washington hawthorn	Crataegus	phaenopyrum
	E			5092*	CRSU5	fleshy hawthorn	Crataegus	succulenta
	E			5093*	CRUN	dwarf hawthorn	Crataegus	uniflora
	E			0520	DIOSP	persimmon spp.	Diospyros	spp.
X	E			0521	DIVI5	common persimmon	Diospyros	virginiana
X	E			0522	DITE3	Texas persimmon	Diospyros	texana
X	E			0531	FAGR	American beech	Fagus	grandifolia
	E	W		0540	FRAXI	ash spp.	Fraxinus	spp.
X	E			0541	FRAM2	white ash	Fraxinus	americana
X	E			0543	FRNI	black ash	Fraxinus	nigra
X	E			0544	FRPE	green ash	Fraxinus	pennsylvanica
X	E			0545	FRPR	pumpkin ash	Fraxinus	profunda
X	E			0546	FRQU	blue ash	Fraxinus	quadrangulata
X	E			0548	FRCA3	Carolina ash	Fraxinus	caroliniana
X	E			0549	FRTE	Texas ash	Fraxinus	texensis
	E			0550	GLEDI	locust spp.	Gleditsia	spp.
X	E			0551	GLAQ	water locust	Gleditsia	aquatica
X	E			0552	GLTR	honeylocust	Gleditsia	triacanthos
X	E			0555	GOLA	loblolly bay	Gordonia	lasianthus
X	E	W		0561	GIBI2	Ginkgo, maidenhair tree	Ginkgo	biloba
X	E			0571	GYDI	Kentucky coffeetree	Gymnocladus	dioicus
	E			0580	HALES	silverbell spp.	Halesia	spp.
X	E			0581	HACA3	Carolina silverbell	Halesia	carolina
X	E			0582	HADI3	two-wing silverbell	Halesia	diptera
X	E			0583	HACA3	little silverbell	Halesia	parviflora
X	E			0591	ILOP	American holly	Ilex	opaca
	E	W		0600	JUGLA	walnut spp.	Juglans	spp.
X	E			0601	JUCI	butternut	Juglans	cinerea
X	E	W		0602	JUNI	black walnut	Juglans	nigra
	E	W		0605	JUMI	Texas walnut	Juglans	microcarpa

Core	East	West	Woodland	FIA Code	PLANTS Code	Common Name	Genus	Species
X	E			0611	LIST2	sweetgum	Liquidambar	styraciflua
X	E			0621	LITU	yellow-poplar	Liriodendron	tulipifera
X	E			0641*	MAPO	Osage-orange	Maclura	pomifera
	E			0650	MAGNO	magnolia spp.	Magnolia	spp.
X	E			0651	MAAC	cucumbertree	Magnolia	acuminata
X	E			0652	MAGR4	southern magnolia	Magnolia	grandiflora
X	E			0653	MAVI2	sweetbay	Magnolia	virginiana
X	E			0654	MAMA2	bigleaf magnolia	Magnolia	macrophylla
X	E			0655	MAFR	mountain or Fraser magnolia	Magnolia	fraseri
X	E			0657	MAPY	pyramid magnolia	Magnolia	pyramidata
X	E			0658	MATR	umbrella magnolia	Magnolia	tripetala
	E	W		0660*	MALUS	apple spp.	Malus	spp.
X	E			0662*	MAAN3	southern crabapple	Malus	angustifolia
X	E			0663*	MACO5	sweet crabapple	Malus	coronaria
X	E			0664*	MAIO	prairie crabapple	Malus	ioensis
	E			0680	MORUS	mulberry spp.	Morus	spp.
X	E			0681	MOAL	white mulberry	Morus	alba
X	E			0682	MORU2	red mulberry	Morus	rubra
X	E			0684	MONI	black mulberry	Morus	nigra
	E			0690	NYSSA	tupelo spp.	Nyssa	spp.
X	E			0691	NYAQ2	water tupelo	Nyssa	aquatica
X	E			0692	NYOG	Ogeechee tupelo	Nyssa	ogeche
X	E			0693	NYSY	blackgum	Nyssa	sylvatica
X	E			0694	NYBI	swamp tupelo	Nyssa	biflora
X	E			0701*	OSVI	eastern hophornbeam	Ostrya	virginiana
X	E			0711	OXAR	sourwood	Oxydendrum	arboreum
X	E			0712	PATO2	paulownia, empress-tree	Paulownia	tomentosa
X	E			0721	PEBO	redbay	Persea	borbonia
X	E			0722	PLAQ	water-elm, planertree	Planera	aquatica
X	E			0731	PLOC	American sycamore	Platanus	occidentalis
	E	W		0740	POPUL	cottonwood and poplar spp.	Populus	spp.
X	E	W		0741	POBA2	balsam poplar	Populus	balsamifera
X	E			0742	PODE3	eastern cottonwood	Populus	deltoides
X	E			0743	POGR4	bigtooth aspen	Populus	grandidentata
X	E			0744	POHE4	swamp cottonwood	Populus	heterophylla

Core	East	West	Woodland	FIA Code	PLANTS Code	Common Name	Genus	Species
X	E	W		0745	PODEM	plains cottonwood	Populus	deltoides ssp. monilifera
X	E	W		0746	POTR5	quaking aspen	Populus	tremuloides
X		W		0747	POBAT	black cottonwood	Populus	balsamifera ssp. trichocarpa
X		W		0748	POFR2	Fremont's cottonwood	Populus	fremontii
X		W		0749	POAN3	narrowleaf cottonwood	Populus	angustifolia
X	E			0752	POAL7	silver poplar	Populus	alba
X	E			0753	PONI	Lombardy poplar	Populus	nigra
	E	W		0760	PRUNU	cherry and plum spp.	Prunus	spp.
	E	W		0761*	PRPE2	pin cherry	Prunus	pensylvanica
X	E			0762	PRSE2	black cherry	Prunus	serotina
	E	W		0763*	PRVI	common chokecherry	Prunus	virginiana
	E			0764	PRPE3	peach	Prunus	persica
X	E			0765*	PRNI	Canada plum	Prunus	nigra
X	E			0766*	PRAM	American plum	Prunus	americana
	E			0769	PRAL5	Allegheny plum	Prunus	alleghaniensis
	E	W		0770	PRAN3	Chickasaw plum	Prunus	angustifolia
X	E			0771	PRAV	sweet cherry, domesticated	Prunus	avium
	E			0772	PRCE	sour cherry, domesticated	Prunus	cerasus
	E			0773	PRDO	European plum, domesticated	Prunus	domestica
	E			0774	PRMA	Mahaleb plum, domesticated	Prunus	mahaleb
	E	W		0800	QUERC	oak – deciduous spp.	Quercus	spp.
X	E			0802	QUAL	white oak	Quercus	alba
X	E			0804	QUBI	swamp white oak	Quercus	bicolor
X	E			0806	QUCO2	scarlet oak	Quercus	coccinea
X	E			0808	QUSIS	Durand oak	Quercus	sinuata var. sinuata
X	E			0809	QUEL	northern pin oak	Quercus	ellipsoidalis
X	E			0812	QUFA	southern red oak	Quercus	falcata
X	E			0813	QUPA5	cherrybark oak	Quercus	pagoda
X	E			0816	QUIL	scrub oak	Quercus	ilicifolia
X	E			0817	QUIM	shingle oak	Quercus	imbricaria
X	E			0819	QULA2	turkey oak	Quercus	laevis
X	E			0820	QULA3	laurel oak	Quercus	laurifolia
X	E			0822	QULY	overcup oak	Quercus	lyrata
X	E			0823	QUMA2	bur oak	Quercus	macrocarpa

Core	East	West	Woodland	FIA Code	PLANTS Code	Common Name	Genus	Species
X	E			0824	QUMA3	blackjack oak	Quercus	marilandica
X	E			0825	QUMI	swamp chestnut oak	Quercus	michauxii
X	E			0826	QUMU	chinkapin oak	Quercus	muehlenbergii
X	E			0827	QUNI	water oak	Quercus	nigra
X	E			0828	QUBU2	Nuttall oak	Quercus	buckleyi
X	E			0830	QUPA2	pin oak	Quercus	palustris
X	E			0831	QUPH	willow oak	Quercus	phellos
X	E			0832	QUPR2	chestnut oak	Quercus	prinus
X	E			0833	QURU	northern red oak	Quercus	rubra
X	E			0834	QUSH	Shumard’s oak	Quercus	shumardii
X	E			0835	QUST	post oak	Quercus	stellata
	E			0836	QUSI2	Delta post oak	Quercus	similis
X	E			0837	QUVE	black oak	Quercus	velutina
X	E			0838	QUVI	live oak	Quercus	virginiana
X	E			0840	QUMA6	dwarf post oak	Quercus	margarettiae
X	E			0841	QUMI2	dwarf live oak	Quercus	minima
X	E			0842	QUIN	bluejack oak	Quercus	incana
X	E			0844	QUOG	Oglethorpe oak	Quercus	oglethorpensis
	E			0845	QUPR	dwarf chinkapin oak	Quercus	prinoides
X		W	w	0846	QUGR3	gray oak	Quercus	grisea
X		W	w	0847	QURU4	netleaf oak	Quercus	rugosa
X	E	W		0901	ROPS	black locust	Robinia	pseudoacacia
	E	W		0919	SASAD	western soapberry	Sapindus	saponaria var. drummondii
	E	W		0920	SALIX	willow spp.	Salix	spp.
	E	W		0921*	SAAM2	peachleaf willow	Salix	amygdaloides
	E	W		0922	SANI	black willow	Salix	nigra
	E	W		0923	SABE2	Bebb willow	Salix	bebbiana
X	E			0925	SACA5	coastal plain willow	Salix	caroliniana
X	E			0926	SAPY	balsam willow	Salix	pyrifolia
	E	W		0927	SAAL2	white willow	Salix	alba
X	E			0929	SASE10	weeping willow	Salix	sepulcralis
X	E			0931	SAAL5	sassafras	Sassafras	albidum
	E			0934	SORBU	mountain ash spp.	Sorbus	spp.
	E			0935*	SOAM3	American mountain ash	Sorbus	americana
X	E			0936	SOAU	European mountain ash	Sorbus	aucuparia
X	E			0937	SODE3	northern mountain ash	Sorbus	decora

Core	East	West	Woodland	FIA Code	PLANTS Code	Common Name	Genus	Species
	E			0940	SWMA2	mahogany	Swietenia	mahagoni
	E			0950	TILIA	basswood spp.	Tilia	spp.
X	E			0951	TIAM	American basswood	Tilia	americana
	E			0952	TIAMH	white basswood	Tilia	americana var. heterophylla
	E			0953	TIAMC	Carolina basswood	Tilia	americana var. caroliniana
	E			0970	ULMUS	elm spp.	Ulmus	spp.
X	E			0971	ULAL	winged elm	Ulmus	alata
X	E			0972	ULAM	American elm	Ulmus	americana
X	E			0973	ULCR	cedar elm	Ulmus	crassifolia
X	E			0974	ULPU	Siberian elm	Ulmus	pumila
X	E			0975	ULRU	slippery elm	Ulmus	rubra
X	E			0976	ULSE	September elm	Ulmus	serotina
X	E			0977	ULTH	rock elm	Ulmus	thomasii
	E			0986	AVGE	black mangrove	Avicennia	germinans
	E			0987	COER2	buttonwood mangrove	Conocarpus	erectus
	E			0988	LARA2	white mangrove	Laguncularia	racemosa
X	E			0989	RHMA2	American mangrove	Rhizophora	mangle
	E	W		0991	TAMAR2	saltcedar	Tamarix	spp.
X	E			0992	MEQU	melaleuca	Melaleuca	quinquenervia
X	E			0993	MEAZ	chinaberry	Melia	azedarach
X	E			0994	TRSE6	Chinese tallowtree	Triadica	sebifera
X	E			0995	VEFO	tungoil tree	Vernicia	fordii
X	E			0996	COOB2	smoketree	Cotinus	obovatus
	E	W		0997	ELAN	Russian-olive	Elaeagnus	angustifolia
X	E	W		0998	2TB	unknown hardwood	Tree	broadleaf
X	E	W		0999	2TREE	Other, or unknown tree	Tree	unknown

Appendix 4. Site Tree Selection Criteria and Species List

A. Eastern U.S. Site-Tree Selection Criteria

Ideally, site trees in the eastern U.S. should be between 20-70 years old. If preferred trees cannot be found in this age range, expand the age range to 15-120 years. Reject trees outside the 15-120 year age range, trees that exhibit signs of damage, trees with ring patterns that show signs of suppression, trees less than 5.0 inches DBH, trees with abnormalities at DBH, and trees with rotten cores. A list of preferred site-tree species is provided. Site trees should be selected in the following order of preference:

1st Choice: representative of the stand, on the list for your region.
2nd Choice: representative of the stand, on the list for an adjoining eastern region.
3rd Choice: not representative of the stand, on the list for your region.
4th Choice: not representative of the stand, on the list for an adjoining eastern region.

Note: NE = Northeast, NC = North Central, SO = Southern

Code	Common Name	Region	NC Figure Number
	-------------------- **Softwood Species** --------------------		
0012	balsam fir	NE, NC	55
0043	Atlantic white-cedar	NE	
0068	eastern redcedar	NE, NC	58
0070	larch (introduced)	NE	
0071	tamarack (native)	NE, NC	60
0094	white spruce	NE, NC	67
0095	black spruce	NE, NC	70
0097	red spruce	NE	
0105	jack pine	NE, NC	74
0107	sand pine	SO	
0110	shortleaf pine	NE, NC, SO	80
0111	slash pine	SO	
0121	longleaf pine	SO	
0122	Ponderosa pine	NC	Plains 2
0125	red pine	NE, NC	95
0128	pond pine	NE, SO	
0129	eastern white pine	NE, NC, SO	103
0130	Scotch pine	NE, NC	95
0131	loblolly pine	NE, NC, SO	Do not use
0132	Virginia pine	NE, NC, SO	None
0135	Arizona pine	SO	
0202	Douglas-fir	SO	
0241	northern white cedar	NE, NC	126
0261	eastern hemlock	NE, NC	127
	-------------------- **Hardwood Species** --------------------		
0316	red maple	NE, NC	1
0317	silver maple	NE, NC	4
0318	sugar maple	NE, NC	3
0371	yellow birch	NE, NC	6
0375	paper birch	NE, NC	9

Code	Common Name	Region	NC Figure Number
0402	bitternut hickory	NE, NC	10
0407	shagbark hickory	NE, NC	10
0462	hackberry	NC	Plains 3
0531	American beech	NE, NC	11
0541	white ash	NE, NC	13
0543	black ash	NE, NC	14
0544	green ash	NE, NC	15
0602	black walnut	NC	16
0602	Plains states	NC	Plains 1
0611	sweetgum	NE, NC, SO	21
0621	yellow-poplar	NE, NC, SO	25
0742	eastern cottonwood	NE, NC, SO	28
0743	bigtooth aspen	NE, NC	32
0745	plains cottonwood	SO	
0746	quaking aspen	NE, NC, SO	32
0741	balsam poplar	NC	32
0748	Fremont poplar	SO	
0749	narrowleaf cottonwood	SO	
0762	black cherry	NC	34
0802	white oak	NE, NC, SO	41
0823	bur oak	NC	41
0826	chinkapin oak	NC	41
0806	scarlet oak	NE, NC, SO	49
0812	southern red oak	NE, SO	
0813	cherrybark oak	NE, NC, SO	None
0817	shingle oak	NE, NC, SO	49
0827	water oak	NE, SO	
0830	pin oak	NE, NC, SO	49
0809	northern pin oak	NC	49
0832	chestnut oak	NE, NC, SO	None
0833	northern red oak	NE, NC, SO	48
0835	post oak	NE, NC, SO	41
0837	black oak	NE, NC, SO	49
0901	black locust	NE, NC	50
0951	American basswood	NE, NC	51
0972	American elm	NE, NC	53
0975	Slippery Elm	NC	53
0977	Rock Elm	NC	53

B. Western U.S. Site-Tree Selection Criteria

Ideally, site trees in the western U.S. should be between 35-80 years old. If preferred trees cannot be found in this age range, expand the age range to 15-250 years. Reject trees outside the 15-250 year age range, trees that exhibit signs of damage, trees with ring patterns that show signs of suppression, trees less than 5.0 inches DBH, trees with abnormalities at DBH, trees with rotten cores, and woodland species. A list of preferred site-tree species is provided. Site trees should be selected in the following order of preference:

1st Choice: representative of the stand, on the list for your region.
2nd Choice: representative of the stand, on the list for an adjoining western region.
3rd Choice: not representative of the stand, on the list for your region.
4th Choice: not representative of the stand, on the list for an adjoining western region.

Note: PNW = Pacific Northwest FIA, RMRS = Rocky Mountain FIA

Code	Common Name	Region
	-------------------- **Softwood Species** --------------------	
0011	Pacific silver fir	PNW
0015	white fir	RMRS, PNW
0017	grand fir	RMRS, PNW
0018	corkbark fir	RMRS
0019	subalpine fir	RMRS, PNW
0020	California red fir	RMRS, PNW
0021	shasta red fir	PNW
0022	noble fir	PNW
0073	western larch	RMRS, PNW
0081	incense-cedar	RMRS, PNW
0093	Engelmann spruce	RMRS, PNW
0094	white spruce	RMRS, PNW
0095	black spruce	PNW
0096	blue spruce	RMRS
0098	sitka spruce	PNW
0104	foxtail pine	RMRS
0108	lodgepole pine	RMRS, PNW
0109	Coulter pine	PNW
0112	Apache pine	RMRS
0116	Jeffrey pine	RMRS, PNW
0117	sugar pine	RMRS, PNW
0119	western white pine	RMRS, PNW
0120	bishop pine	PNW
0122	ponderosa pine	RMRS, PNW
0135	Arizona pine	RMRS
0201	bigcone Douglas-fir	PNW
0202	Douglas-fir	RMRS, PNW
0211	redwood	PNW
0231	Pacific yew	PNW
0242	western redcedar	RMRS, PNW
0263	western hemlock	RMRS, PNW
0264	mountain hemlock	RMRS, PNW

Code	Common Name	Region
	-------------------- **Hardwood Species** --------------------	
0312	bigleaf maple	PNW
0351	red alder	PNW
0375	paper birch	RMRS, PNW
0741	balsam poplar	RMRS, PNW
0745	plains cottonwood	RMRS
0746	quaking aspen	RMRS, PNW
0747	black cottonwood	RMRS, PNW
0748	Fremont poplar	RMRS
0749	narrowleaf cottonwood	RMRS

Appendix 5. Determination of Stocking Values for Land Use Classification

Stocking values are required to determine if a CONDITION STATUS = 1 (accessible forest land) exists on a plot. This will determine which data items must be recorded for the condition. When the CONDITION STATUS is in question (usually a nonforest area that is in the process of reverting to forest land or a marginal site that can only support a low number of trees), the crew must determine if there is sufficient stocking to classify the condition as forest. A minimum stocking value of 10 percent is required for accessible forest land (unless the condition was previously forested, such as a recent clear cut).

The following tables show the stocking values to assign to trees or the number of trees per acre to determine if a plot meets the minimum stocking to be considered forest land. In the determination of stocking for this purpose, the field crew should consider the condition over its entire area, not just the trees and seedlings that would be tallied on the subplots and microplots, especially when the plot straddles conditions. Also, for stocking purposes, consider a clump of trees (e.g., stump sprouts) less than 5 inches DBH to be a single tree.

The number of trees per acre needed to obtain minimum stocking depends on the DBH of the largest tree on the plot in the condition being evaluated, and the species and DBH of each of the tally trees. If the condition occurs on all four subplots and the trees are distributed fairly evenly over the entire condition area, the following steps can be used to determine if the condition has the minimum number of trees per acre for forest land.

Observe all of the trees on the plot and classify the condition, based on the tree with the largest DBH, into one of the following groups; the largest tree observed has a DBH of 5 inches or greater, 4.0-4.9 inches, 3.0-3.9 inches, 2.0-2.9 inches, 1.0-1.9 inches or less than 1.0 inch DBH. If you are using the *Stocking Values* table to determine if the condition meets minimum stocking, use table 5a, 5b, 5c, 5d, 5e, or 5f. If you are using the *Number of Trees* table to determine if the condition meets minimum stocking, use table 5g.

When using a *Stocking Values* table, begin a tally of each subplot and microplot and sum the stocking values for each tree tallied based upon its species and size class. When the stocking values for the tallied trees equals or exceeds 10, the condition meets the minimum stocking requirement for forest land.

For example, a condition that was formerly nonforest is no longer being maintained as nonforest and has begun to revert. A check of all four subplots and microplots confirms that the largest tree there is in the 3.0 – 3.9 inches DBH class. The tally of microplot 1 is one red maple (species code = 316) seedling. The sum of the stocking value (table 5a) to this point is 2.4 and the tally continues on microplot 2.

Subplot Number	Plot Type	Species	Size Class	Number Tallied	Stocking Value
1	2	316	< 1.0	1	2.4
Total					2.4

The tally at microplot 2 is two red maple seedlings. The stocking value for the two seedlings is 4.8. The cumulative stocking value to this point is 7.2. Since the minimum value of 10 percent stocking has not been reached, the tally continues to subplot 3.

Subplot Number	Plot Type	Species	Size Class	Number Tallied	Stocking Value
1	2	316	< 1.0	1	2.4
2	2	316	< 1.0	2	4.8
Total					7.2

At microplot 3 one sugar maple (species code = 318) sapling in the 1.0 – 1.9-inch DBH class is tallied. The cumulative stocking value is now 15.1 and the condition meets the minimum stocking to be considered forest land.

Subplot Number	Plot Type	Species	Size Class	Number Tallied	Stocking Value
1	2	316	< 1.0	1	2.4
2	2	316	< 1.0	2	4.8
3	2	318	1.0 – 1.9	1	7.9
Total					15.1

When trees of more than one diameter class are present, their contribution towards meeting the minimum must be combined. For example:

> In a lodgepole pine stand (species code = 108), the largest tree in the condition is 5.0+ inches DBH. If at least 12 trees that are 5.0-6.9 inches DBH are found on the four subplots, the minimum stocking of 10 percent (table 5b: 5th row, 1st column) is met. In the same condition only 3 tally trees in the 13.0-14.9-inch DBH class are needed to meet minimum stocking of 10 percent. If the tally were two 5.0-6.9-inch trees and two 13.0-14.9-inch DBH class trees (total stocking of 3 x 0.9 + 2 x 3.8 = 9.4), the combined stocking would not meet the minimum 10 percent (9.4 < 10) and the condition would be classified nonforest.

When using the *Number of Trees* table (table 5g), estimate the number of trees per acre by the diameter classes. When a condition exists on all 4 of the 24-ft radius subplots, each tally tree (DBH $\geq$ 5.0 inches) represents 6 trees per acre and each sapling (DBH $\geq$ 1.0 inch to < 5.0 inches) or seedling observed on the 4 microplots represents 75 trees per acre.

In sparse stands of smaller trees, a more accurate observation of trees per acre can be determined by observing trees < 5.0 inches DBH on the 24-ft radius subplot. In many forest types no more than 180 trees per acre of the largest diameter class are needed to meet the minimum stocking requirements, a total of 30 trees on all 4 subplots, 7 or 8 smaller trees on each subplot, will provide minimum stocking.

Other things observed on the plot will influence the determination of condition status. In the last lodgepole pine example, evidence of a recent disturbance that reduced the stocking (cutting, fire, etc.) should be considered. Also, a very uneven distribution of the trees across the condition can greatly change the observed number of trees per acre on plots installed across the condition.

If the condition does not cover all four subplots entirely, trees per acre must be expanded using an expansion factor. The expansion factor is equal to 400/sum of the percent of subplot area (%ARE) for the condition. The trees per acre value of every diameter class is multiplied by this expansion factor.

If the trees are not uniformly distributed throughout the condition or the condition occurs on only a small portion of the plot (half the plot or less), use your best judgment in assigning status. You may place several additional temporary subplots in the condition in order to get a larger sample to base stocking on. When additional temporary subplots or judgment is used to assign land use, a note should be made on the plot sheet. Use the following procedure to establish these temporary subplots in a condition:

A. Consider locations 120.0 feet horizontal distance from the highest numbered subplot in the condition. First consider the location 0^{o} azimuth from the subplot center. If this location is unsuitable, consider in order locations at azimuth 120^{o}, and 240^{o}. When a suitable location has been found, establish the temporary subplot. Temporary subplots should be entirely within the condition (locations should not be within 24.0 feet of a mapped boundary).

B. If Step A fails to yield a suitable subplot location, repeat Step A at each of the next highest-numbered regular subplots in the condition.

C. If Steps A and B have been exhausted and a suitable temporary subplot still has not been found, repeat Step A at each temporary subplot in turn, beginning with the first temporary subplot that was established.

If more than one temporary subplot is to be established, repeat Steps A and B to establish the second lowest- numbered temporary subplot next, and continue in order until you have enough temporary subplots established in the condition to get a good, representative estimate of stocking. The general rule for establishing temporary subplots is:

- Install the lowest temporary subplot off the highest established subplot, until all the established subplots have been exhausted.
- Then establish the lowest temporary subplot yet to be established off the lowest one already established (lowest off highest, then lowest off lowest).

If there is a transition zone between two conditions use your best judgment to be sure that trees tallied in the transition zone do not have too much weight in the assignment of a land use.

Table 5a. Stocking values for all tallied trees on the four subplots and microplots

	DBH of the largest tally tree in the condition																				
	5.0+						4.0-4.9					3.0-3.9				2.0-2.					
	DBH of tally tree						DBH of tally tree					DBH of tally tree				DBH of tall					
Species	**5.0-6.9**	**4.0-4.9**	**3.0-3.9**	**2.0-2.9**	**1.0-1.9**	**Seed-ling**	**4.0-4.9**	**3.0-3.9**	**2.0-2.9**	**1.0-1.9**	**Seed-ling**	**3.0-3.9**	**2.0-2.9**	**1.0-1.9**	**Seed-ling**	**2.0-2.9**	**1.0-1.9**				
10, 12, 16, 18, 19, 70, 71, 90, 91, 93, 94, 96, 97, 992	0.7	6.9	5.2	4.0	2.6	1.2	7.9	6.2	4.6	3.0	1.4	7.6	5.7	3.7	1.8	7.4	4.9				
57, 61, 95	0.7	6.2	4.7	3.6	2.3	1.1	7.1	5.6	4.2	2.7	1.3	6.9	5.1	3.3	1.6	6.7	4.4				
67, 68, 105, 107, 115, 123, 126, 130, 132, 230, 232, 250, 299	1.0	9.1	6.9	5.3	3.4	1.6	10.4	8.3	6.1	4.0	1.9	10.1	7.5	4.9	2.3	9.9	6.5				
108	0.5	5.0	3.7	2.9	1.9	0.8	5.7	4.5	3.3	2.2	1.0	5.5	4.1	2.7	1.3	5.4	3.5				
110	0.8	7.3	5.5	4.3	2.7	1.2	8.3	6.6	4.9	3.2	1.5	8.1	6.0	3.9	1.9	7.9	5.2				
66, 113, 122, 321, 323, 800, 823, 826, 846, 847	0.5	5.0	3.8	2.9	1.9	0.9	5.7	4.6	3.4	2.2	1.0	5.6	4.1	2.7	1.3	5.4	3.6				
125, 136	0.7	6.8	5.1	4.0	2.6	1.2	7.7	6.1	4.6	3.0	1.4	7.5	5.6	3.7	1.7	7.3	4.8				
129	0.8	7.5	5.7	4.4	2.8	1.3	8.6	6.8	5.1	3.3	1.5	8.4	6.2	4.1	1.9	8.1	5.3				
131	0.9	8.3	6.3	4.8	3.1	1.4	9.4	7.5	5.6	3.6	1.7	9.2	6.8	4.5	2.1	8.9	5.9				
202	0.7	6.8	5.1	4.0	2.6	1.2	7.7	6.2	4.6	3.0	1.4	7.5	5.6	3.7	1.7	7.3	4.8				
43, 241	0.7	6.1	4.6	3.6	2.3	1.0	6.9	5.5	4.1	2.7	1.2	6.8	5.0	3.3	1.6	6.6	4.3				
240, 260, 261, 262	0.8	7.7	5.8	4.5	2.9	1.3	8.7	7.0	5.2	3.4	1.6	8.5	6.3	4.1	2.0	8.3	5.4				

Table 5a. Stocking values for all tallied trees on the four subplots and microplots

	DBH of the largest tally tree in the condition																			
	5.0+						4.0-4.9					3.0-3.9				2.0-2.				
	DBH of tally tree						DBH of tally tree					DBH of tally tree				DBH of tall				
Species	5.0-6.9	4.0-4.9	3.0-3.9	2.0-2.9	1.0-1.9	Seed-ling	4.0-4.9	3.0-3.9	2.0-2.9	1.0-1.9	Seed-ling	3.0-3.9	2.0-2.9	1.0-1.9	Seed-ling	2.0-2.9	1.0-1.9				
310, 316, 317, 319, 320, 341, 356, 357, 358, 367, 381, 391, 420, 421, 424, 471, 481, 491, 550, 551, 555, 561, 571, 580, 581, 582, 583, 591, 653, 680, 681, 682, 684, 701, 711, 760, 761, 763, 764, 765, 766, 769, 770, 771, 772, 773, 774, 919, 920, 921, 922, 923, 925, 926, 927, 929, 934, 935, 936, 937, 940, 986, 987, 988, 989, 991, 994, 995, 996, 997, 998, 999	1.0	9.6	7.2	5.6	3.6	1.6	10.9	8.7	6.4	4.2	2.0	10.6	7.9	5.2	2.4	10.3	6.8				
350, 351, 352, 353, 355, 492	1.3	11.7	8.8	6.8	4.4	2.0	13.3	10.6	7.9	5.1	2.4	13.0	9.6	6.3	3.0	12.6	8.3				
314, 315, 318, 330, 331, 332, 333, 334, 336, 337, 370, 371, 372, 377, 450, 451, 452, 531, 552, 712	1.2	10.9	8.2	6.3	4.1	1.8	12.4	9.8	7.3	4.8	2.2	12.1	9.0	5.9	2.8	11.7	7.7				
373, 374, 375, 378, 379	1.1	10.5	7.9	6.1	4.0	1.8	12.0	9.5	7.1	4.6	2.1	11.6	8.7	5.7	2.7	11.3	7.4				

Table 5a. Stocking values for all tallied trees on the four subplots and microplots

	DBH of the largest tally tree in the condition																				
	5.0+						4.0-4.9					3.0-3.9				2.0-2.					
	DBH of tally tree						DBH of tally tree					DBH of tally tree				DBH of tall					
Species	**5.0-6.9**	**4.0-4.9**	**3.0-3.9**	**2.0-2.9**	**1.0-1.9**	**Seed -ling**	**4.0-4.9**	**3.0-3.9**	**2.0-2.9**	**1.0-1.9**	**Seed-ling**	**3.0-3.9**	**2.0-2.9**	**1.0-1.9**	**Seed-ling**	**2.0-2.9**	**1.0-1.9**				
400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 422, 423, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 520, 521, 522, 549, 641, 660, 662, 663, 664, 802, 804, 806, 808, 809, 812, 813, 816, 817, 819, 820, 822, 824, 825, 827, 828, 830, 831, 832, 833, 834, 835, 836, 837, 838, 840, 841, 842, 845, 901, 931, 981	1.2	11.6	8.8	6.8	4.4	2.0	13.2	10.5	7.8	5.1	2.4	12.9	9.6	6.3	3.0	12.5	8.2				
600, 601, 602, 603, 604, 605, 606	1.4	12.7	9.6	7.4	4.8	2.2	14.5	11.5	8.5	5.6	2.6	14.1	10.5	6.9	3.2	13.7	9.0				
220, 221, 222, 611, 690, 691, 692, 693, 694	0.7	6.8	5.2	4.0	2.6	1.2	7.8	6.2	4.6	3.0	1.4	7.6	5.6	3.7	1.7	7.4	4.9				
741, 743, 746	1.2	10.9	8.3	6.4	4.1	1.9	12.5	9.9	7.3	4.8	2.2	12.1	9.0	5.9	2.8	11.8	7.8				
540, 541, 542, 543, 545, 546, 547, 548, 621, 650, 651, 652, 654, 655, 657, 658, 720, 721, 722, 762, 993, 7211	1.0	9.3	7.0	5.4	3.5	1.6	10.6	8.4	6.3	4.1	1.9	10.3	7.7	5.0	2.4	10.0	6.6				
950, 951, 952, 953	1.0	9.2	7.0	5.4	3.5	1.6	10.5	8.4	6.2	4.0	1.9	10.2	7.6	5.0	2.3	10.0	6.5				

Table 5a. Stocking values for all tallied trees on the four subplots and microplots

	DBH of the largest tally tree in the condition																				
	5.0+						4.0-4.9					3.0-3.9				2.0-2.					
	DBH of tally tree						DBH of tally tree					DBH of tally tree				DBH of tall					
Species	**5.0-6.9**	**4.0-4.9**	**3.0-3.9**	**2.0-2.9**	**1.0-1.9**	**Seed-ling**	**4.0-4.9**	**3.0-3.9**	**2.0-2.9**	**1.0-1.9**	**Seed-ling**	**3.0-3.9**	**2.0-2.9**	**1.0-1.9**	**Seed-ling**	**2.0-2.9**	**1.0-1.9**				
313, 345, 460, 461, 462, 463, 544, 729, 730, 731, 732, 740, 742, 744, 745, 747, 748, 749, 752, 753, 970, 971, 972, 973, 974, 975, 976, 977	1.2	10.8	8.1	6.3	4.1	1.8	12.3	9.8	7.2	4.7	2.2	12.0	8.9	5.8	2.7	11.6	7.6				

Table 5b. Stocking values for all trees tallied on the subplot only													
Species	**5.0-6.9**	**7.0-8.9**	**9.0-10.9**	**11.0-12.9**	**13.0-14.9**	**15.0-16.9**	**17.0-18.9**	**19.0-20.9**	**21.0-22.9**	**23.0-24.9**			
10, 12, 16, 18, 19, 70, 71, 90, 91, 93, 94, 96, 97, 992	0.7	1.1	1.6	2.1	2.6	3.2	3.8	4.4	5.1	5.			
57, 61, 95	0.7	0.9	1.1	1.4	1.6	1.9	2.1	2.4	2.6	2.			
67, 68, 105, 107, 115, 123, 126, 130, 132, 230, 232, 250, 299	1.0	1.5	2.2	3.0	3.8	4.7	5.6	6.6	7.7	8.			
108	0.5	0.9	1.3	1.7	2.2	2.8	3.4	4.1	4.8	5.			
110	0.8	1.3	2.0	2.7	3.6	4.6	5.7	6.9	8.2	9.			
66, 100,113, 122, 321, 323, 800, 823, 826, 846, 847	0.5	1.0	1.5	2.2	2.9	3.8	4.9	6.0	7.3	8.			
125, 136	0.7	1.2	1.7	2.3	3.0	3.7	4.6	5.4	6.4	7.			
129	0.8	1.2	1.7	2.3	2.9	3.6	4.2	5.0	5.7	6.			
131	0.9	1.5	2.1	2.9	3.8	4.8	5.9	7.1	8.3	9.			
202	0.7	1.1	1.6	2.1	2.7	3.3	4.0	4.7	5.4	6.			
43, 241	0.7	1.1	1.6	2.3	3.0	3.8	4.7	5.7	6.8	7.			
240, 260, 261, 262	0.8	1.5	2.4	3.6	4.9	6.5	8.4	10.4	12.8	15.			
310, 316, 317, 319, 320, 341, 356, 357, 358, 367, 381, 391, 420, 421, 424, 471, 481, 490, 491, 550, 551, 555, 561, 571, 580, 581, 582, 583, 591, 631, 653, 680, 681, 682, 683, 684, 701, 711, 760, 761, 763, 764, 765, 766, 768, 769, 770, 771, 772, 773, 774, 821, 852, 853, 854, 855, 856, 857, 858, 859, 860, 863, 864, 865, 866, 873, 874, 876, 877, 882, 883, 884, 885, 886, 887, 888, 890, 891, 895, 896, 897, 906, 907, 908, 909, 912, 913, 914, 915, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 934, 935, 936, 937, 940, 982, 986, 987, 988, 989, 991, 994, 995, 996, 997, 998, 999	1.0	1.6	2.2	3.0	3.8	4.6	5.5	6.5	7.5	8.			
350, 351, 352, 353, 355, 492	1.3	1.9	2.6	3.3	4.1	5.0	5.9	6.8	7.8	8.			
314, 315, 318, 330, 331, 332, 333, 334, 336, 337, 370, 371, 372, 377, 450, 451, 452, 531, 552, 712	1.2	2.0	3.0	4.2	5.6	7.2	9.0	11.0	13.1	15.			
373, 374, 375, 378, 379	1.1	1.9	3.0	4.2	5.6	7.2	9.0	11.0	13.1	15.			

Table 5b. Stocking values for all trees tallied on the subplot only

Species	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-22.9	23.0-24.9			
360, 361, 362, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 422, 423, 431, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 520, 521, 522, 549, 641, 660, 661, 662, 663, 664, 801, 802, 804, 805, 806, 807, 808, 809, 812, 813, 815, 816, 817, 818, 819, 820, 822, 824, 825, 827, 828, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 845, 901, 931, 981, 5091, 5092, 5093	1.2	2.0	2.9	3.9	5.0	6.2	7.5	8.9	10.4	11.9			
600, 601, 602, 603, 604, 605, 606	1.4	2.1	2.9	3.9	4.9	5.9	7.1	8.3	9.6	10.9			
220, 221, 222, 611, 690, 691, 692, 693, 694	0.7	1.3	1.9	2.7	3.6	4.6	5.7	7.0	8.3	9.8			
741, 743, 746	1.2	1.8	2.5	3.2	4.0	4.9	5.8	6.8	7.8	8.9			
540, 541, 542, 543, 545, 546, 547, 548, 621, 650, 651, 652, 654, 655, 657, 658, 720, 721, 722, 762, 993, 7211	1.0	1.4	1.8	2.2	2.6	3.0	3.5	3.9	4.3	4.8			
950, 951, 952, 953	1.0	1.8	2.8	4.0	5.5	7.2	9.1	11.3	13.7	16.3			
313, 345, 460, 461, 462, 463, 544, 729, 730, 731, 732, 740, 742, 744, 745, 747, 748, 749, 752, 753, 970, 971, 972, 973, 974, 975, 976, 977	1.2	2.0	3.0	4.2	5.6	7.2	8.9	10.9	13.0	15.2			

Appendix 6. Glossary

Accessible Forest Land – Land that is within sampled area (the population of interest), is accessible and 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 (appendix 3) of any size 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, 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 prevent normal regeneration and succession such as regular mowing, grazing, or recreation activities.

ACTUAL LENGTH – For trees with broken or missing tops. The actual length of the tree is recorded to the nearest 1.0 foot from ground level to the highest remaining portion of the tree still present and attached to the bole. If the top is intact, this item may be omitted. Forked trees should be treated the same as unforked trees.

Agricultural Land – Land managed for crops, pasture, or other agricultural use. Evidence includes geometric field and road patterns, fencing, and the traces produced by livestock or mechanized equipment. The area must be at least 1.0 acre in size and 120.0 feet. wide at the point of occurrence.

Annular Plot – A circular, fixed area plot with a radius of 58.9 feet. Annular plots may be used for sample intensification or for sampling relatively rare events.

ARTIFICIAL REGENERATION SPECIES – Indicates the predominant species that is planted or seeded in an artificially regenerated condition.

Blind check – a re-installation done by a qualified inspection crew without production crew data on hand; a full re-installation of the plot for the purpose of obtaining a measure of data quality. The two data sets are maintained separately. Discrepancies between the two sets of data are not reconciled. Blind checks are done on production plots only.

Bole – The main stem of a tree, extending from one foot above the ground to the point on the tree where DOB reaches 4 inches

Boundary – The intersection of two or more conditions on a subplot or microplot. Each boundary is described by recording the azimuth and horizontal distance from the subplot or microplot center to the left and right points of where the boundary intersects the perimeter of the subplot or microplot. An azimuth and distance to a corner point may also be described, if one exists. If multiple boundaries exist at a subplot, they are recorded in the order of their occurrence on the subplot, starting from north and proceeding around the compass.

Census Water – Rivers and streams that are more than 200 feet wide and bodies of water that are greater than 4.5 acres in size.

Certification plot – a plot installed by a certification candidate. It may be a training plot or a production plot. The candidate working alone installs the plot.

Cold check – an inspection done either as part of the training process, or as part of the ongoing QC program. Normally the installation crew is not present at the time of inspection. The inspector has the completed data in-hand at the time of inspection. The inspection can include the whole plot or a subset of the plot. Discrepancies between the two sets of data may be reconciled. Cold checks are done on production plots only.

CONDITION CLASS – The combination of discrete landscape and forest attributes that identify and define different strata on the plot. Examples of such attributes include condition status, forest type, stand origin, stand size, owner group, reserve status and stand density.

Cropland – Land under cultivation within the past 24 months, including orchards and land in soil improving crops, but excluding land cultivated in developing improved pasture.

CROWN CLASS – A classification of trees based on dominance in relation to adjacent trees within the stand as indicated by crown development and the amount of sunlight received from above and sides.

Cull – Portions of a tree that are unusable for industrial wood products because of rot, form, or other defect.

Diameter at Breast Height (DBH) – The diameter of the bole of a tree at breast height (4.5 feet above the ground), measured outside of the bark.

Diameter at Root Collar (DRC) – The diameter of a tree measured at the ground line or stem root collar, measured outside of the bark.

Diameter Outside Bark (DOB) – A diameter that may be taken at various points on a tree, or log, **outside** of the bark. Diameter Outside Bark is often estimated.

Federal Information Processing Standard (FIPS) – A unique code identifying U.S. States and counties (or units in Alaska).

Forest Industry Land – Land owned by companies or individuals that operate wood-using plants.

Forest Trees – Plants having a well-developed, woody stem and usually more than 12 feet in height at maturity.

FOREST TYPE – A classification of forest land based upon the trees or tree communities that constitute the majority of stocking on the site.

GPS – Global Positioning System. Information from this system is collected and used to determine the latitude and longitude of each plot.

Hardwoods – Dicotyledonous trees, usually broad-leaved and deciduous.

Hot check – an inspection normally done as part of the training process. The inspector is present on the plot with the trainee and provides immediate feedback regarding data quality. Data errors are corrected. Hot checks can be done on training plots or production plots.

Idle Farmland -- Former cropland or pasture that has not been tended within the last 2 years and that has less than 10 percent stocking with live trees.

Improved Pasture -- Land that is currently maintained and used for grazing. Evidence of maintenance, besides the degree of grazing, includes condition of fencing, presence of stock ponds, periodic brush removal, seeding, irrigation, or mowing.

Inclusion – An area that would generally would be recognized as a separate condition, except that it is not large enough to qualify. For example, a ½ acre pond within a forested stand.

Industrial Wood – All roundwood products, except firewood.

Inspection crew – a crew of qualified QC/QA individuals whose primary responsibility is the training, certification and inspection of production crews.

Land Area – As defined by the Bureau of the Census: The area of dry land and land temporarily or partially covered by water such as marshes, swamps, and river flood plains (omitting tidal flats below mean tide); streams, sloughs, estuaries and canals less than 200 feet in width, and ponds less than 4.5 acres in area.

Maintained Road – Any road, hard topped or other surfaces, that is plowed or graded periodically and capable of use by a large vehicle. Rights-of-way that are cut or treated to limit herbaceous growth are included in this area.

Marsh – Low, wet areas characterized by heavy growth of weeds and grasses and an absence of trees.

Measurement Quality Objective (MQO) – Describes the acceptable tolerance for each data element. MQOs consist of two parts: a statement of the tolerance and a percentage of time when the collected data are required to be within tolerance.

Merchantable Top – The point on the bole of trees above which merchantable material cannot be produced. Merchantable top is 1.5 inches for western woodland species and 4.0 for all other species.

Microplot – A circular, fixed-radius plot with a radius of 6.8 feet that is used to sample trees less than 5.0 inches at DBH, as well as other vegetation.

National Forest Land – Federal lands which have been legally designated as National Forests or purchase units, and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands.

Native American (Indian) Land – Tribal lands held in fee, or trust, by the Federal government but administered for Indian tribal groups and Indian trust allotments. This land is considered "Private Lands", Owner Group 40.

Non-census Water – Bodies of water from 1 to 4.5 acres in size and water courses from 30 feet to 200 feet in width.

Nonforest Land -- Land that does not support, or has never supported, forests, and lands formerly forested where use for timber management is precluded by development for other uses. Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining rights-of-way, power line clearings of any width, and noncensus water. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120.0 feet wide, and clearings, etc., more than one acre in size, to qualify as nonforest land.

Nonstockable – Areas of forest land that are not capable of supporting trees because of the presence of rock, water, etc.

Other Federal Lands – Federal land other than National Forests. These include lands administered by the USDI Bureau of Land Management, USDI National Park Service, USDI Fish and Wildlife Service, Department of Defense, Department of Energy, Army Corps of Engineers, and military bases.

OWNER CLASS -- A variable that classifies land into fine categories of ownership.

OWNER GROUP – A variable that classifies land into broad categories of ownership; Forest Service, Other Federal Agency, State and Local Government, and Private. Differing categories of Owner Group on a plot require different conditions.

Phase 1 (P1) – FIA activities done as part of remote-sensing and/or aerial photography.

Phase 2 (P2) – FIA activities done on the network of ground plots formerly known as FIA plots.

Phase 3 (P3) – FIA activities done on a subset of Phase 2 plots formerly known as Forest Health Monitoring plots. Additional ecological indicator information is collected from Phase 3 plots.

Plot – A cluster of four subplots that samples approximately 1/6 acre. The subplots are established so that subplot 1 is centered within the sample and the centers of subplots 2, 3,and 4 are located 120.0 feet from the center of subplot 1 at azimuths of 360, 120, and 240 degrees, respectively. Each subplot has an associated microplot and annular plot

PRIVATE OWNER INDUSTRIAL STATUS – Indicates whether Private land owners own and operate a wood processing plant.

Production crew – a crew containing at least one certified individual. The crew is involved in routine installation of plots.

Production plot – a plot that belongs to the 6000-acre grid database. It may also be used for training purposes.

REGENERATION STATUS – A stand descriptor that indicates whether a stand has been naturally or artificially regenerated.

Reserved Land – Land that is withdrawn from timber utilization by a public agency or by law.

RESERVE STATUS – An indication of whether the land in a condition has been reserved.

Saplings – Live trees 1.0 to 4.9 inches DBH.

Seedlings – Live trees less than 1.0 DBH that are at least one foot tall.

Softwoods – Coniferous trees, usually evergreen having needles or scale-like leaves.

STAND AGE – A stand descriptor that indicates the average age of the live trees not overtopped in the predominant stand size-class of a condition.

STAND DENSITY – A stand descriptor that indicates the relative tree density of a condition class. The classification is based on the number of stems/unit area, basal area, tree cover, or stocking of all live trees in the condition which are not overtopped, compared to any previously defined condition class tree density.

STAND SIZE – A stand descriptor that indicates which size-class of trees that are not overtopped constitutes the majority of stocking in the stand.

State, County and Municipal Lands – Lands owned by states, counties, and local public agencies or municipalities, or lands leased to these government units for 50 years or more.

Stocking – The relative degree of occupancy land by trees, measured as basal area or the number of trees in a stand by size or age and spacing, compared to the basal area or number of trees required to fully utilize the growth potential of the land; that is, the stocking standard.

Subplot – A circular, fixed-area plot with a radius of 24.0 feet. Each subplot represents ¼ of the fixed plot sample unit.

TOTAL LENGTH – The total length of the tree, recorded to the nearest 1.0 foot from ground level to the tip of the apical meristem. For trees growing on a slope, measure on the uphill side of the tree. If the tree has a broken or missing top, the total length is estimated to what the length would be if there were no missing or broken top. Forked trees should be treated the same as unforked trees

Training plot – a plot established for training or certification purposes only. It does NOT belong to the 6000-acre grid database.

Transition Zone – An area where a distinct boundary between two or more different conditions cannot be determined.

Appendix 7. Tolerance / MQO / Value / Units Table

NC items not collected in the field are in light print and italics. n/a is not applicable.

Variable Name	Tolerance	MQO	Values	Units
General Description				
New Subplot Location	+/- 7 feet	at least 95% of the time	n/a	feet
New Microplot Location	+/- 1 foot	at least 95% of the time	n/a	feet
Starting Point				
NC SP distance to PC	+/- 66.0 ft	at least 99% of the time	0001- 9999	feet
NC SP azimuth to PC	+/- 10 degrees	at least 99% of the time	1-360	degrees
NC SP Latitude	+/- 140 ft	at least 99% of the time	NC: NAD 83	NC- Degrees and decimal minutes
NC SP Longitude	+/- 140 ft	at least 99% of the time	NC: NAD 83	NC- Degrees and decimal minutes
Reference Tree				
NC Reference DBH	+/- 0.1" per 20"	at least 95% of the time	0001 to 9999	inches
NC Reference species	No errors	at least 99% of the time for genus at least 95% of the time for species	Appendix 3	
NC Reference distance	+/- 0.3 ft	at least 90% of the time	1 - 60	feet
NC Reference azimuth	+/- 10 degrees	at least 90% of the time	1-360	degrees
NC Reference MARK	No errors	at least 99% of the time	n/a	n/a
Plot Level Data				
STATE	No errors	at least 99% of the time	Appendix 1	n/a
UNIT	No errors	at least 99% of the time	Appendix 1	n/a
COUNTY	No errors	at least 99% of the time	Appendix 1	n/a
PLOT NUMBER	No errors	at least 99% of the time	0001 to 9999	n/a
PLOT STATUS	No errors	at least 99% of the time	1	n/a
SAMPLE KIND	No errors	at least 99% of the time	1 to 3	n/a
NC SAMPLE KIND	No errors	at least 99% of the time	0, 6, 8	n/a
PREVIOUS PLOT NUMBER	No error	at least 99% of the time	0001 to 9999	n/a
FIELD GUIDE VERSION	*No errors*	*at least 99% of the time*	*2.0*	*n/a*
YEAR	No errors	at least 99% of the time	$\geq$ 2003	year
MONTH	No errors	at least 99% of the time	Jan – Dec (01 – 12)	month
DAY	No errors	at least 99% of the time	01 to 31	day
DECLINATION	*No errors*	*at least 99% of the time*	*-359.0 to 359.0*	*degrees*
HORIZONTAL DISTANCE TO IMPROVED ROAD	No errors	at least 90% of the time	1 to 9	n/a
WATER ON PLOT	No errors	at least 90% of the time	0 to 5, 9	n/a

Variable Name	Tolerance	MQO	Values	Units
QA STATUS	No errors	at least 99% of the time	1 to 7	n/a
CREW TYPE	No errors	at least 99% of the time	1, 2	n/a
GPS UNIT	No errors	at least 99% of the time	0 to 4	n/a
GPS SERIAL NUMBER	No errors	at least 99% of the time	000001 to 999999	n/a
COORDINATE SYSTEM	No errors	at least 99% of the time	1, 2	n/a
LATITUDE	+/- 140 ft	at least 99% of the time	NC: NAD 83	degrees, seconds **NC- Degrees and decimal minutes**
LONGITUDE	+/- 140 ft	at least 99% of the time	NC: NAD 83	degrees, seconds **NC- Degrees and decimal minutes**
UTM ZONE	*No errors*	*at least 99% of the time*	*03-19Q and 03-19W*	
EASTING (X) UTM	*+/- 140 ft*	*at least 99% of the time*		
NORTHING (Y) UTM	*+/- 140 ft*	*at least 99% of the time*		
AZIMUTH TO PLOT CENTER	+/- 3 degrees	at least 99% of the time	000 at plot center 001 to 360 not at plot center	degrees
DISTANCE TO PLOT CENTER	+/- 6 ft	at least 99% of the time	000 at plot center 001 to 200 if a Laser range finder not used 001 to 999 if a Laser range finder is used	feet
GPS ELEVATION		at least 99% of the time	-00100 to 20000	feet
GPS ERROR	No errors	at least 99% of the time	000 to 070 if possible 071 to 999 if an error < 70 cannot be obtained	feet
NUMBER OF READINGS	No errors	at least 99% of the time	001 to 999	n/a
GPS FILENAME	*No errors*	*at least 99% of the time*	*English, alpha-numeric*	*n/a*
PLOT-LEVEL NOTES	n/a	n/a	English, alpha-numeric	n/a
P3 HEXAGON NUMBER	*No errors*	*at least 99% of the time*		*n/a*
P3 PLOT NUMBER	*No errors*	*at least 99% of the time*	*1 to 9*	*n/a*
NC OWNER FIRST NAME	No errors	at least 99% of the time	English, alpha-numeric	n/a
NC OWNER LAST NAME	No errors	at least 99% of the time	English, alpha-numeric	n/a
NC OWNER STREET	No errors	at least 99% of the time	English, alpha-numeric	n/a

Variable Name	Tolerance	MQO	Values	Units
NC OWNER CITY	No errors	at least 99% of the time	English, alpha-numeric	n/a
NC OWNER STATE	No errors	at least 99% of the time		n/a
NC OWNER ZIP	No errors	at least 99% of the time		n/a
Condition Class Information				
CONDITION CLASS NUMBER	No errors	at least 99% of the time	1 to 9	n/a
CONDITION CLASS STATUS	No errors	at least 99% of the time	1 to 5	n/a
CONDITION NONSAMPLED REASON	No errors	at least 99% of the time	01, 02, 03, 10	n/a
RESERVED STATUS	No errors	at least 99% of the time	0, 1	n/a
OWNER GROUP	No errors	at least 99% of the time	10, 20, 30, 40	n/a
FOREST TYPE	No errors	at least 99% of the time in group at least 95% of the time in type no MQO when STAND SIZE CLASS = 0	Appendix 2	n/a
STAND SIZE CLASS	No errors	at least 99% of the time	0 to 6	class
REGENERATION STATUS	No errors	at least 99% of the time	0, 1	n/a
TREE DENSITY	No errors	at least 99% of the time	1 to 3	n/a
OWNER CLASS	No errors	at least 99% of the time	11-13; 21-25; 31-33; 41-45	class
PRIVATE OWNER INDUSTRIAL STATUS	No errors	at least 99% of the time	0, 1	n/a
ARTIFICIAL REGENERATION SPECIES	No errors	at least 99% of the time	Appendix 3	n/a
STAND AGE	+/- 10%	at least 95% of the time	000 to 997, 998, 999	year
DISTURBANCE 1	No errors	at least 99% of the time	00; 10-12; 20-22; 30-32;40-46; 50-55; 60; 70; 80	n/a
DISTURBANCE YEAR 1	+/- 1 year for 5-year measure. cycles +/ 2 years for > 5-year measure. cycles	at least 99% of the time	Since the previous plot visit, or the past 5 years for plots visited for the first time; 9999 if disturbance occurs continuously over time	year
DISTURBANCE 2	No errors	at least 99% of the time	00; 10-12; 20-22; 30-32;40-46; 50-55; 60; 70; 80	n/a

Variable Name	Tolerance	MQO	Values	Units
DISTURBANCE YEAR 2	+/- 1 year for 5-year measure. cycles +/ 2years for > 5-year measure. cycles	at least 99% of the time	Since the previous plot visit, or the past 5 years for plots visited for the first time; 9999 if disturbance occurs continuously over time	year
DISTURBANCE 3	No errors	at least 99% of the time	00; 10-12; 20-22; 30-32;40-46; 50-55; 60; 70; 80	n/a
DISTURBANCE YEAR 3	+/- 1 year for 5-year measure. cycles +/ 2years for > 5-year measure. cycles	at least 99% of the time	Since the previous plot visit, or the past 5 years for plots visited for the first time; 9999 if disturbance occurs continuously over time	year
TREATMENT 1	No errors	at least 99% of the time	00, 10, 20, 30, 40, 50	n/a
TREATMENT YEAR 1	+/- 1 year for 5-year measure. cycles +/- 2 years for >5-year measure. cycles	at least 99% of the time	Since the previous plot visit, or the past 5 years for plots visited for the first time	year
TREATMENT 2	No errors	at least 99% of the time	00, 10, 20, 30, 40, 50	n/a
TREATMENT YEAR 2	+/- 1 year for 5-year measure. cycles +/- 2 years for >5-year measure. cycles	at least 99% of the time	Since the previous plot visit, or the past 5 years for plots visited for the first time	year
TREATMENT 3	No errors	at least 99% of the time	00, 10, 20, 30, 40, 50	n/a
TREATMENT YEAR 3	+/- 1 year for 5-year measure. cycles +/- 2 years for >5-year measure. cycles	at least 99% of the time	Since the previous plot visit, or the past 5 years for plots visited for the first time	year
PHYSIOGRAPHIC CLASS	No errors	at least 80% of the time	xeric: 11, 12, 13, 19 mesic: 21, 22, 23, 24, 25, 29 hydric: 31, 32, 33, 34, 35, 39	n/a
PRESENT NONFOREST LAND USE	No errors	at least 99% of the time	10-15; 20; 30-33; 40	n/a

Variable Name	Tolerance	MQO	Values	Units
NC LAND USE	No errors	at least 99% of the time	21-22, 41, 41, 45, 46, 50-62, 64-69, 71, 72, 79, 80, 89, 90, 96, 99	n/a
Subplot Information				
SUBPLOT NUMBER	No errors	at least 99% of the time	1 to 4	n/a
SUBPLOT/ANNULAR PLOT STATUS	No errors	at least 99% of the time	1 to 3	n/a
SUBPLOT NONSAMPLED REASON	No errors	at least 99% of the time	01 to 05, 10	n/a
SUBPLOT CENTER CONDITION	No errors	at least 99% of the time	1 to 9	n/a
MICROPLOT CENTER CONDITION	No errors	at least 99% of the time	1 to 9	n/a
SUBPLOT SLOPE	+/- 10 %	at least 90% of the time	000 to 155	percent
SUBPLOT ASPECT	+/- 10 degrees	at least 90% of the time	000 to 360	degrees
SNOW/WATER DEPTH	+/- 0.5 ft	at the time of measurement	0.0 to 9.9	feet
SUBPLOT/ANNULAR PLOT CONDITION LIST	*No errors*	*at least 99% of the time*	*1000 to 9876*	*n/a*
Boundary Data				
SUBPLOT NUMBER	No errors	at least 99% of the time	1 to 4	n/a
PLOT TYPE	No errors	at least 99% of the time	1 to 3	n/a
BOUNDARY CHANGE	No errors	at least 99% of the time	0 to 3	n/a
CONTRASTING CONDITION	No errors	at least 99% of the time	1 to 9	n/a
LEFT AZIMUTH	+/- 10 degrees	at least 90% of the time	001 to 360	degrees
CORNER AZIMUTH	+/- 10 degrees	at least 90% of the time	000 to 360	degrees
CORNER DISTANCE	+/- 1 ft	at least 90% of the time	microplot: 01 to 07 (6.8 ftactual limiting distance) subplot: 01 to 24 annular plot: 01 to 59 (58.9 ft actual limiting distance)	feet
RIGHT AZIMUTH	+/- 10 degrees	at least 90% of the time	001 to 360	degrees
% AREA	n/a	n/a	n/a	n/a
Tree and Sapling Data				
SUBPLOT NUMBER	No errors	at least 99% of the time	1 to 4	n/a
TREE RECORD NUMBER	No errors	at least 99% of the time	000, 001 to 999	n/a
NC PLOT TYPE	No errors	at least 99% of the time	1,2	n/a
CONDITION CLASS NUMBER	No errors	at least 99% of the time	1 to 9	n/a
AZIMUTH	+/- 10 degrees	at least 90% of the time	001 to 360	degrees

Variable Name	Tolerance	MQO	Values	Units
HORIZONTAL DISTANCE	microplot:+/- 0.2 ft subplot: +/- 1.0 ft annular plot: +/- 3.0 ft	at least 90% of the time	microplot: 00.1 to 06.8 subplot: 00.1 to 24.0 annular plot: 00.1 to 58.9	feet
PREVIOUS TREE STATUS	No errors	at least 95% of the time	1, 2	n/a
PRESENT TREE STATUS	No errors	at least 95% of the time	0 to 3	n/a
RECONCILE	No errors	at least 95% of the time	1 to 4: valid for new trees on the plot 5 to 8: valid for remeasured trees that no longer qualify as tally	n/a
STANDING DEAD	No errors	At least 99% of the time	0, 1	n/a
MORTALITY	*No errors*	*at least 85% of the time*	*0, 1*	*n/a*
SPECIES	No errors	at least 99% of the time for genus at least 95% of the time for species	Appendix 3	n/a
DIAMETER	+/- 0.1 inch per 20.0 inch increment of measured diameter on all live trees and dead trees with DECAY CLASS = 1, 2 +/-1.0 inch per 20.0 inch increment of measured diameter on dead trees with DECAY CLASS = 3, 4, 5	at least 95% of the time	0001 to 9999	inches
DIAMETER CHECK	No errors	at least 99% of the time	0 to 2	n/a
NC TREE CLASS	No errors	at least 99% of the time	20, 30, 31, 40 - 45	n/a
ROTTEN / MISSING CULL	+/- 10%	at least 90% of the time	00 to 99	percent
TOTAL LENGTH	+/- 10% of true length	at least 90% of the time	005 to 400	feet
ACTUAL LENGTH	+/- 10% of true length	at least 90% of the time	005 to 400	feet
LENGTH METHOD	No errors	at least 99% of the time	1 to 3	n/a
NC TREE GRADE	No errors	at least 99% of the time		
CROWN CLASS	No errors	at least 85% of the time	1 to 5	n/a
UNCOMPACTED LIVE CROWN RATIO	+/- 10%	at least 90% of the time	00 to 99	percent
COMPACTED CROWN RATIO	+/- 10%	at least 80% of the time	00 to 99	percent

Variable Name	Tolerance	MQO	Values	Units
DAMAGE LOCATION 1	+/- 1 location class	at least 80% of the time	0 to 9	class
DAMAGE TYPE 1	No errors	at least 80% of the time	1-5; 11-13; 20-25; 31	n/a
DAMAGE SEVERITY 1	+/- 1 valid class unless otherwise defined by the DAMAGE TYPE	at least 80% of the time	Defined for each DAMAGE TYPE	class
DAMAGE LOCATION 2	+/- 1 location class	at least 80% of the time	0 to 9	class
DAMAGE TYPE 2	No errors	at least 80% of the time	1-5; 11-13; 20-25; 31	n/a
DAMAGE SEVERITY 2	+/- 1 valid class unless otherwise defined by the DAMAGE TYPE	at least 80% of the time	Defined for each DAMAGE TYPE	class
NC DAMAGE AGENT (Standard)	No errors	At least 95% of the time	0, 100, 113, 130, 140, 150, 170, 190, 200, 210, 220, 240, 250, 251, 252, 252, 254, 257, 260, 271, 281, 282, 290, 291, 292, 300, 400, 500, 800, 860	n/a
NC DAMAGE AGENT (MN)	No errors	At least 95% of the time	0, 100, 101, 113, 130, 131, 140, 150, 170, 190, 200, 210, 212, 220, 240, 241, 250, 251, 252, 252, 254, 257, 260, 261, 262, 263, 271, 281, 282, 290, 291, 292, 300, 302, 307, 309, 400, 402, 404, 409, 500, 800, 811, 850, 860, 900, 901, 902, 903, 904, 905, 906, 907, 908	n/a
CAUSE OF DEATH	No errors	at least 80% of the time	10 to 80	n/a
MORTALITY YEAR	+/- 1year for 5-year measure. cycles +/- 2years for > 5-year measure. cycles	at least 70% of the time	1995 or higher	year
DECAY CLASS	+/- 1 class	at least 90% of the time	1 to 5	class
LENGTH TO DIAMETER MEASUREMENT POINT	+/- 0.2 ft	at least 90% of the time	00.1 to 15.0	inches
ROUGH CULL	*+/- 10 %*	*at least 90% of the time*	*00 to 99*	*percent*
MISTLETOE CLASS	*+/- 1 class*	*at least 90% of the time*	*0 to 6*	*class*
TREE NOTES	n/a	n/a	English, alpha-numeric	n/a

Variable Name	Tolerance	MQO	Values	Units
NC BALSAM BOUGHS HARVESTED	No errors	at least 80% of the time	0, 1	n/a
NC BOUGH HARVESTING GUIDELINES	No errors	at least 80% of the time	0, 1	n/a
NC PAPER BIRCH BARK CHARACTERISTICS	No errors	at least 80% of the time	0, 1	n/a
NC LOWER/UPPER TRUNK CURVATURE	No errors	at least 95% of the time	0, 1, 2	n/a
NC LOWER/UPPER BARK HARVESTED	No errors	at least 99% of the time	0 to 5	n/a
NC LOWER/UPPER SURFACE FEATURES	No errors	at least 99% of the time	See section 5	n/a
NC LOWER/UPPER BARK CHARATER	No errors	at least 95% of the time	1 to 4	n/a
Seedling Data				
SUBPLOT NUMBER	No errors	at least 99% of the time	1 to 4	n/a
SPECIES	No errors	at least 90% of the time for genus at least 85% of the time for species	Appendix 3	n/a
CONDITION CLASS NUMBER	No errors	at least 99% of the time	1-9	n/a
SEEDLING COUNT	No errors for 5 or less per species +/- 20% over a count of 5	at least 90% of the time	001-999	number
Site Tree Information				
CONDITION CLASS LIST	No errors	at least 99% of the time	1 to 9 or 10000 to 98765	n/a
SPECIES	No errors	at least 99% of the time for genus at least 95% of the time for species	Appendix 3	n/a
DIAMETER	+/- 0.1 inch per 20 inches of diameter on trees with a measured diameter	at least 95% of the time	0001 to 9999	inches
SITE TREE LENGTH	+/- 10% of true length	at least 90% of the time	001 to 999	Feet
TREE AGE AT DIAMETER	+/- 5 years	at least 95% of the time	001 to 999	year
SITE TREE NOTES	n/a	n/a	English, alpha-numeric	n/a
SUBPLOT NUMBER	No errors	at least 99% of the time	1 to 4	n/a

Variable Name	Tolerance	MQO	Values	Units
AZIMUTH	+/- 10 degrees	at least 90% of the time	001 to 360	degrees
HORIZONTAL DISTANCE	+/-5 ft	at least 90% of the time	000.1 to 200.0	feet
NC SITE INDEX METHOD	No errors	at least 99% of the time	1, 2	n/a
NC FIELD SITE INDEX	No errors	at least 99% of the time	1 to 999	n/a
NONFOREST / NONSAMPLED PLOTS				
STATE	No errors	at least 99% of the time	Appendix 1	n/a
UNIT	No errors	at least 99% of the time	Appendix 1	n/a
COUNTY	No errors	at least 99% of the time	Appendix 1	n/a
PLOT NUMBER	No errors	at least 99% of the time	0001 to 9999	n/a
PLOT STATUS	No errors	at least 99% of the time	2, 3	n/a
PLOT NONSAMPLED REASON	No errors	at least 99% of the time	01 to 10	n/a
SAMPLE KIND	No errors	at least 99% of the time	1 to 3	n/a
NC SAMPLE KIND	No errors	at least 99% of the time	0, 6, 8	n/a
PREVIOUS PLOT NUMBER	No errors	at least 99% of the time	0001 to 9999	
FIELD GUIDE VERSION	No errors	at least 99% of the time	2.0	n/a
YEAR	No errors	at least 99% of the time	$\geq$ 2003	year
MONTH	No errors	at least 99% of the time	Jan – Dec (01 – 12)	month
DAY	No errors	at least 99% of the time	01 to 31	Day
DECLINATION	*No errors*	*at least 99% of the time*	*-359.0 to 359.0*	*degrees*
QA STATUS	No errors	at least 99% of the time	1 to 7	n/a
CREW TYPE	No errors	at least 99% of the time	1, 2	n/a
GPS UNIT	No errors	at least 99% of the time	0 to 4	n/a
GPS SERIAL NUMBER	No errors	at least 99% of the time	000001 to 999999	n/a
COORDINATE SYSTEM	No errors	at least 99% of the time	1, 2	n/a
LATITUDE	+/- 140 ft	at least 99% of the time		degrees, seconds
LONGITUDE	+/- 140 ft	at least 99% of the time		degrees, seconds
UTM ZONE	*No errors*	*at least 99% of the time*	*03-19Q and 03-19W*	
EASTING (X) UTM	*+/- 140 ft*	*at least 99% of the time*		
NORTHING (Y) UTM	*+/- 140 ft*	*at least 99% of the time*		
AZIMUTH TO PLOT CENTER	+/- 3 degrees	at least 99% of the time	000 at plot center 001 to 360 not at plot center	degrees
DISTANCE TO PLOT CENTER	+/- 6 ft	at least 99% of the time	000 at plot center 001 to 200 if a Laser range finder not used 001 to 999 if a Laser range finder is used	feet
GPS ELEVATION		at least 99% of the time	-00100 to 20000	feet

Variable Name	**Tolerance**	**MQO**	**Values**	**Units**
GPS ERROR	No errors	at least 99% of the time	000 to 070 if possible 071 to 999 if an error < 70 cannot be obtained	feet
NUMBER OF READINGS	No errors	at least 99% of the time	001 to 999	n/a
GPS FILENAME	*No errors*	*at least 99% of the time*	*English, alpha-numeric*	*n/a*
CONDITION CLASS STATUS 1	*No errors*	*at least 99% of the time*	*2 to 5*	*n/a*
CONDITION CLASS STATUS 2	*No errors*	*at least 99% of the time*	*2 to 5*	*n/a*
CONDITION CLASS STATUS 3	*No errors*	*at least 99% of the time*	*2 to 5*	*n/a*
CONDITION CLASS STATUS 4	*No errors*	*at least 99% of the time*	*2 to 5*	*n/a*
PLOT-LEVEL NOTES	n/a	n/a	English, alpha-numeric	n/a
P3 HEXAGON NUMBER	*No errors*	*at least 99% of the time*		*n/a*
P3 PLOT NUMBER	*No errors*	*at least 99% of the time*	*1 to 9*	*n/a*
NC LAND USE	No errors	at least 99% of the time	50-62, 64-69, 72, 79, 80, 89, 90, 96, 99	n/a

NC Appendix 8. North Central Regional Helps

List of specific instructions on re-measurement by State

Illinois and some plots in South Dakota-

Trees:

If the last measure was cycle 4 there was a 4 point plot installed at the plot location. All old trees must be accounted for on the subplot and any new trees that grew into the subplot. All Tree status codes are valid. The microplot done on the plot at cycle 4 will not be re-measured, install the microplot in the new offset position and measure all trees less than 5.0 inches.

If the last cycle the plot was done was prior to cycle 4 then the old subplots are not being measured and a new 4 point plot (1-4) is being installed. No old trees. Only tree status codes of 1 & 2 are valid.

Condition examples:

The following are some examples of how to handle conditions that change or boundaries that change from one measurement to the next.

Example 1:

two previous conditions which occur on subplots 1-4
the second condition has changed so that it is now the same as the condition it was previously separated from

What to do:

Record one condition. This plot will be sent out with only one condition the next time it is measured.

Example 2:

more than one condition in the previous measure
still the same conditions and you agree with the mapping within the manual guidelines

What to do:

Record as was recorded last measure but increase the age to reflect time.

Example 3:

more than one condition occurs on the plot
more than one condition was recorded on the plot last measure
this visit the condition boundaries are totally different

What to do:

Record the conditions as you see them and do not worry about matching the last measure.

Iowa, Wisconsin, Michigan, Minnesota, Missouri –

Trees:

Follow NC Table 3

Conditions:

Condition information from the previous inventory will be printed on the plot sheet. If the data is still the same enter as is. If not complete condition data as if this was the first time they were defined.

Boundary:
Any Microplot 121-124 that has multiple conditions, record Boundary Data on the micrpolot. If the boundarys have stayed the same record as on the data sheets for subplots. If the boundarys were incorrect or changed, record a BOUNDARY CHANGE code and new boundary data.

North Dakota, Kansas, Nebraska, South Dakota

All plots in these states outside the Black Hills of South Dakota are new plots with no re-measurement or re-location of any old plot data.

The **Black Hills National Forest of South Dakota** does have re-measurement plots that were last measured with the modified four-point design. They were done as a fixed radius subplot of 24.0 feet radius with a microplot located at subplot center with a radius of 6.8 feet. All trees on the subplot will be re-measured and treated as re-measurement trees (All tree status codes are valid). The old microplot will not be re-measured. All trees less than 5.0 inches DBH will be tallied on the new microplot location, 12 feet at 90 degrees from subplot center.

Special Note for **DBH/DRC** Within the North Central Research stateion (NCRS), DRC is only collected on Rocky Mountain Juniper (*Juniperis scopulorum*) [SPP = 66] in the states of **North Dakota, South Dakota**, and **Nebraska**. Rocky Mountain Juniper is generally found in the western half of these states. Rocky Mountain Juniper can be generally differentiated from Eastern Redcedar (*Juniperus virginiana*) [SPP = 68] in that Eastern Redcedar has tigher, less-shaggy bark than and generally is more tree-form than the shrubby, shaggy-barked Rocky Mountain Juniper. Crews should note that the ranges of these two species overlap in the previously mentioned states and that the two species hybridize.

In most cases (see figure 23, example no. 3), if one measurement of DRC at the root collar can be accomplished, then take one measurement, mark the DRC measurement point with paint. In situations where due to growth habits and/or soil level, one measurement is impossible (figure 23, example no. 6), then measure the qualifying stems, mark each measurement location with paint. If the crew has a calculator, calculate the DRC with the formula in section 5.9.4 and record this value. The value should be recorded in the DBH field on the data recorder. If the crew does not have a calculator, then record the individual diameters on the plot sheet, calculate the DRC when the crew returns to the office with the formula and then replace the DRC with the calculated DRC value. [NOTE: HORIZONTAL DISTANCE (DIST) and AZIMUTH (AZM) recorded is to “the geographic center of the tree”.]

Procedure to calibrate your eye for tree length estimation:

A suggested process of estimated and actually measured heights would be as follows:

- Trees 1 and 2. Estimate height first, then measure height. Make adjustment based on original estimate and ensuing actual measurement. Adjust ensuing height estimates by correction factor.
- Trees 3 and 4. Estimate height.
- Tree 5. Estimate height first, then measure height. Make adjustment based on original estimate and ensuing actual measurement. Adjust ensuing height estimates by correction factor.
- Trees 6 through 9. Estimate height.
- Tree 10. Estimate height first, then measure height. Make adjustment based on original estimate and ensuing actual measurement. Adjust ensuing height estimates by correction factor.
- Trees 11 through 15. Estimate height.
- Tree 16. Estimate height first, then measure height. Make adjustment based on original estimate and ensuing actual measurement. Adjust ensuing height estimates by correction factor.
- Estimate heights on all remaining trees on plot.

This process of estimation and checking with measurement should be initiated on a daily basis. Each day the field crew member should check their estimates and incorporate their correction factor.

To calculate the correction factor, use the following:

$$\text{Correction factor} = \frac{\text{Actual height measurement}}{\textbf{ESTIMATED HEIGHT}}$$

For example, tree number one's height is estimated to be 50 feet. After the height is estimated, the tree is measured with an actual height measurement of 45 feet. In this example, the correction factor would be 45/50 = 0.9. If a similar result is obtained for tree number 2 (a correction factor of ~0.9), the estimated heights for trees 3 and 4 should be corrected by a factor of 0.9. If tree 3 is estimated to be 60 feet in height, applying a correction factor of 0.9 would give a tree height of 54 feet. Continue to use the most recent correction factor until a new correction factor is determined by actual height measurements for tree numbers 5, 10, and 16. After a sufficient number of trees have been estimated and actually measured, the field crew member should be able to incorporate their correction factor into their original height estimate.

Cochran, W.G. 1963. **Sampling techniques second edition**. P. 327-354. John Wiley and Sons, Inc. New York.

Tree Grade & Tree Class

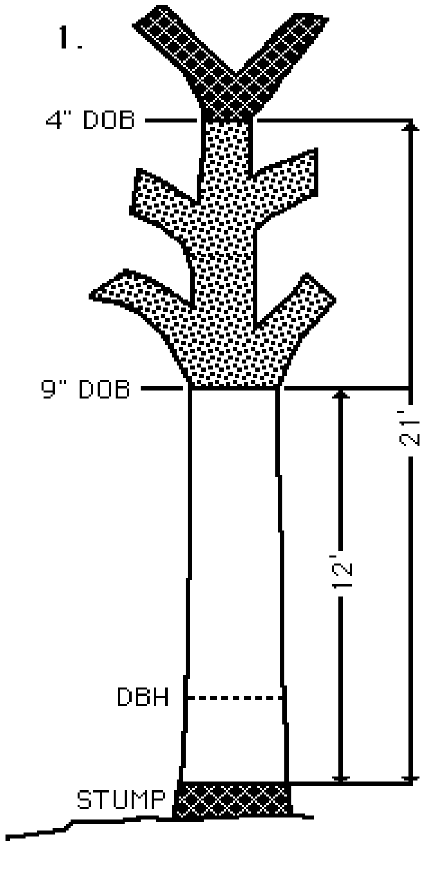
On the following pages are examples explaining tree classification

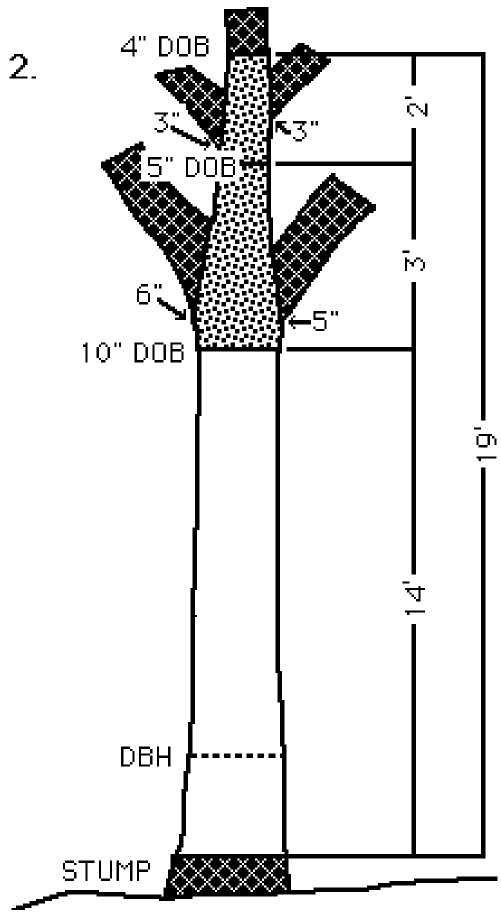
1. Tree class decision trees for pole or large sapling sized trees
2. Tree class decision tree for saw-log sized trees
3. Figures 10.1 – 10.5 Hardwood trees are represented in the figures, however softwoods may be implied using a minimum 7.0" saw-log top DOB.

There are also several pages on tree grading including:

4. Tree grading: defects
5. Tree grade decision tree for hardwood grades
6. Tree grade decision tree for softwood grades

NC Figure 8.1





1. A GROWING-STOCK HARDWOOD SAWTIMBER TREE

Sawlog length terminates at 9" top DOB. The sawlog meets both minimum log-grade specifications and the minimum12-foot qualification for a growing-stock tree. The upper-stem portion contains no cull and terminates at 4" DOB. Sawlog length is recorded as 12 feet; bole length as 21 feet.

Sawlog

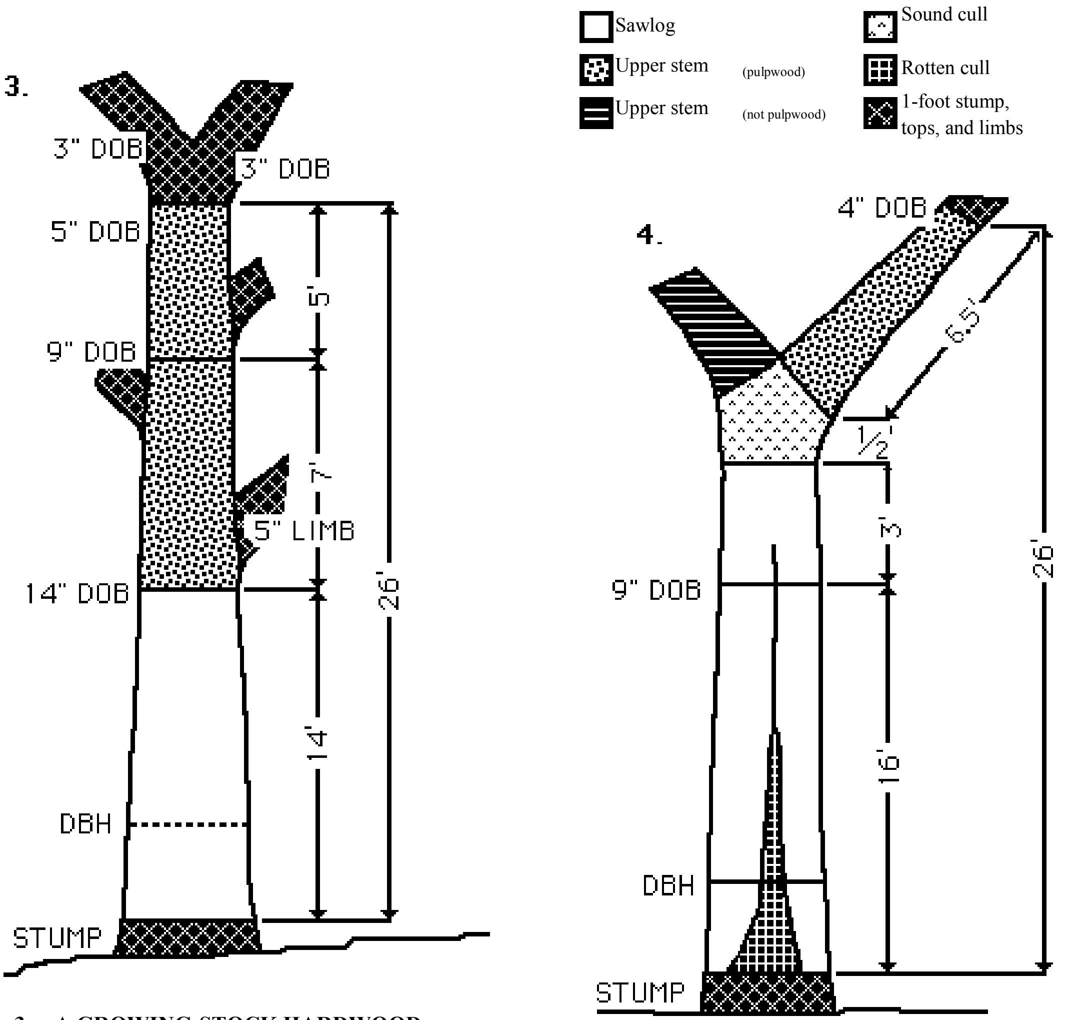
Upper stem
(Pulpwood)

1-foot stump,
top, and limbs

2. HARDWOOD GRADED 1, 2, OR 3 OR A SOFTWOOD SAWTIMBER TREE

Sawlog portion is terminated by limbs creating a full diameter stopper. Each limb is over 2" in diameter, and their sum exceeds the diameter at the stopping point (10" DBH). The sawlog contains no cull and meets minimum grade specifications. Sawlog length is 14 feet. The upper-stem portion contains no cull and terminates at 4" DOB, 5 feet above the sawlog portion. Bole length is 19 feet. Cubic-foot cull is 0 for the tree.

NC Figure 8.2



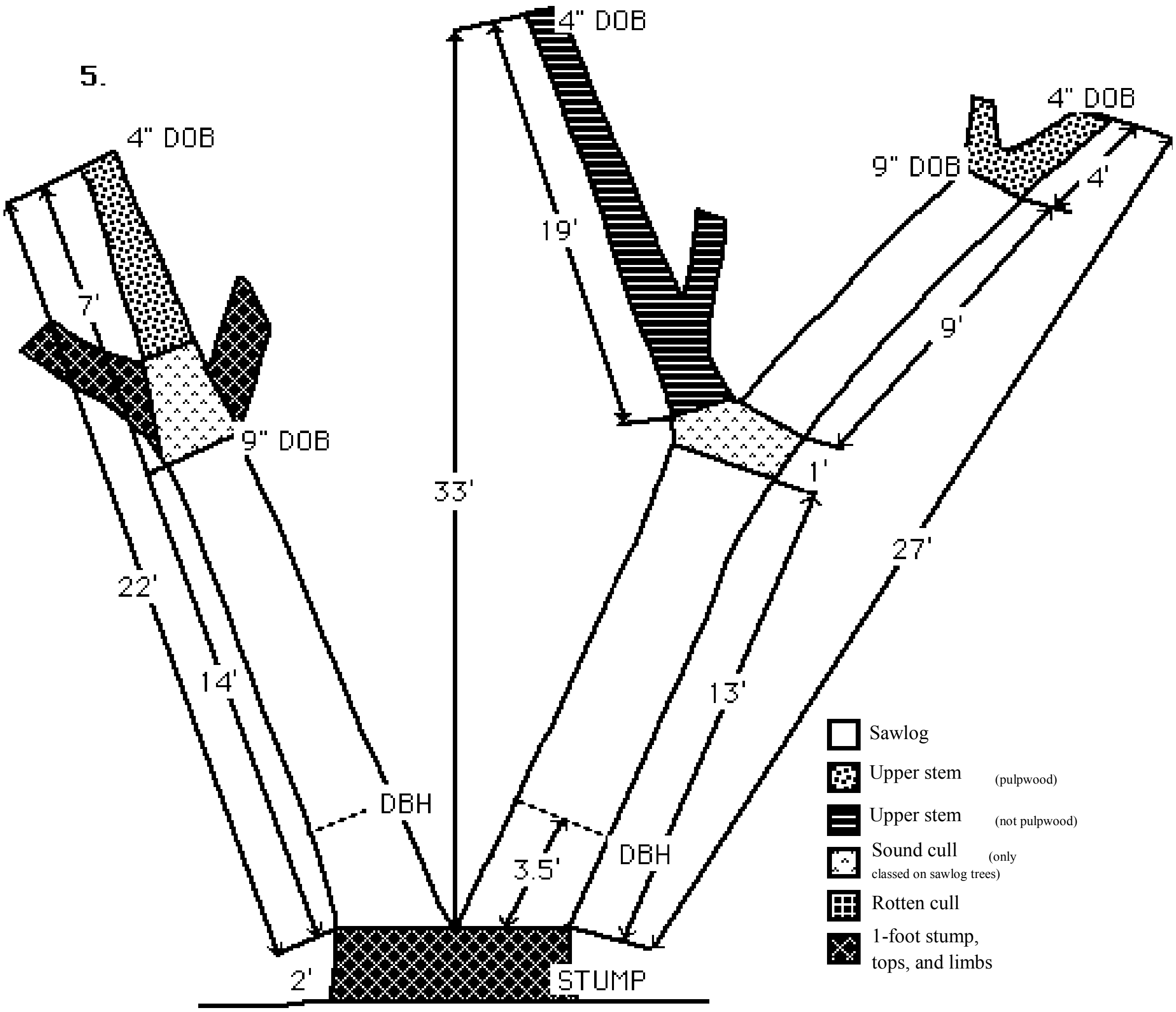
3. A GROWING-STOCK HARDWOOD, GRADE 4, SAWTIMBER TREE

There are no sawlogs in the 21-foot sawlog portion that have minimum clear-panel length to meet hardwood factory log-grade 3 specifications, but the bottom 14 feet contain no rot or sweep and meets hardwood construction-grade 4 specifications. The sawlog terminates at 14 feet, because the 5-inch diameter limb creates a one-third diameter stopper for hardwood construction-grade 4, and only a 6-foot section is left above the 1-foot sawlog stopper. Log grade specifications require a minimum sawlog length of 8 feet. Bole length is terminated at 26 feet with a 5-inch top DOB because of a fork with two 3-inch diameter limbs. Cull board feet and cull cubic feet are zero.

4. A HARDWOOD SAWTIMBER TREE

The sawlog length is 16 feet to the 9" DOB. The bottom 2 feet are over 50 percent rotten and does not meet log-grade specifications. The next 14-foot section meets minimum factory log-grade specifications, but contains some cull due to a frost crack and a narrow cone of rot extending up from the bottom. A 6 1/2-foot section above a 1/2-foot fork at 19 1/2 feet terminates the bole at 26 feet. Board-foot cull includes the entire board-foot volume in the bottom 2 feet, and the unusable board-foot volume in the next 14 feet. Cubic-foot cull includes the cubic-foot volume loss due to rot in the first 16 feet.

NC Figure 8.3

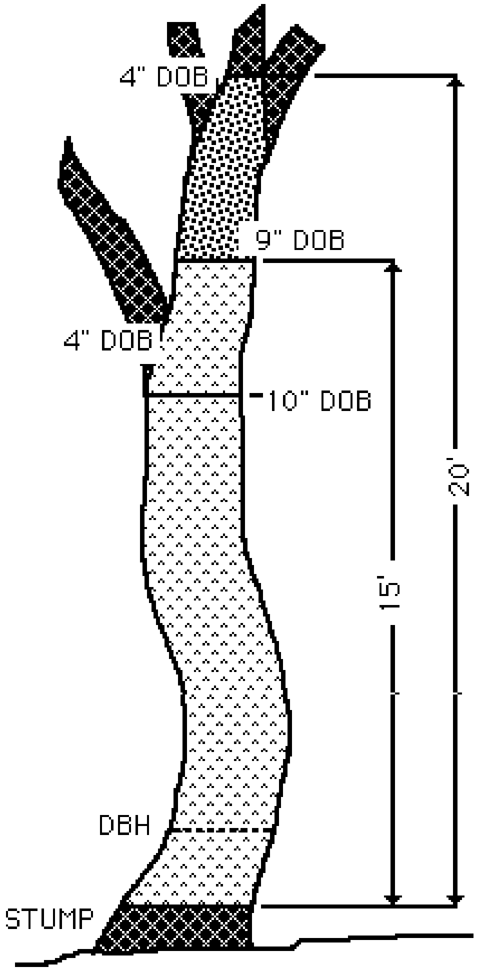


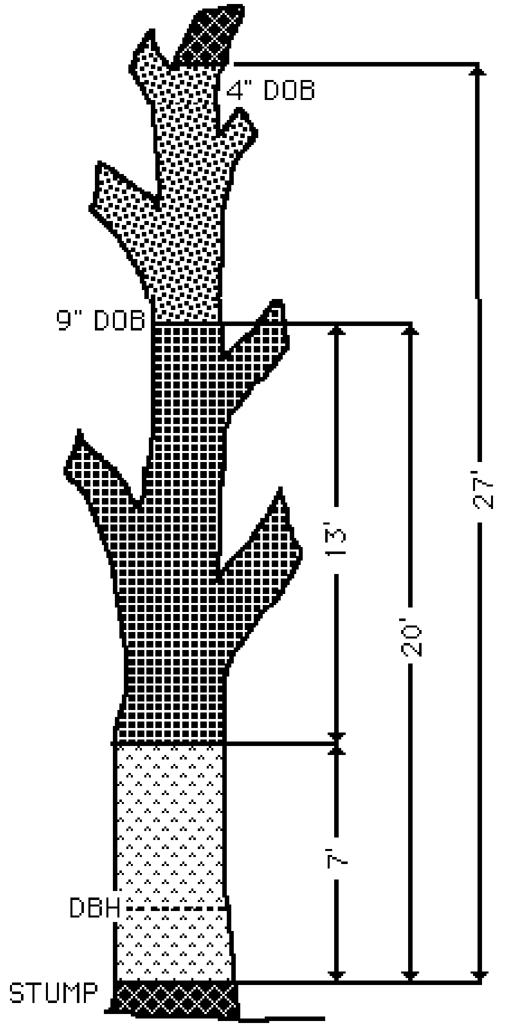
5. TWO HARDWOOD SAWTIMBER TREES

Since the lowest fork is below DBH, each fork is appraised and recorded as a separate tree. The lower 14 feet of the left-hand fork (or tree) meets log-grade specifications. The bole length is 22 feet and the sawlog length is 14 feet. Cull board feet is zero and cubic-foot cull is zero.

In the right-hand tree, a 13-foot merchantable sawlog, plus a 9-foot merchantable sawlog in the right-hand fork (with an intervening one-foot section of sound cull) is recorded as 23 feet of sawlog length. A 4-foot section of the right-hand fork meets pulpwood specifications, making the bole length 27 feet. When a tree forks above DBH, measurements are recorded on one fork only. Merchantable bole length is recorded continuing up the same fork that has the highest merchantable sawlog length. In this illustration, the left-hand fork on the right-hand tree had a higher merchantable bole length at 33 feet, but the right-hand fork on the same tree had a higher merchantable sawlog length, so the bole length is recorded as 27 feet using the right-hand fork.

NC Figure 8.4





6. A ROUGH HARDWOOD SAWTIMBER TREE

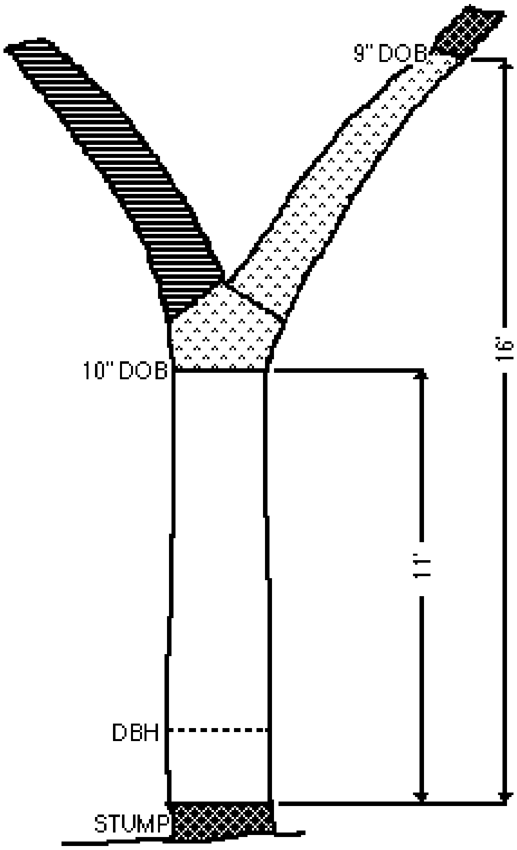
Sawlog portion is 15 feet long. There is no sawlog present that will meet minimum hardwood log grades 1-4. Minimum clear-panel length is not present for grade 3 and sweep plus a 1/3 diameter limb stopper prevents grade 4. Since more than half the board-foot volume is lost as sound cull, it is a rough tree (tree class 30). Bole length is taken 20 feet to the 4-inch DOB. Cull cubic foot is zero.

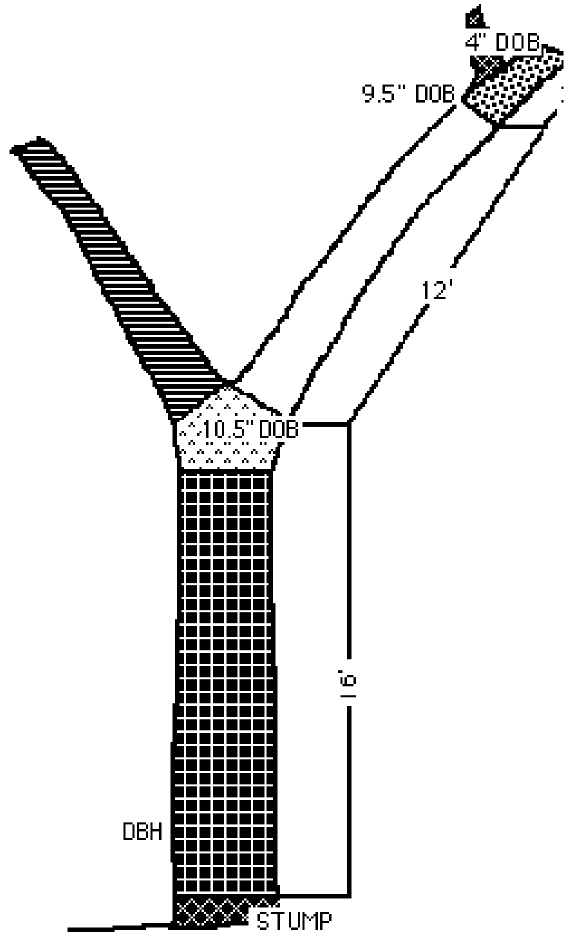
Sawlog
Upper stem (pulpwood)
Upper stem (not pulpwood)
Sound cull
Rotten cull
1-foot stump, tops, and limbs

7. A ROTTEN HARDWOOD SAWTIMBER TREE

The sawlog portion is 20 feet long. The entire volume of a 13-foot section is cull, because it will not meet log-grade specifications because of excessive rot. This creates a 7-foot sound cull section beneath, since there is not a minimum sawlog length of 8 feet. Since there is no sawlog that will meet minimum log-grade specifications, the tree is cull. Because more than half the board-foot volume loss is due to rot, the tree is a rotten cull tree (tree class 40). Bole length is 27 feet and cubic-foot cull represents only the rotten cubic-foot volume within the 13-foot rotten section.

NC Figure 8.5





8. A TREE CLASS 31

The sawlog portion is 16 feet to the 9.0" DOB. The tree does not contain a 12-foot merchantable sawlog, or two 8-foot merchantable sawlogs, because of a fork at 11 feet. This classifies the tree as a cull and since it contains a merchantable sawlog at least 8 feet long, it is a tree class 31. Bole length and cubic-foot cull are handled in the same way as for other trees, culling out for rot and missing wood only.

- Sawlog
- Upper stem (pulpwood)
- Upper stem (not pulpwood)
- Sound cull
- Rotten cull
- 1-foot stump, tops, and limbs

9. A TREE CLASS 31

The sawlog portion is 28 feet and stops at a point just below where the tree forks for a second time at a 9.5" DOB. The first 16 feet do not meet minimum log-grade specifications, but there is a 12-foot merchantable sawlog above the first fork. Since over 2/3 of the total board-foot volume between the 1-foot stump and the top of the merchantable sawlog is cull, this is a cull tree, but since the tree contains a merchantable sawlog, it is a tree class 31.
Bole length and cubic-foot cull are handled in the same way as for other trees, culling out for rot and missing wood only.

SWEEP DEDUCTION IN BOARD FEET

Sweep departure (inches)	Sweep length (feet)	Scaling diameter of section with sweep (inches) 6	7	8	9	10	12	14	16	18	20	22	24	26	28
2	6	1	1	2	2	3	3	4	5	6	6	7	8	9	9
	8	1	1	2	2	3	4	5	5	6	7	8	8	9	10
	10	1	1	2	2	3	4	4	5	6	7	7	8	9	10
	12	1	1	2	2	2	3	4	4	5	5	6	6	7	8
	14	1	1	1	1	1	2	2	2	3	3	3	4	4	5
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	6	2	3	3	4	5	6	7	9	10	11	13	14	15	17
	8	2	3	4	5	6	7	9	10	12	14	15	17	19	20
	10	2	4	5	6	6	8	10	12	13	15	17	19	20	22
	12	3	4	5	6	7	9	11	12	14	16	18	19	21	23
	14	3	4	5	6	7	9	10	12	14	16	17	19	21	23
	16	3	4	5	6	6	8	10	11	13	14	16	18	19	21
4	6	3	4	5	6	7	8	11	13	15	17	18	20	22	24
	8	4	5	6	7	9	11	14	16	18	21	23	25	28	30
	10	5	6	8	9	10	13	16	19	21	24	27	29	32	35
	12	5	7	8	10	12	14	18	20	23	26	29	32	35	38
	14	6	8	9	11	12	16	19	22	25	28	31	35	38	41
	16	6	8	10	11	13	16	19	23	26	29	32	35	39	42
5	6		5	6	8	9	11	14	16	19	22	24	27	29	32
	8	5	7	8	10	12	15	18	21	24	27	31	34	37	40
	10	6	8	10	12	15	18	21	25	29	33	36	40	44	48
	12	8	10	12	12	16	20	25	29	33	37	41	45	50	54
	14	9	11	13	16	18	22	27	32	36	41	45	50	54	59
	16	10	12	15	17	20	24	29	34	39	44	48	53	58	63
6	6			8	9	11	14	17	20	24	27	30	33	36	39
	8			11	12	14	18	22	26	30	34	38	42	46	50
	10		10	13	15	18	23	27	32	36	41	46	51	56	60
	12		12	15	18	21	26	32	37	42	48	53	58	64	69
	14	11	15	18	20	23	29	36	41	47	53	59	65	71	77
	16	13	16	20	23	26	32	39	45	52	58	64	71	77	83
7	6				11	13	16	21	24	28	32	36	39	43	47
	8				15	17	22	27	31	36	41	46	51	56	60
	10				19	21	27	33	39	44	50	56	62	67	73
	12				22	25	32	39	45	52	58	65	71	78	84
	14				25	29	36	44	51	58	66	73	81	88	95
	16			24	28	33	40	49	57	64	72	80	88	96	104
8	6						19	24	28	33	37	41	46	50	54
	8						25	31	37	42	48	54	59	65	70
	10					25	32	39	46	52	59	66	72	79	86
	12					30	37	46	53	61	69	76	84	92	100
	14					34	43	52	61	69	78	87	96	105	113
	16				34	39	48	58	68	77	87	97	106	116	125
9	6							27	32	37	42	47	52	57	62
	8						29	36	42	48	55	61	68	74	80
	10						37	44	52	60	67	75	83	91	99
	12						43	52	61	70	80	88	97	106	115
	14						50	61	71	81	91	101	111	121	131
	16						57	68	79	90	102	113	124	135	146

CROOK DEDUCTION IN BOARD FEET

Crook departure (inches)	Crook length (feet)	Scaling diameter of section with crook (inches)													
		6	**7**	**8**	**9**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**
1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	2	0	0	0	1	1	1	1	1	1	2	2	2	2	2
	3	1	1	1	1	1	1	2	2	2	2	3	3	3	4
	4	1	1	1	1	1	2	2	3	3	3	4	4	4	5
	5	1	1	1	1	2	2	3	3	4	4	5	5	6	6
	6	1	1	2	2	2	3	3	4	5	5	6	6	7	8
2	1	0	0	0	1	1	1	1	1	1	2	2	2	2	3
	2	1	1	1	1	1	2	2	2	3	3	4	4	4	5
	3	1	1	2	2	2	3	3	4	4	5	6	6	7	7
	4	1	1	2	2	3	3	4	5	6	7	8	8	9	10
	5	1	2	2	3	3	4	5	6	8	8	10	10	11	13
	6	2	2	3	4	4	5	7	8	9	10	12	13	14	15
3	1	0	0	1	1	1	1	2	2	2	3	3	3	3	4
	2	1	1	2	2	2	2	3	4	4	5	6	6	7	7
	3	1	2	2	3	3	4	5	6	7	8	9	9	10	11
	4	2	2	3	3	4	5	6	8	9	10	11	12	13	15
	5	2	3	4	4	5	6	8	10	11	13	14	16	17	19
	6	2	3	4	5	6	8	10	12	14	15	17	19	20	23
4	1	1	1	1	1	1	2	2	2	3	3	4	4	4	5
	2	1	2	2	2	3	3	4	5	6	7	8	8	9	10
	3	1	2	3	4	4	5	7	8	9	10	11	12	13	15
	4	2	3	4	4	5	7	9	10	12	13	15	17	18	20
	5	3	3	5	6	7	9	11	13	15	17	19	21	22	25
	6	3	5	6	7	8	11	13	15	18	20	23	25	27	30
5	1			1	2	2	2	3	3	4	4	5	5	6	6
	2			2	3	4	4	5	6	7	8	9	10	11	12
	3			4	4	5	7	8	10	11	12	14	16	17	19
	4			5	6	6	9	11	13	15	17	19	21	22	25
	5			6	7	8	11	13	16	19	21	24	26	28	31
	6			8	9	10	13	16	19	23	26	29	32	34	38
6	1				2	2	2	3	4	4	5	6	6	7	8
	2				3	4	5	6	7	9	10	11	13	13	15
	3				5	6	8	10	12	13	15	17	19	20	22
	4				7	8	10	13	15	18	20	23	25	27	30
	5				9	10	13	16	19	23	25	29	32	34	38
	6				11	13	16	20	23	27	31	34	38	41	45
8	1						3	5	5	6	7	8	8	9	10
	2						7	9	10	12	13	15	17	18	20
	3						10	13	16	18	20	23	25	27	30
	4						14	17	20	24	27	30	33	36	40
	5						17	22	26	30	34	38	42	45	50
	6						21	26	31	36	41	46	51	54	60
10	1								6	7	8	10	10	11	12
	2								12	14	16	19	21	23	25
	3								19	22	25	28	31	34	37
	4								26	29	34	37	41	45	49
	5								32	37	42	47	52	57	62
	6								39	45	51	57	63	69	75

TREE GRADING : DEFECTS

1-BIRD PECK

- 4 per sq. foot are needed to be considered a defect
- not a defect in softwoods
- a grade 3 log can not be dropped to a grade 4 solely due to bird peck

2- BUMPS

- Need to have 1" rise in a 1' section to be considered a defect – in all species

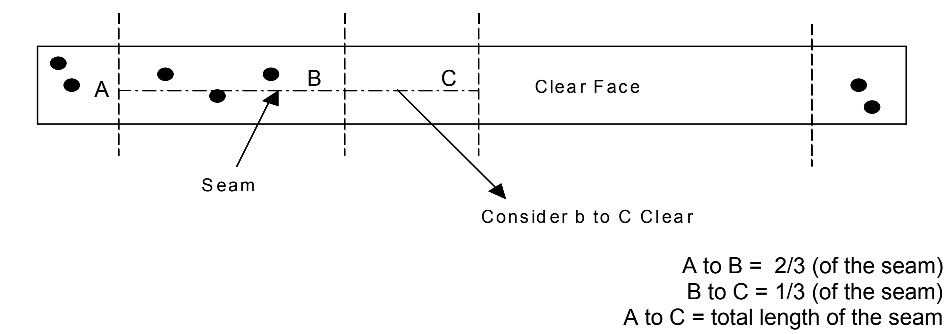
3- SEAMS / FROST CRACKS / ECT…

- Tight seams contain no rot
- All seams are considered unsound and not permited for grade 4.

  *try to put a straight seam on the boundary of 2 of your faces
  if you can, thus eliminating it as a defect

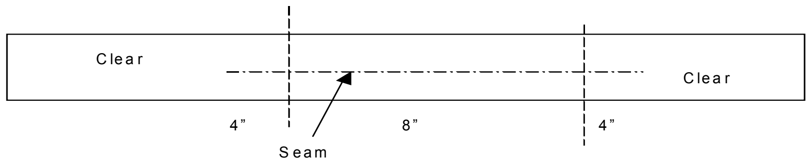
THE 1/3 RULE:
When a seam enters a clear cutting it can be overlaid with your clear cutting 1/3 of its length (see NC Figure 8.6

- Extend the clear face 1/3 into the total seam length
- Section B to C is considered clear



NC Figure 8.6 The 1/3 rule

The ¼ RULE:
When a seam falls entirely inside a clear face, you can include ¼ of the seams total length on each end in the clear cuttings for each end (NC Figure 8.7).



NC Figure 8.7 The ¼ Rule

4- OVER GROWTH OF UNCERTAIN ORIGIN
These are faint or indistinct breaks in the normal bark pattern.
When no distinctive outline that tells what happened from surface appearance

Requirements:

- If a distortion breaks up the bark pattern and stands out as being different from the rest of the bole (heavy)

  a defect on all trees and grades

- If the distortion is starting to blend in with the normal bark pattern on the bole (light)

  ** not a defect at all**

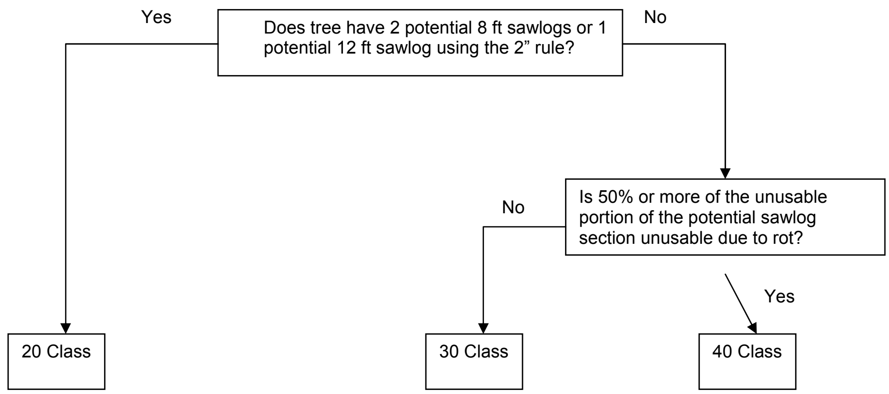
5 – WOUNDS:
Injuries that expose sapwood / heartwood are defects. The following are a few for wounds.
** Old wounds are commonly associated with stain / decay /insects and the affected area becomes a defect

** New wounds (less than 1 year old) are disregarded as long as deterioration is not visible

** New or old wounds look superficial just disregard them

6- BURLS:
A burl is a sound woody protuberance on the bole. A burl is a defect, but contains minimum cull boards when it comes to a deduction.

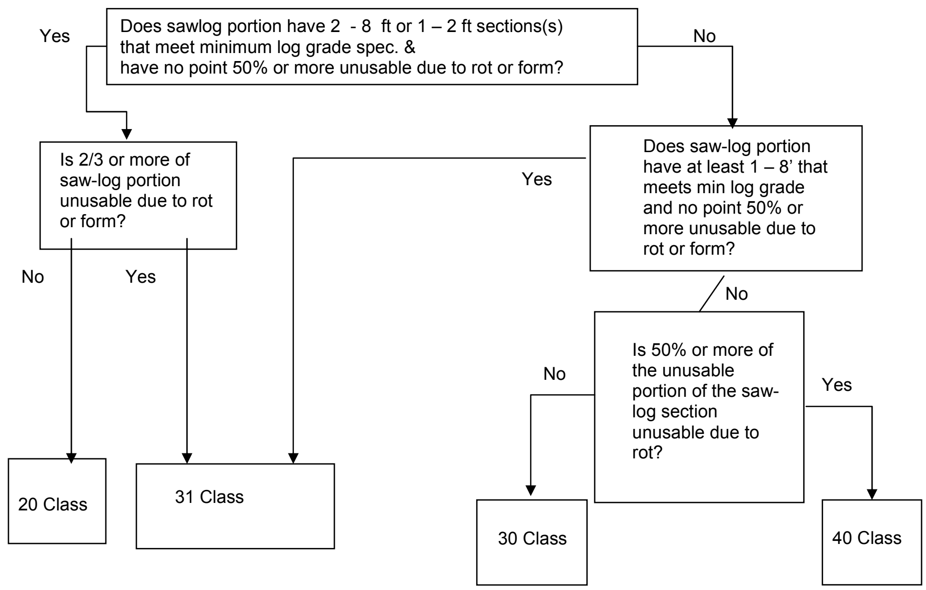
Tree Class Decision Tree
Pole or large sapling sized trees



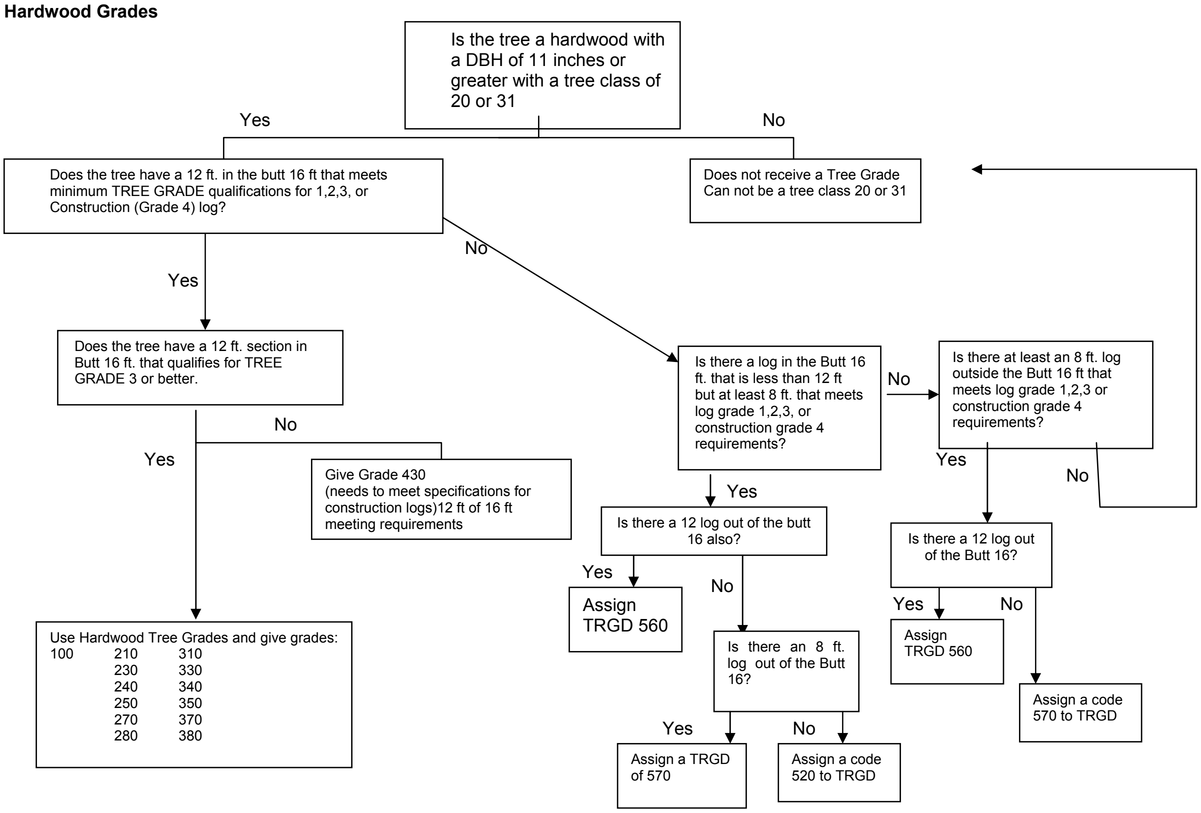
The 2 inch Rule:

Assume all trees will attain sawlog size
Assume that the trees diameter increases uniformly along its bole.
Subtract 2” from the trees current DBH this would be the DOB of the saw log top

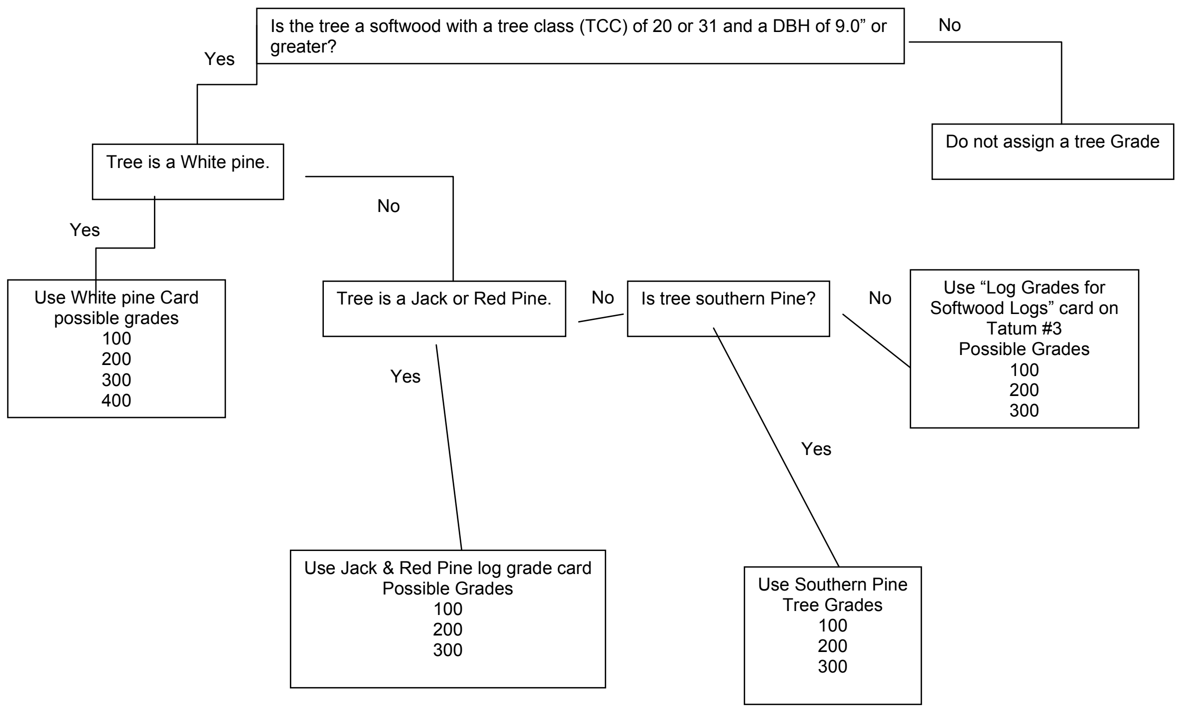
Tree Class Decision Tree
Sawlog sized tree



Hardwood Grades



Log Grades for Softwoods



NC Appendix 9. NC GPS

Rockwell Global Positioning System (GPS) instructions

Exact geographic coordinates will need to be obtained for each field plot. The coordinates will aid in the analysis of the plot data and locating the plot for the next survey. The Precision Lightweight GPS Receiver (PLGR's - pronounced "Plugger"), manufactured by Rockwell International, will be used for this task. Instructions for use can be found in the accompanying "Operations and Maintenance Manual", however, it contains much extraneous information that we do not have to be concerned with. Below is a synopsis for the day to day use of the "Plugger" unit.

Setup Instructions

Setting up the "Plugger", with the correct parameters needs only be done once. However, the unit should be checked each day for correct settings.

After turning the unit on, press the "Menu" button (key 3). The main menu will be displayed:

⇦move⇨	⇳ select
STATUS	SETUP
INIT	TEST
HELP	<more>⇳ P

One of the menu items will be flashing, move to the "SETUP" menu by pressing the arrow-right or arrow-left button (keys 4 or 6) and select the item by pressing the page-down button (key 5). The first page of the SETUP menu will be displayed:

	Explanation
SETUP MODE: **STBY** No tracking, low power.	**St**and **By** power saving mode
SV - TYPE: **all-Y** ⇳ P	Track only Y-code signals

The items in bold in the above menu page are the options that can be set. Move to each item by pressing one of arrow keys (keys 4 or 6), the item will begin to flash when it is active. When you have moved to the desired item, press the page-down button (key 5) until the correct option is displayed. The above mode should be set to **STBY** (Stand By) just for setting up the unit and would not be used in normal field operations. The SV-TYPE may need to be set to "mixed" if an error message stating "insufficient number of satellites…" appears when using the unit. However, the "all-Y" option is the most accurate and should be used whenever possible.

To proceed to the next menu page, press an arrow key until the ⇳ appears next to the "P". Press the page-down button (key 5) again to move on to the next page: (Note if any item is flashing, continue to press an arrow key (keys 4 or 6) until nothing is flashing and the page-up/down symbols appear next to the "⇳" in the lower right corner - nothing on the screen should be flashing when you desire to move to the next menu page.). The next page is **VERY IMPORTANT**, set the units according to the display below:

	Explanation
SETUP UNITS	**L**atitude / **L**ongitude displayed in Degrees and
L/L-dm. English	minutes. Use **English** units (miles, feet, mph)
ELev : **feet MSL**	Elevation above **M**ean **S**ea **L**evel in **feet**.
ANGL : **Deg Mag** ⇳ P	Azimuths in **Deg**rees from **Mag**netic north

Move on to the next page when the page appears as above.

The next page is:

	Explanation
SETUP MAGVAR	Magnetic Variation is
TYPE : **Calc** deg	**Calc**ulated by the system in degrees
WMM 1995	
⇳ P	

Set the page as shown above. Next, page-down to the next menu page.

	Explanation
SETUP	
ELHold : **automatic**	Auto- calculates when to hold elevation constant
TIME : **Zulu**	Time will display in 24 hour clock (i.e.1:00PM=1300)
ERR : **+/- ft** ⇳ P	Error displayed as plus or minus in feet

Set the page as shown above. Next, page-down to the next menu page.

	Explanation
SETUP DTM : **NAR**	Datum set to the North American 1983
No Amer-83/GRS80	using the GRS spheroid
AUTOMATIC OFF	The unit will automatically turn off in 20 minutes
TIMER : **20 min** ⇳ P	

The above page is **VERY IMPORTANT**, please make sure the Datum is set to "**NAR**".

Set the page as shown above. Next, page-down to the next menu page.

	Explanation
SETUP I/O	Input/out parameters for the serial port.
SERIAL : **Standard**	However, we will not use it.
HAVEQUICK : **Off**	
1PPS : **Off** ⇳ P	

This page should already be as shown, if not please make the appropriate changes and continue on to the next page.

	Explanation
SETUP AUTOMARK	This option would automatically take a point at a
MODE : **off** WP000	specified time or interval in time. However, it
##-##-## ####Z	should be set to off.
REPEAT 0000 ⇳ P	

Make sure that the MODE is set to **off**, that is the only thing to worry about on this page. This is the last page in the setup menu. Paging to the next page will bring you back to the first page of the setup menu. If not, press page-down key (5) until the first page does appear. Press menu to display the main menu.

Operations in the Field

Acquiring a Daily Almanac

The first time the PLGR is turned on each day, known as a "Cold Start", the PLGR starts searching for Satellite Vehicles(SVs). The first information the PLGR receives from each satellite (health, ephermis, etc.) is picked up from the CA-code signal. The PLGR looks for the best geometry among the SVs in view and locks on to them. Your receiver will not instantly obtain a precise and accurate position fix. You should be prepared to **allow 15 to 20 minutes** for the receiver to obtain the daily almanac (at the start of the day) before it will collect accurate position data. The longer the PLGR has been in storage the more time it will take to determine a precise position. During this time the receiver must be set to CONTINUOUS (CONT) mode. Begin by turning the PLGR on:

Action	KEY #
Turn the PLGR on	Key 1

Upon turning the unit on, the battery status will be displayed. A warning will be given if it is low on power. **Always** carry a spare battery pack with you! After the start up test is performed by the unit, the POSITION page will be displayed:

FIX OLD
N 44° 59.089'
W 93° 11.092'
Elh +00941 ft ⇳ P

The receiver mode can be viewed in the upper left corner of the first position to be displayed. When the unit is first turned on it will be in the quick "FIX" mode (if it is using only battery power).

The receiver will need to be in to the **CONT** mode, begin by going to the main menu:

Action	KEY #	Screen	
Display Main Menu Page	Key 3	⇦move⇨	⇳ select
		STATUS	**SETUP**
		INIT	TEST
		HELP	<more> ⇳ P

Move to the "SETUP" menu item by pressing one of the arrow buttons (keys 4 or 6), it will be active when it is flashing, then select the SETUP menu by pressing the down key (key 5). The first page of the SETUP menu will be displayed:

Action	KEY #	Screen	Menu Explanation
Display Setup Menu	Keys 6,5	SETUP MODE: FIX	Obtains a quick fix of position,
		Quick POS fix,	then goes to stand-by mode,
		then STBY	and eventually turns off
		SV-Type: all Y ⇳ P	Track only Y-code signals

Change the Mode to the Continuous Mode:

Action	KEY #	Screen	Menu Explanation
Change Mode to (**CONT**)inuous	Keys 6,2	SETUP MODE: **CONT** Continuous POS and VEL update	Calculates its position and velocity continuously
		SV-Type: all Y ⇳ P	Tracks only Y-code signals

The items in **bold** in the above menu page are the options that can be set. Move to each item by pressing one of arrow keys (keys 4 or 6), the item will begin to flash when it is active. When you have moved to the desired item, press the page-down button (key 5) until the correct option is displayed. The above mode should be set to **CONT** (Continuos), this is just for the "cold start" up of the unit and should not be used for acquiring the position of the plot center.

When you have changed the receiver to the CONT mode, press the "POS" button (key 8). Check the error in the upper right hand corner of the position screen, it will probably be very high for a few minutes. After about 5 minutes the error should have dropped somewhat. Also check the almanac age by pressing the page-up button (key 2) - while the position screen is displayed. When it states that the age is 1 day, the receiver is ready to collect the plot coordinates. This may take some time so be patient. The unit will turn itself off if left untouched for 10 minutes, so while you are waiting for it to acquire the almanac, it would be wise to press the "POS" key every 5 minutes or so to prevent this. When the almanac has been obtained, you may switch the unit off and proceed to the plot center or, if you are already at the plot center, proceed with the next section - Collecting the Plot Center Coordinate. If the above was done correctly, the Almanac Age should be one day.

Collecting the Plot Center Coordinate

When you have found or established the pin at plot center, stand over the pin holding the receiver - preferably facing south. If you have not acquired the almanac for the day do so by completing the above section. If the almanac has been acquired (that is the almanac age is one day, - check this by pressing the "POS" button (key 8) and then the page-down button (key 5) twice) proceed…

change the operating mode to **AVG**, to do this:

Press the "Menu" button (key 3). The main menu will be displayed:

⇦move⇨	⇳ select
STATUS	**SETUP**
INIT	TEST
HELP	<more> ⇳ P

One of the menu items will be flashing, move to the "SETUP" menu by pressing one of the arrow keys (keys 4 or 6) and select the item by the page-down button (key 5). Next the first page of the SETUP menu will be displayed:

	Menu Explanation
SETUP MODE: **AVG**	The **AV**ERA**G**ING mode continuously records a
Static POS fix,	new position and averages with previous
better accuracy	1positions. DO NOT MOVE the PLGR.
SV - TYPE: all Y ⇳ P	Track only Y-code signals

The items in **bold** in the above menu page are the options that can be set. Move to the mode item by pressing the right-arrow button (key 6), the item will begin to flash when it is active. When you have moved to the "MODE" item, press the page-down button (key 5) until the **AVG** option is displayed. The averaging mode will continually record a position and average them together, it is therefore very important that you **DO NOT MOVE** the PLGR unit while it is averaging. After the AVG mode is displayed, press the "POS" button (key 8). "AVG" will now be displayed in the upper left corner of the screen. After approximately 15 seconds (or several minutes) the unit will display the number of positions it has averaged together and continually update the resulting "average" coordinate. Allow the unit to collect at least 180 points (this will take about 3 minutes). After which the coordinates for the plot center may be entered into the HUSKY and recorded onto the plot sheet. The coordinates are in degrees and decimal minutes for the latitude and longitude, enter and record the full number to the 3rd decimal place of the minutes, **DO NOT ROUND**! After you have entered and recorded the coordinates the PLGR unit may be turned off by pressing the off button twice.

The PLGR unit screen will look like this:

AVG 00180 ±36Ft
N11^{0}11,111^0
W 011^{0}11,111^0
EL ±11111ft ⇳P

The GPS Error (ERRS) to record in the data recorder for the plot is 36 in the above example.

What to Do When You Can't Get to Plot Center

If plot center happens to be inaccessible, go to a point from which you know the distance and azimuth to plot center. At this point, obtain the coordinates as you would for the PC explained above. When the unit has averaged over 180 points into its calculation, copy the averaged coordinate displayed onto a sheet of paper exactly as it is displayed (**DO NOT ROUND!**).

Next press the "WP" button (key 7). The Way Point menu will appear:

WP ⇦move⇨ ⇳ sel
ENTER EDIT COPY
SR-CALC **RNG-CALC**
DIST CLEAR ROUTE

Move to the "ENTER EDIT" item and enter the coordinate–creating a Way Point. Next, return to the Way Point menu and move to "RNG-CALC" item with the arrow buttons (keys 4 or 6) and press the page-down button (key 5) when the "RNG-CALC" item flashes. The following screen will appear:

CALC from WP000
RNG 0000.0 ft
AZ 360.0(M
EL +00000 ft ⇳ P

This is the coordinate calculation screen. Here you will enter the distance (range) and azimuth to the plot center. Move to the way point item with the arrow-right button (key 6), when the "000" flashes next to the "WP", press the page-down button (key 5), the way point number of the coordinate you have just entered should appear. If not, continue pressing the down button until it does. When you have the correct way point number displayed, move to the range (RNG) item with the arrow-right key (key 6) so that the "0000" will flash, then press the page-down button (key 5) and the first digit will begin to flash. If your distance is less than 1000 feet, move on to the next digit by pressing the arrow-right button (key 6). When the appropriate digit flashes select the correct number with the page-down or page-up buttons (keys 2 or 5). Next, move to the (AZ)imuth item and enter the azimuth to the PC in the same way. Move past the (EL)evation item to the (P)age so that the page-up and down arrow (⇳) appears next to the P symbol. Next, press the page-down button (key 5). The calculated coordinates for the PC will now appear on the screen.

Maintenance

The "Plugger" unit uses 8 AA Alkaline power batteries good for about four hours of operation and will need to be replaced every few days. Power batteries can be accessed by removing the power battery cover at the top of the unit. The "Plugger" unit also has one AA size lithium memory battery that is located at the bottom end of the unit. The memory battery is only replaced as a maintenance action annually and is used to maintain power to the memory for critical information - **NEVER REMOVE THIS BATTERY**! This removes the encryption codes and reduces the accuracy of position coordinates.

Keep the unit clean and dry as you would the HUSKY. Unless you are about to be overrun by the enemy - **NEVER EVER PRESS THE "NUM LOCK" BUTTON AND THE "MARK'BUTTON SIMULTANEOUSLY**! This will clear all the special encryption codes from the unit and it will have to be returned to the Missoula Technology Development Center for recoding - costing you money and the severance of your index and middle fingers! To check that encryption codes are in the unit press the "Menu" key twice. You should see the following menu with "CRPTO" displayed in the lower left of the screen:

Data-XFR	SV-SEL
DOP-CALC	ALERTS
SINCGARS	KOI-18
CRPTO	<more> ⇳ P

From time to time, way points should be cleared out of the memory. This can be done by pressing the WP button and moving down to the "CLEAR" item. Select it and enter the range of way points you wish to clear, then move to and select the "Activate" item to clear them.

LOCATING FIELD PLOTS WITH THE ROCKWELL PLUGGER:

This out line describes how we are using the GPS to locate “New Samples” (where the coordinates are provided by St. Paul). The concepts listed below also apply to other situations, which occur in the field, and are not limited to use with new samples.

OVERVIEW:

A. *Acquire the daily almanac*
B. Pick an sp tree, collect 180 readings and save the coordinates as WP # 1 (this is what is put on the plot sheet)
C. *Manually enter your destination (provided) coordinates, save it as WP # 2*
D. *Now we want to navigate to our destination (PC)*
E. *When you get close to your destination(about 100') you will need to take another wp, just like we did at SP. Call this WP # 3.*
F. Calculate the distance and azimuth between WP #3 and WP #2, then chain out the distance provided to arrive at PC (WP# 2) without any biases.
G. If the location you arrive at is different than the location on the image provided adjust your location on the ground to match the image.

GENERAL STEP BY STEP DIRECTIONS:

Establishment of New Samples plots using GPS:
Your Plot sheet will provided you with the plot center coordinates for all plots. To begin this process you will need to manually enter the plot coordinates in the GPS unit. The following list will walk you through the buttons to push to enter these coordinates:

The first 3 steps are part of our current normal plot procedures, which all employees are familiar with

A Acquire the daily almanac

Acquire the daily almanac. See Rockwell Plugger or Garmin GPS unit instructions.

B Pick an SP tree, collect 180 readings and save the coordinates as WP # 1

Collect coordinates at your SP tree, save this as a WP (WP1). To collect a waypoint we must be in “AVG” mode:

C Manually enter your destination (provided) coordinates, save it as WP # 2

To begin, manually enter the plot coordinates in to the GPS unit. The following list will walk you through the buttons to push to enter to enter the coordinates:

hit the WP key (key 7)
the screen should now appear like this:
With the “enter” key flashing
WP <move> sel
ENTER EDIT COPY
SR-CALC RNG-CALC
DIST CLEAR ROUTE

Use the right / left arrows to highlight ENTER and press the down arrow (key 5)

The screen will look like this:

WP000 UNUSED000
N 90 00.000'
E 00 00.000'
No EL CLR ^P

Note the WP number in the upper left corner of the screen. This will be the waypoint the coordinates are stored as and to which you will be navigating, so it is important number. It is good idea to change the waypoint number to coincide with your SP tree (WP1), your PC location (WP2) and your 100-200' from your destination WP as (WP3). To do this, right arrow until the WP #### is blinking. Hit NUM LOCK and using the keypad, enter the plot number (last 3 digits) or what ever number you want to call the waypoint. Now right arrow to the next line.

Right arrow over N to 90. Hit NUM Lock and enter the coordinates for North/ Latitude. Once these numbers have been entered, hit NUM LOCK and right arrow to the next line. Down arrow to change the E to a W. This is critical! Once you have changed the E to a W, right arrow to the 000 and hit NUM LOCK. Enter the West / longitudinal coordinates.

Once the coordinates have been entered, turn off NUM LOCK and right arrow to the P. Down arrow to store the waypoint. It will be saved as the waypoint you designated earlier.

D Now we want to navigate to our destination (PC)

Now, click on NAV. The screen will look like this:

SLOW DIRECT

WP001 MARK002

^P

Use the right / left arrow keys (keys 4/6) to make the "SLOW" feature blink.

Use the up / down arrow keys (2/5) to choose either CUSTOM OR 2D FAST (THIS IS WHAT THE SOUTH SAYS TO DO. WE HAVE HAD BETTER LUCK WITH "SLOW")navigation methods.

Right arrow to WP and enter the waypoint which you wish to navigate to. This is why you numbered it when you entered it. The screen should look like:

SLOW DIRECT

WP 002 *(if you are going to WP2)* Mark 002

Right arrow to P and then hit the down arrow

The next screen will tell you where you need to go. The variables may not be the same for everyone but you will need to at least have a AZ and RNG to tell you where you need to go and how far it is.

NOTE: THE NAV FUNCTION WILL NOT WORK IF PLUGGER IS STILL IN AVG MODE.

E When you get close to your destination (about 100') you will need to take another WP, just like we did at SP.

Follow the GPS until you are within 100-200 feet of the plot, you know this by the RNG reading on your screen. Set the GPS down and hold the POS button until the screen says AVG and the unit begins taking hits. Again, you must collect at least 180 points for the coordinates to be accurate. Once the GPS has recorded at least 180 points store the current position as a waypoint, assign it a number as we did in step 3 (WP3).

F Calculate the distance and azimuth between WP #3 and WP #2, then chain out the distance provided to arrive at PC (WP# 2) without any biases

Hit the WP key

WP <move> ^sel

Enter Edit Copy

SR-CALC RNG-CALC

DIST CLEAR ROUTE

Right arrow to DIST and then hit the down arrow

The screen should look like this:

DIST WP003>>002

RNG ##.##FEET

AZ ###.# DEGREES

This screen allows you to calc the horizontal distance between you last waypoint (3), which is between 100-200 feet from you destination (WP1) plot center. You will have to use the up/down arrows to choose the WP you want to calc between.

You can use this same screen to get a dist and az from your sp to pc waypoints. This would be recorded on your plot sheet. This will also give you some guide lines on pacing into a plot if you loose your satellites

Once you have this dist and az you will need to chain as we have chained in the past. This is to ensure that there is no bias in the final pin position

G Check location on the image with location you are at.

Once you arrive at the location, check the image provided with the plot. If you are in the same location as is indicated on the image collect the GPS coordinates here and record them for the field plot location.

If you are not at the location on the image, make the adjustment so that you are there then collect a GPS reading.

Garmin GPS Instructions

GARMIN INSTRUSTIONS

GARMIN SET-UP INSTRUSTIONS –

(Buttons on GPS in caps and items on screen and plot sheet in "__")

Please check the Datum status on a regular basis!!!

The Garmin should be collecting data in the map datum NAD 83. To check/set this item, complete the following instructions.

1. Locate the Main Menu screen by hitting PAGE until the list of options appears.
2. Use the UP or DOWN arrow keys to highlight "Setup Menu" and press ENTER.
3. Use the UP or DOWN arrow keys to highlight "Navigation" and press ENTER.
4. Check to verify if the "Map Datum" is set on NAD 83. If not, use the UP or DOWN arrow keys to highlight the Datum that it is set on.
5. Once it is highlighted, use the UP or DOWN arrow keys to scroll through the list until NAD 83 is displayed. Then press ENTER to select it.
6. Click on PAGE to return to the Main Menu screen.

This will set the unit up for data collection in the field.

The time can also be set on the Garmin. This is not essential to the operation of the unit, but it may be desirable for the crewmembers.

1. Locate the Main Menu screen by hitting PAGE until the list of options appears.
2. Use the UP or DOWN arrow keys to highlight "Setup Menu" and press ENTER.
3. Use the UP or DOWN arrow keys to highlight "System" and press ENTER.
4. Check to verify if the "OffSet" is set on –06:00 for Central Time and –05:00 Day Light Savings Time or –05:00 for Eastern Time and –04:00 for Day Light Savings Time.. If not, use the UP or DOWN arrow keys to highlight the digits to the right of "OffSet" and press ENTER.
5. Use the Right arrow key to highlight the second digit.
6. Use the UP or DOWN arrow keys to select the correct offset setting and press ENTER.
7. Click on PAGE to return to the Main Menu screen.

This will set the unit up for the correct time for the time zone it is located in.

Collecting SP and PC Coordinates on a Plot That Has Been Established

(Buttons on GPS in caps and items on screen and plot sheet in "—")

1. Find the SP (Starting Point) tree that the old crew established.
2. Measure the DBH and record it, along with a brief description of where the tree is located, on the top left of the plot sheet in the "SP description" section.
3. Re-paint SP so the next crew can relocate the tree easier.
4. Turn the GPS on and allow it to track satellites automatically.
5. Once the GPS has moved from the satellite page to the position page (see manual to see examples of these pages), the SP (starting point) data can be collected. Place the GPS at the base of the SP tree and hit the MARK button. This will give you the "Waypoint" screen.

To set Waypoints and Name Them:

6. The waypoint number will need to be changed. To do this, use the DOWN arrow to highlight the number given to it automatically (auto # should range from 001-999). Once it is highlighted, hit the ENTER key. This will allow the use of the UP, DOWN, RIGHT, or LEFT arrow keys to rename the waypoint. The new number should be the last four digits of the plot number plus 'SP' (starting point). Ex. 0123SP. Later, when the instructions refer back to this, use the last four digits plus 'PC' (point center).
7. After the waypoint has been renamed, hit the ENTER key.
8. Now, use the UP or DOWN arrow keys to highlight "Average?" at the bottom of the screen and hit the ENTER key.
9. Allow the GPS to collect data for **3 to 5 minutes**. This will ensure the position is near exact.
10. After the time has passed, highlight "Save?" at the bottom of the page and hit "ENTER".
11. Once this is done, hit PAGE three times to get to the "Main Menu". Highlight "Waypoint List" and hit ENTER. Use the UP and DOWN arrows to highlight the waypoint you stored for 'SP' and hit ENTER. This will display the coordinates for 'SP'.
12. Write the coordinates on the top right portion of the plot sheet and this will complete the info for the starting point.
13. Use the course to sample data that the old crew provided to navigate from Starting Point to Point Center.
14. Once the PC (Point Center) pin has been located, the actual point center is now located on the ground and we need to mark the new coordinates. Place the GPS on the pin that was found in the ground and hit MARK. Now refer to the numbers 6-9 from above once again. This point will be named 'PC'. **Before the waypoint is saved, note the error (+ or – xx.x from this screen) on the back of the plot sheet**. This will need to be entered into the data recorder later.
15. Once the error note is made continue with numbers 10 and 11 from above and begin entering the Latitude and Longitude into the data recorder.
16. In order to get the elevation, go back to the position menu (hit "PAGE" 4 times and read "ALT" to get the elevation in feet.
17. Enter the last 6 digits of the 8-digit serial number for (GPS #).
18. Enter "2" for GPS UNIT (UNIT) because it is an "other brand".
19. Enter the error (+ or – xx.x) that you noted earlier.
20. Enter "180" for # of readings in the data recorder. This # is established by waiting 3-5 min.

Navigation With Coordinates for a New Plot

(Buttons on GPS in caps and items on screen and plot sheet in "__")

1. Find a suitable SP (starting point) tree that is close to the plot and recognizable on the photo or DOQ.
2. Measure DBH and paint an "SP" near DBH and at the base of the tree. Then document the DBH and location on the front of the plot sheet in the "SP Description" section.
3. Turn the GPS on and allow it to track satellites automatically.
4. Once the GPS has moved from the satellite page to the position page (see manual to see examples of these pages), the SP (starting point) data can be collected. Place the GPS at the base of the SP tree and hit the MARK button. This will give you the "Waypoint" screen.

To set Waypoints and Name Them:

5. The waypoint number will need to be changed. To do this, use the DOWN arrow to highlight the number given to it automatically (auto # should range from 001-999). Once it is highlighted, hit the ENTER key. This will allow the use of the UP, DOWN, RIGHT, or LEFT arrow keys to rename the waypoint. The new number should be the last four digits of the plot number plus 'SP' (starting point). Ex. 0123SP. Later, when the instructions refer back to this, use the last four digits plus 'PC' (point center), 'MP' (mid point), or 'C' (center) respectively.
6. After the waypoint has been renamed, hit the ENTER key.
7. Now, use the UP or DOWN arrow keys to highlight "Average?" at the bottom of the screen and hit ENTER.
8. Allow the GPS to collect data for **3 to 5 minutes**. This will ensure the position is near exact.
9. After the time has passed, highlight "Save?" at the bottom of the page and hit ENTER.
10. Once this is done, hit PAGE three times to get to the "Main Menu". Highlight "Waypoint List" and hit ENTER. Use the UP and DOWN arrows to highlight the waypoint you stored for 'SP' and hit ENTER. This will display the coordinates for 'SP'.
11. Write the coordinates on the top right portion of the plot sheet and this will complete the info for the starting point.
12. While in this screen, use the UP arrow to highlight "NEW?" and hit ENTER. This is where the 'PC' (point center) coordinates from the back of the plot sheet are entered.
13. Name it the same way "SP" was named only with a 'PC'. Once the name is complete, hit ENTER. This will automatically enter the coordinates of your current location. Don't panic! This can be changed. Use the DOWN arrow key to highlight the coordinates and hit ENTER. Now use the UP, DOWN, RIGHT, and LEFT arrow keys to change the info to the PC coordinates. Hit ENTER twice and this saves it.
14. Hit GOTO and use the UP and DOWN arrows to highlight the waypoint with 'PC' at the end. Hit ENTER again and this will give the distance and azimuth from 'SP' to 'PC'. Write this information at the top of the plot sheet in the "Course to Sample Location" section.
15. Now is the time to start following the bearing "BRG" and distance "DST" that the GPS is displaying.
16. Once the GPS beeps, and gives the message that 'PC' is approaching, continue until the unit reads within 0.04 mi. Here is where we will want to stop and mark a middle point. Hit MARK and refer to numbers 5-9 from above. This point will be named 'MP'.
17. Hit GOTO again, highlight 'PC', and hit ENTER. Note the distance and azimuth from 'MP' to 'PC'. This is the "Course to Sample" **that needs to be chained** with a tape. Use a compass and measuring tape to go the exact measurements **(0.04 mi = 211.2 ft, 0.03 mi =158.4 ft, 0.02 mi =105.6 ft, and 0.01 mi =52.8 ft)**. The exact location that you stop at on the measuring tape will be where the pin is placed. The reason for this is to take the bias out of using the GPS for the point center location. **Note: Be sure to cross reference the ground location with the photo or DOQ to be sure there is not a major mistake in navigating from 'SP' to 'PC'. Re-evaluate if the locations differ more than 33 feet. <u>IF THERE IS A MAJOR DIFFERENCE BETWEEN THE PHOTO OR DOQ LOCATION AND THE LOCATION ON THE GROUND, THE PHOTO OR DOQ LOCATION IS CORRECT AND THE PLOT SHOULD BE RELOCATED TO MATCH THE 'X' OR THE PINPRICK.</u>**
18. This brings us down to the last operation. Actual point center is now located on the ground and we need to mark the new coordinates. Place the GPS on the pin that was placed in the ground and hit MARK. Now refer to the numbers 5-8 from above once again. This point will be named 'C' for center. **Before the waypoint is saved, note the error (+ or – xx.x from**

this screen) on the back of the plot sheet. This will need to be entered into the data recorder later.

19. Once the error note is made continue with numbers 9 and 10 from above and begin entering the Latitude and Longitude into the data recorder.
20. In order to get the elevation, go back to the position menu, hit PAGE four times, and read "ALT" to get the elevation in feet.
21. Enter the last 6 digits of the 8-digit serial number for (GPS #).
22. Enter "2" for GPS UNIT (UNIT) because it is an "other brand".
23. Enter the error (+ or – xx.x) that you noted earlier.
24. Enter "180" for # of readings in the data recorder. This # is established by waiting 3-5 minutes.

NC Appendix 10. Tatum Guides

Plot Data

Plot status (STAT)

1	Sampled -At least one forested condition
2	Sampled – no forested conditions
3	Nonsampled

Plot nonsampled reason (REAS)

1	Outside U.S. boundary
2	Denied access area
3	Hazardous situation
6	Lost plot
7	Plot in wrong location
10	Other

Horizontal Distance Roads (RDIS)

1	= or <100 ft
2	101'-300'
3	301'-500'
4	501'- 1000'
5	1001'-1/2 mile
6	½ to 1 mile
7	1 to 3 miles
8	3 to 5 miles
9	Greater than 5 miles

Water on Plot(WTYP)

0	None
1	Permanent Streams small
2	Permanent water (non-census)
3	Ditch/Canal
4	Temporary streams
5	Flood zones
9	Other temporary water

QA Status (QAST)

1	Standard Production plot
2	Cold Check
3	Reference plot (off grid)
4	Training / Practice plot (off grid)
5	Botched plot file
6	Blind check
7	Production plot (hot check)

Crew Type (CRTY)

1	Standard field crew
2	QA crew

GPS Unit (UNIT)

0	Not collected
1	Rockwell (PLGR)
2	Other Brand
3	Trimble GeoExplorer or Pathfinder Pro
4	Recreational GPS (Garmin)

GPS

Last 6 digits of serial number

Condition Data

Condition Number (CON#)

Record a number assigned to the defined condition.

Condition Status (STAT)

1	Accessible forest land
2	Nonforest land
3	Noncensus water
4	Census water
5	Nonsampled

Condition nonsampled reason (REAS)

1	Outside U.S. boundary
2	Denied access area
3	Hazardous situation
10	Other

Stand-Size Class (STSZ)

0	Non-stocked
1	0.0 – 4.9 in
2	5.0 – 8.9(soft),5.0-10.9(hard)
3	9.0-19.9(soft), 11.0-19.9(hard)
4	20.0-39.9
5	40.0 +
6	Cover trees (non-tallied)

Reserve Status (RESV)

0	Not Reserved
1	Reserved

Owner Group (OWNG)

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

Forest Type (FTYP)

101	Jack Pine
102	Red Pine
103	White Pine
104	E Whie pine/E Hemlock
105	Eastern Hemlock
121	Balsam fir
122	White Spruce
123	Red spruce
124	Red spruce/balsam fir
125	Black Spruce
126	Tamarack
127	Northern white-cedar
141	Longleaf pine
142	Slash pine
161	Loblolly pine
162	Shortleaf pine
163	Virginia pine
164	Sand pine
165	Table-mountain pine
166	Pond pine
167	Pitch pine
168	Spruce pine
181	Eastern Redcedar
182	Rocky Mountain juniper
221	Ponderosa pine
381	Scotch pine
382	Australian pine
383	Other exotic softwoods
384	Norway spruce
385	Introduced larch
401	EWP/N RedOak/White ash
402	Eastern redcedar-hardwood
403	Longleaf pine/oak
404	Shorleaf pine-/oak
405	Virginia pine/southern red oak
406	Loblolly pine/hardwood
407	slash pine/hardwood
409	Other pine/hardwood
501	Post-blackjack
502	Chestnut oak
503	White oak-red oak-hickory
504	White oak
505	Nothern red oak
506	Yellow-poplar/white oak/n. red oak
507	Sassafras-persimmon
508	Sweetgum/yellow-poplar
509	Bur oak
510	Scarlet oak
511	Yellow-poplar
512	Black walnut
513	Black locust
514	Southern scrub oak
515	Chestnut-black-scarlet oak
519	Red maple/ oak
601	Swamp chestnum oak-cherrybark oak
602	Sweetgum/Nuttall oak/willow oak
605	Overcup oak /water hickory
606	Atlantic white-cedar
607	Baldcypress / water tupelo
608	Sweetby /swamp tupelo/red maple
701	Black ash/ American elm/ red maple
702	River birch/ sycamore
703	Cottonwood
704	Willow
705	Sycamore/ pecan/ American elm
706	Sugarberry/ hackberry/ elm/ green ash
707	Silver maple / American elm
708	Red maple / lowland
709	Cottonwood/ willow
710	Oregon ash
801	Sugar maple/-beech-/ yellow birch
802	Black cherry
803	Cherry-ash-yellow poplar
805	Hard maple/ basswood
807	Elm/ ash/ upland
809	Red maple/ upland
901	Aspen
902	Paper birch
904	Balsam poplar
991	Paulownia
992	Melaluca
993	Eucalyptus
995	Other exotic hardwoods
999	Non stocked

Regeneration Status (SORI)

0	Natural
1	Artificial

Tree Density (DENS)

Code	Tree Density
1	Initial density class
2	Density class 2 - density different than 1
3	Density class 3 - density different than 1 and 2

Owner Class (OWNC)

Code	Owner Class

11 National Forest
12 National Grassland
13 Other Forest Service

21 National Park Service
22 Bureau of Land Management
23 Fish and Wildlife Service
24 Departments of Defense/Energy
25 Other Federal

31 State
32 Local (County, Municipality, etc.)
33 Other Non Federal Public

41 Corporate
42 Non Governmental Conservation/Natural Resources Organization
43 Unincorporated Local Partnerships/ Associations/Clubs
44 Native American (Indian)
45 Individual

NC Owner Acres (NCPA)

Code	Acres
1	1-4
2	5-9
3	10-19
4	20-49
5	50-99
6	100-499
7	500-2499
8	2500-4999
9	5000+

Private Owner Industrial Status (INDU)

Code	Owner Class
0	Land not owned by industrial owner
1	land owned by industrial owner

Disturbance (DIS1,2,3)

Code Distrurbance
00 None
10 Insects
20 Disease
30 Fire
- 31 Ground Fire
- 32 Crown Fire

40 Animal damage
- 41 Beaver
- 42 Porcupine
- 43 Deer/ungulate
- 46 Domestic animal/livestock

50 Weather
- 51 Ice
- 52 Wind
- 53 Flooding
- 54 Drought

70 Unknow/not sure / other
80 Human-caused

Treatment (TRE1,2,3)

Code	Treatment
00	None
10	Cutting
20	Site preparation
30	Artificial Regeneration
40	Natural Regeneration
50	Other silvicultural treatment

Physiographic Class (PHYS)

Code	Physiographic Class
11	Dry Tops.
12	Dry Slopes
13	Deep Sands
19	Other Xeric.
21	Flatwoods
22	Rolling Uplands
23	Moist Slopes and Coves
24	Narrow Floodplains/Bottomlands
25	Broad Floodplains/Bottomlands.
29	Other Mesic
31	Swamps/Bogs
32	Small Drains
33	Bays and wet pocosins
34	Beaver ponds.
35	Cypress ponds.
39	Other hydric.

Present nonforest land use (NFLU)

10 Agricultural land
- 11 Cropland
- 12 Pasture
- 13 Idle farmland
- 14 Orchard
- 15 Christmas tree plantation

20 Rangeland
30 Developed
- 31 Cultural
- 32 Rights-of-way
- 33 Recreation

40 Other

NC Land USE (NCLU)

Code	Land Use
20	Timberland
21	Pastured Timberland
22	Plantations
40	Unproductive forest land
41	Reserved forest land-unproductive
45	Reserved forest land-productive
57	Wide windbreaks (> 120’)
59	Wooded pasture
46	Christmas tree plantations
50	Reserved nonforest with trees
51	Cropland with trees
52	Improved pasture w/ trees
53	Wooded strip (natural)
54	Idle farmland with trees
55	Marsh with trees
56	Narrow windbreaks (< 120’)
58	Shelterbelt
71	Urban forest land
72	Urban and other with trees
61	Cropland
62	Improved pasture
64	Idle farmland
65	Marsh
66	Other farmland
67	Urban and other areas
68	Rights-of-way
69	Nonforest (reserved)
80	Noncensus water
89	Noncensus water (reserved)
90	Census water
96	Inaccessible
99	Denied access

Tree Data

Plot Type/NC Plot Type (TYPE)

1 subplot
2 microplot

Condition Number (CON#)

Record the condition number that the tree is a part of.

Previous Tree Status (PAST)

1 Live tree
2 Dead tree

Present Tree Status (TRST)

0 No history
1 Live tree
2 Dead tree
3 Removal

Reconcile (RECO)

1 Ingrowth
2 Through growth
3 Missed live
4 Missed dead
5 Shrank
6 Missing
7 Cruiser error
8 Procedural change

Azimuth (AZM)

Record as compass degrees

Standing Dead (DEAD)

0 No
1 Yes

Diameter Check (DCHE)

0 Measured accurately
1 Estimated
2 Different location

Some have been removed for space.

Tree Species (SPP)

0010 fir spp.
0012 balsam fir
0016 Fraser fir
0043 Atlantic white-cedar
0057 redcedar / juniper spp.
0061 Ashe juniper
0066* Rocky Mountain juniper
0067 southern redcedar
0068 eastern redcedar
0071 tamarack (native)
0090 spruce spp.
0091 Norway spruce
0093 Engelmann spruce
0094 white spruce
0095 black spruce
0096 blue spruce
0097 red spruce
0100 pine spp.
0105 jack pine
0108 lodgepole pine
0110 shortleaf pine
0113 limber pine
0115 spruce pine
0122 ponderosa pine
0123 Table Mountain pine
0125 red pine
0126 pitch pine
0129 eastern white pine
0130 Scotch pine
0131 loblolly pine
0132 Virginia pine
0136 Austrian pine
0202 Douglas-fir
0220 cypress spp.
0221 baldcypress
0222 pondcypress
0241 northern white-cedar
0260 hemlock spp.
0261 eastern hemlock
0262 Carolina hemlock
0299 Unknown conifer

0310 maple spp.
0313 Boxelder
0314 black maple
0315* striped maple
0316 red maple
0317 silver maple
0318 sugar maple
0319* Mountain maple
0320 Norway maple
0321 Rocky Mountain maple
0323 chalk maple
0330 buckeye, horsechestnut spp.
0331 Ohio buckeye
0332 yellow buckeye
0336 red buckeye
0337 painted buckeye
0341* ailanthus
0345* mimosa/silktree
0355 European alder
0356* serviceberry spp.
0357* common serviceberry
0358* roundleaf serviceberry
0367* Pawpaw
0370 birch spp.
0371 yellow birch
0372 sweet birch
0373 river birch
0374 Water birch
0375 paper birch
0377 Virginia roundleaf birch
0379 gray birch
0381* Chittamwood/gum bumelia
0391* American hornbeam, musclewood
0400 hickory spp.
0401 water hickory
0402 bitternut hickory
0403 pignut hickory
0404 pecan
0405 shellbark hickory
0406 nutmeg hickory
0407 shagbark hickory
0408 black hickory
0409 mockernut hickory
0410 sand hickory
0411 scrub hickory
0412 red hickory
0413 southern shagbark hickory
0420 chestnut spp.
0421 American chestnut
0422 Allegheny chinkapin
0423 Ozark chinkapin
0424 Chinese chestnut
0450 catalpa spp.
0451 southern catalpa
0452 northern catalpa
0460 hackberry spp.
0461 sugarberry
0462 hackberry
0463 netleaf hackberry
0471* eastern redbud
0481 yellowwood
0491 flowering dogwood
0500* hawthorn spp.
0501* cockspur hawthorn
0502* downy hawthorn
0503* Brainerd hawthorn
0504* pear hawthorn
0505* Fireberry hawthorn
0506* broadleaf hawthorn
0507* fanleaf hawthorn
0508* Oneseed hawthorn
0509* scarlet hawthorn
5091* Washington hawthorn
5092* fleshy hawthorn
5093* dwarf hawthorn
0521 common persimmon
0531 American beech
0540 ash spp.
0541 white ash
0543 black ash
0544 green ash
0545 pumpkin ash
0546 blue ash
0548 Carolina ash
0549 Texas ash
0550 locust spp.
0551 water locust
0552 honeylocust
0555 loblolly bay
0561 Ginkgo, maidenhair tree
0571 Kentucky coffeetree
0580 silverbell spp.
0581 Carolina silverbell
0582 two-wing silverbell
0583 little silverbell
0591 American holly
0600 walnut spp.
0601 butternut
0602 black walnut
0605 Texas walnut
0611 sweetgum
0621 yellow-poplar
0641* Osage-orange
0650 magnolia spp.
0651 cucumbertree
0652 southern magnolia
0653 sweetbay
0654 bigleaf magnolia
0655 mountain or Fraser magnolia
0657 pyramid magnolia
0658 umbrella magnolia
0660* apple spp.
0662* southern crabapple
0663* sweet crabapple
0664* prairie crabapple
0680 mulberry spp.
0681 white mulberry
0682 red mulberry
0684 black mulberry
0690 tupelo spp.
0691 water tupelo
0692 Ogeechee tupelo
0693 blackgum
0694 swamp tupelo
0701* eastern hophornbeam
0711 sourwood
0712 paulownia, empress-tree
0721 redbay
0722 water-elm, planertree

0731	American sycamore
0740	cottonwood and poplar spp.
0741	balsam poplar
0742	eastern cottonwood
0743	bigtooth aspen
0744	swamp cottonwood
0745	plains cottonwood
0746	quaking aspen
0747	black cottonwood
0748	Fremont's cottonwood
0749	narrowleaf cottonwood
0752	silver poplar
0753	Lombardy poplar
0760	cherry and plum spp.
0761*	pin cherry
0762	black cherry
0763*	common chokecherry
0764*	peach
0765*	Canada plum
0766*	American plum
0769*	Allegheny plum
0770*	Chickasaw plum
0771*	sweet cherry, domesticated
0772*	sour cherry, domesticated
0773*	European plum, domesticated
0774*	Mahaleb plum, domesticated
0800	oak – deciduous spp.
0802	white oak
0804	swamp white oak
0806	scarlet oak
0808	Durand oak
0809	northern pin oak
0812	southern red oak
0813	cherrybark oak
0816	scrub oak
0817	shingle oak
0819	turkey oak
0820	laurel oak
0822	overcup oak
0823	bur oak
0824	blackjack oak
0825	swamp chestnut oak
0826	chinkapin oak
0827	water oak
0828	Nuttall oak
0830	pin oak
0831	willow oak
0832	chestnut oak
0833	northern red oak
0834	Shumard's oak
0835	post oak
0836	Delta post oak
0837	black oak
0838	live oak
0840	dwarf post oak
0841	dwarf live oak
0842	bluejack oak
0844	Oglethorpe oak
0845	dwarf chinkapin oak
0846	gray oak
0847	netleaf oak
0901	black locust
0919	western soapberry
0920	willow spp.
0921*	peachleaf willow
0922	black willow
0923	Bebb willow
0925	coastal plain willow
0926	balsam willow
0927	white willow
0929	weeping willow
0931	sassafras
0934	mountain ash spp.
0935*	American mountain ash
0936	European mountain ash
0937	northern mountain ash
0940	mahogany
0950	basswood spp.
0951	American basswood
0952	white basswood
0953	Carolina basswood
0970	elm spp.
0971	winged elm
0972	American elm
0973	cedar elm
0974	Siberian elm
0975	slippery elm
0976	September elm
0977	rock elm
0986	black mangrove
0987	buttonwood mangrove
0988	white mangrove
0989	American mangrove
0991	saltcedar
0992	melaleuca
0993	chinaberry
0994	Chinese tallowtree
0995	tungoil tree
0996	smoketree
0997	Russian-olive
0998	unknown hardwood
0999	Other, or unknown tree

NC Tree Class/Decay Class (TCC)

20	Growing Stock
30	Rough Cull, Salvable, and Salvable-down
31	Short-log Cull
40	Rotten Cull
41	Solid
42	Solid punky
43	Punky
44	Disintegrating
45	Gone

Percent Rotten/Missing Cull (ROTT)

Record the percent rotten or missing cubic foot cull on all live and dead trees as a percent.

Total Lenth (THGT)

Record to the nearest 1.0 ft.
P2 – all live trees > or = 5.0 in
P3 – all live trees > or = 1.0 in

Actual Length (ACTU)

Record the actual length to the nearest 1.0 ft.
P2 – all live and standing dead tally trees > or = 5.0 in
P3 - – all live tally trees > or = 1.0 in
Only record for trees with broken or missing tops

Length Method (METH)

1. Total and actual lengths are field measured with a measurement instrument (e.g., clinometer, relascope)
2. Total length is visually estimated, actual length is measured with an instrument.
3. Total and actual lengths are visually estimated.

Crown Class(CCC)

1	Open Grown
2	Dominant
3	Codominant
4	Intermediate
5	Overtopped

Compacted Crown Ratio (CRC)

Record as percent

Damage Location (LOC1, 2)

0	No damage
1	Roots (exposed) and
2	Roots, stump, and lower bole
3	Lower bole
4	Lower and upper bole
5	Upper bole
6	Crownstem
7	Branches
8	Buds and Shoots
9	Foliage

Damage Type (DAM1, DAM2)

01	Canker, gall
02	Conks, fruiting bodies, and signs of advanced decay
03	Open wounds
04	Resinosis or gummosis
05	Cracks and seams
11	Broken bole or roots
12	Brooms
13	Broken or dead roots
20	Vines in the crown
21	Loss of apical dominance, dead terminal
22	Broken or dead
23	Excessive branching or brooms
24	Damaged Buds, shoots or foliage
25	Discoloration of Foliage
31	Other

Damage Severity (SEV1, SEV2)

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

Damage Agents (NCD1, 2)

000	Healthy
100	Insect defoliators
113	Gypsy Moth
130	Shoot and Branch Insects
140	Branch Gall Insects
150	Bole Borers
170	Bark Beetles
190	Root/Root Collar Insects
200	Roliage Diseases

210 Shoot Blights
220 Mistletoe
240 Bole Rusts
250 Bole Cankers
251 Eutypella Canker
252 Hypoxylon Canker
254 Nectria Canker
257 Butternut Canker
260 Stem Decay (heartrot)
271 Ash Yellows
281 Dutch Elm Disease
282 Oak Wilt
290 Root/Butt Rot
291 Annosus Root Rot
292 Armillaria Roo Rot
300 Weather
400 Animal Damage
500 Fire
800 Logging/TSI/Other human
860 Chemical

MN Damage Agents (NCD1,2)

000 Healthy
100 Insect defoliators
101 Budworms
110 Forest Tent Caterpillar
113 Gypsy Moth
130 Shoot and Branch Insects
131 White Pine Weevil
140 Branch Gall Insects
150 Bole Borers
170 Bark Beetles
190 Root/Root Collar Insects
200 Foliage Diseases
210 Shoot Blights
212 *Scleroderris*
220 Mistletoe
240 Bole Rusts
241 White Pine Blister Rust
250 Bole Cankers
251 *Eutypella* Canker
252 *Hypoxylon* Canker
254 *Nectria* Canker
257 Butternut Canker
260 Stem Decay (heartrot)
261 *Phellinus pini*
262 *Phellinus tremulae*
263 *Inonotus obliquus*
271 Ash Yellows
281 Dutch Elm Disease
282 Oak Wilt
290 Root/Butt Rot
291 *Annosus* Root Rot
292 *Armillaria* Root Rot
300 Weather
302 Wind
307 Flooding
309 Ice/Snow
400 Animal Damage
402 Moose/Elk/Deer
404 Beaver
409 Cattle/Domestic Livestock
500 Fire
800 Logging/TSI/Other human
811 Imbedded objects - wire, nails
850 Land Use Conversion
860 Chemical
900 Unknown/uncoded Dead
901 Unknown/uncoded Defoliation
902 Unknown/uncoded Discoloration
903 Unknown/uncoded Decline/Dieback
904 Unknown/uncoded Breakage
905 Unknown/uncoded Abnormal Growth or Form in Crown
906 Unknown/uncoded Canker
907 Unknown/uncoded Crack
908 Unknown/uncoded Abnormal Growth or Form on the Bole

Cause of Death (CAUS)

10 Insect
20 Disease
30 Fire
40 Animal
50 Weather
60 Vegetation
70 Unknown/not sure/other
80 Silvicultural or landclearing

Utilization Class (UTIL)

0 Not Utilized
1 Utilized (STAT=3 only)

NC Lower/Upper trunk curvature (LTRU/UTRU)

0 No curvature
1 moderate curvature
2 extreme curvature

Lower/Upper bark harvested (LHAR/UHAR)

0 No bark harvest
1 < 1 year
2 1 year and <3 years
3 3 years and <6 years
4 6 years and <10 years
5 >10 years

NC Lower/Upper surface features (LSUR/USUR)

1 Lichens and Moss
2 Branching
3 Coarse lenticels
4 Branch Scars
5 Blemishes
6 Fungus

NC Lower/Upper bark charater (LCHA/UCHA)

1 0-25%
2 26-50/%
3 51-75%
4 76-100%

NC Boughs Available (BAVA)

0 No boughs available
1 Boughs available

NC Boughs Harvested (BHAR)

0 Not used
1 Used

NC Bough Harvesting Guidelines (GUID)

0 Not used
1 Used

Decay Class (DECA)

Decay class stage (code)	Limbs and branches	Top	% Bark Remaining	Sapwood presence and condition*	Heartwood condition*
1	All present	Pointed	100	Intact; sound, incipient decay, hard, original color	Sound, hard, original color
2	Few limbs, no fine branches	May be broken	Variable	Sloughing; advanced decay, fibrous, firm to soft, light brown	Sound at base, incipient decay in outer edge of upper bole, hard, light to reddish brown
3	Limb stubs only	Broken	Variable	Sloughing; fibrous, soft, light to reddish brown	Incipient decay at base, advanced decay throughout upper bole, fibrous, hard to firm, reddish brown
4	Few or no stubs	Broken	Variable	Sloughing; cubical, soft, reddish to dark brown	Advanced decay at base, sloughing from upper bole, fibrous to cubical, soft, dark reddish brown
5	None	Broken	Less than 20	Gone	Sloughing, cubical, soft, dark brown, OR fibrous, very soft, dark reddish brown, encased in hardened shell

TABLE OF HARDWOOD TREE GRADES FOR FACTORY LUMBER

Grade factor	Grade 1			Grade 2		Grade 3
Length of grading zone (feet)	Butt 16			Butt 16		Butt 16
Length of grading section [a] (feet)	Best 12			Best 12		Best 12
DBH, minimum (inches)	16[b]			13		11
Diameter, minimum inside bark at top of grading section (inches)	13[b]	16	20	11[c]	12	8
Clear cuttings (on the 3 best faces)[d]						
Length, minimum (feet)	7	5	3	3	3	2
Number on face (maximum)		2		2	3	[e]
Yield in face length (minimum)		5/6		4/6		3/6
Cull deduction (including crook and sweep, but excluding shake) maximum within grading section (percent)		9		9[f]		50

a Whenever a 14- or 16-foot section of the butt 16-foot log is better than the best 12-foot section, the grade of the longer section will become the grade of the tree. This longer section, when used, is the basis for determining the grading factors such as diameter and cull deduction.

b In basswood and ash, DIB at top of grading section must be 12 inches and DBH must be 15 inches.

c Grade 2 trees can be 10 inches DIB at top of grading section if otherwise meeting surface requirements for small grade 1s.

d A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth of the surface of the grading section as divided lengthwise.

e Unlimited.

f Fifteen percent crook and sweep or 40 percent total cull deduction are permitted in grade 2, if size and surface of grading section qualify as grade 1. If rot shortens the required clear cuttings to the extent of dropping the butt log to grade 2, do not drop the tree grade to 3 unless the cull deduction for rot is greater than 40 %.

NOTE: The tree grading in this table is based on measuring DBH to the nearest inch, since FIA measures to the higher 10th of a inch use diameter classes, i.e. for grade 1, DBH can be 15.5" and for grade 2, DBH can be 12.5" for this table. Also FIA uses 11 inch as the minimum DBH to record tree grades so there only

FOREST SERVICE STANDARD SPECIFICATIONS FOR HARDWOOD CONSTRUCTION (GRADE 4) LOGS		
Position in tree		Butt & Upper.
Min. diameter, small end		8 inches +.
Min. length, without trim		8 feet +.
Clear cuttings		No requirements.
Sweep allowance, absolute		1/4 d.i.b. of small end for half logs, 1/2 d.i.b. for logs 16 feet long.
Sound surface defects permitted	Single knots	Any number, if no one knot has an average collar diameter over 1/3 of log diameter at point of occurrence.
	Whorled knots	Any number, if sum of collar diameters does not exceed 1/3 of the log diameter at point of occurrence.
	Holes	Any number provided none has a diameter over 1/3 of log diameter at point of occurrence and none extends over 3 inches into included timber.
Unsound defects permitted	Surface	Any number and size if they do not extend into included timber. If they do, they can't exceed size, number, and depth, or limits of sound knots.
	Interior	None allowed; log must be sound internally, but will permit 1 shake not to exceed 1/3 the scaling diameter and a longitudinal split not extending over 5 inches into the contained timber. No center rot.

FOREST SERVICE STANDARD GRADES FOR HARDWOOD FACTORY LUMBER LOGS									
Grading Factors*		Log grades							
		F1			F2				F3
Position in tree		Butts only	Butts & uppers		Butts & uppers				Butts & uppers
Scaling diameter, inches		13-15[b]	16-19	20+	11+[c]	12+			8+
Length without trim, feet		10+			10+	8-9	10-11	12+	8+
Required clear[d] cuttings of each of 3 best faces[e]	Min. length, feet	7	5	3	3	3	3	3	2
	Max. number	2	2	2	2	2	2	3	No limit
	Min. proportion of log length required in clear cutting	5/6	5/6	5/6	2/3	3/4	2/3	2/3	1/2
Maximum sweep & crook allowance	For logs with less than 1/4 of end in sound defects	15%			30%				50%
	For logs with more than 1/4 of end in sound defects	10%			20%				35%
Maximum scaling deduction		40%[f]			50%[g]				50%

[a] From USDA Forest Service Research FPL. 63
[b] Ash and Basswood butts can be 12 inches if otherwise meeting the requirements for small No. 1's
[c] Ten-inch logs of all species can be #2 if they if otherwise meeting the requirements for small No. 1's
[d] A Clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth the surface of the log as divided lengthwise.
[e] A face is ¼ of the surface of the log as divided lengthwise
[f] Otherwise No. 1 logs with 41-60 percent cull can be No. 2.
[g] Otherwise No. 2 logs with 51-60 percent cull can be No. 3.

Code	Limiting Factor
00	Not applicable, already a grade 1, all softwoods
10	Diameter
20	Length
30	Clear cuttings
40	Sweep and crook
50	Cull
60	Position in tree
70	Multiple factors
80	Diameter and clear cutting

EASTERN WHITE PINE SAW-LOG GRADE SPECIFICATIONS

GRADING FACTOR	LOG GRADE 1	LOG GRADE 2	LOG GRADE 3	LOG GRADE 4
1 MINIMUM SCALING	14[1]	6	6	6
2 MINIMUM LOG LENGTH (feet)	10[2]	8	8	8
3 MAXIMUM WEEVIL INJURY (number)	NONE	NONE	2 INJURIES[3]	NO LIMIT
4 MINIMUM FACE REQUIREMENTS	Two full length or four 50% length good faces.*4* (In addition, log knots on balance of faces shall not exceed size limitations of grade 2 logs.)	NO GOOD FACES REQUIRED. Maximum diameter of log knots on three best faces: SOUND RED KNOTS not to exceed 1/6 scaling diameter and 3 inch maximum. DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/12 scaling diameter and 1 1/2 inch maximum.	SOUND RED KNOTS not to exceed 1/3 scaling diameter and 5 inch maximum. DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/6 scaling diameter and 2 1/2 inch maximum	Includes all logs not qualifying for No. 3 or better and judged to have at least one third of their gross volume in sound wood suitable for manufacture into standard lumber.
5 MAXIMUM SWEEP OR CROOK ALLOW-ANCE (percent)	20	30	40	66 2/3
6 MAXIMUM TOTAL SCALING DEDUC-TION (percent)	50	50	50	66 2/3

After the tentative log grade is established from face examination, the log will be reduced in grade whenever the following defects are evident:

7 CONKS, PUNK KNOTS, AND PINE BORER DAMAGE ON BARK SURFACE[5]

Degrade one grade if present on one face
Degrade two grades if present on two faces
Degrade three grades if present on three or more faces

8 LOG END DEFECTS: RED ROT, RING SHAKE, HEAVY STAIN AND PINE BORER DAMAGE OUTSIDE THE HEART CENTER OF THE LOG [5]

Consider log as having a total of 8 quarters (4 on each end) and degrade as indicated below:
Degrade one grade if present in 2 quarters of log ends.
Degrade two grades if present in 3 or 4 quarters of log ends.
Degrade three grades if present in 5 or more quarters of log ends.

1 12 and 13 inch logs with four full length good faces are acceptable.
2 8 foot logs with four full length good faces are acceptable.
3 8 foot Number 3 logs limited to one weevil injury.
4 Minimum 50% length good face must be at least 6 feet.
5 Factors 7 and 8 are not cumulative (total degrade based on more serious of the two). No log to be degraded below grade 4 if net scale is at least one third of gross scale.

WHITE PINE COLLAR DIAMETER LIMITS FOR RED AND BLACK KNOTS				
SCALING	GRADE 1 AND 2		GRADE 3	
DIAMETER (D.I.B. inches)	BLACK KNOTS 1/12th	RED KNOTS 1/6th	BLACK KNOTS 1/6th	RED KNOTS 1/3rd
7	7/12"	1 - 1/6"	1 - 1/6"	2 - 1/3"
8	2/3"	1 - 1/3"	1 - 1/3"	2 - 2/3"
9	3/4"	1 - 1/2"	1 - 1/2"	3"
10	5/6"	1 - 2/3"	1 - 2/3"	3 - 1/3"
11	11/12"	1 - 5/6"	1 - 5/6"	3 - 2/3"
12	1"	2"	2"	4"
13	1 - 1/12"	2 - 1/6"	2 - 1/6"	4 - 1/3"
14	1 - 1/6"	2 - 1/3"	2 - 1/3"	4 - 2/3"
15	1 - 1/4"	2 - 1/2"	**2 - 1/2" MAX**	**5" MAX**
16	1 - 1/3"	2 - 2/3"		
17	1 - 5/12"	2 - 5/6"		
18	**1 - 1/2" MAX**	**3 MAX"**		

LOG GRADES FOR SOFTWOOD LOGS

Grade 1

1. Logs must be 16" d.i.b. or larger, 10' or longer, and with deduction for defect, not over 30 %of gross scale.
2. Logs must be at least 75 % clear on each of three faces.
3. All knots outside clear cutting must be sound and not over 2 1/2" large.

Grade 2

1. Logs must be 12" d.i.b. or larger, 10' or longer, and with a net scale after deduction for defect of at least 50 % of the gross contents of the log.
2. Logs must be at least 50 % clear on each of three faces or 75 % clear on 2 faces.

Grade 3

1. Logs must be 6" d.i.b. or larger, 8' or longer, and with a net scale after deduction for defect of at least 50 % of the gross contents of the log.

Notes: Diameters are d.i.b. at small end of log
% clear refers to % clear in one continuous section

JACK PINE AND RED PINE LOG GRADES

GRADE 1 Logs with 3 or 4 clear faces *
GRADE 2 Logs with 1 or 2 clear faces.
GRADE 3 Logs with no clear faces.

After the tentative log grade is established from above, the log will be degraded one grade for each of the following defects, except that no log can be degraded below grade 3. Net scale after deduction for defect must be at least 50 percent of the gross contents of the log.

1. **SWEEP** Degrade any tentative 1 or 2 log one grade if sweep amounts to 3 or more inches and equals or exceeds one third the diameter inside bark at the small end.

2. **HEART ROT** Degrade any tentative 1 or 2 log one grade if conk, massed hyphae, or other evidence of advanced heart rot is found anywhere in the log.

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* A face is one fourth of the circumference in width extending the full length of the log. Clear faces are those free of: knots measuring more than 1/2 inch in diameter, overgrown knots of any size, and holes more than 1/4 inch in diameter. Faces may be rotated to obtain the maximum number of clear ones.

SOUTHERN PINE TREE GRADES

Always grade the bottom 16-foot log, or the first merchantable log 12 feet or longer in the tree.

Clear face - free of knots measuring more than 1/2 inch in diameter, overgrown knots of any size, holes more than 1/4 inch in diameter. The faces may be rotated if necessary to obtain the maximum number of clear ones.

Overgrown knot - a knot overgrown and buried beneath the log surface, but indicated by a surface bump or distribution of bark pattern.

Tentative Grades

Grade 1 - trees with 3 or 4 clear faces
Grade 2 - trees with 1 or 2 clear faces
Grade 3 - trees with no clear faces

Degrade for Sweep or Heart Rot

(1) Degrade any tentative grade 1 or 2 tree one grade if sweep in the lower 12 feet of the grading sections amount to 3 or more inches and equals or exceeds one-fourth the DBH.

(2) Degrade any tentative 1 or 2 tree one grade if conks, punk knots, or otherwise evidence of advanced heart rot is found anywhere on the tree stem.

1995, FIA-SE

	Two Variable Cubic Foot Lookup Volume Table																	
	MERCHANTABLE HEIGHT (FEET)																	
DBH	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
5	1.0	1.1	1.3	1.5	1.6	1.8	1.9	2.1	2.2	2.4	2.5	2.7	2.8	2.9	3.1	3.2	3.3	3.4
6	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.7	3.9	4.1	4.3	4.4	4.6
7	1.8	2.1	2.3	2.6	2.9	3.1	3.4	3.6	3.9	4.1	4.4	4.6	4.8	5.1	5.3	5.5	5.8	6.0
8	2.3	2.6	2.9	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.5	5.8	6.1	6.4	6.7	7.0	7.3	7.6
9	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.5	5.9	6.3	6.7	7.1	7.4	7.8	8.2	8.6	8.9	9.3
10	3.3	3.8	4.3	4.8	5.3	5.7	6.2	6.6	7.1	7.6	8.0	8.5	9.0	9.4	9.9	10.3	10.8	11.3
11	4.0	4.5	5.1	5.6	6.2	6.8	7.3	7.9	8.4	9.0	9.5	10.1	10.6	11.2	11.7	12.3	12.8	13.4
12	4.6	5.3	5.9	6.6	7.2	7.9	8.5	9.2	9.8	10.5	11.1	11.8	12.4	13.1	13.7	14.4	15.0	15.7
13	5.3	6.1	6.8	7.6	8.3	9.1	9.8	10.6	11.3	12.1	12.8	13.6	14.4	15.1	15.9	16.7	17.4	18.2
14	6.0	6.9	7.8	8.6	9.5	10.4	11.2	12.1	13.0	13.8	14.7	15.6	16.5	17.3	18.2	19.1	20.0	20.9
15	6.8	7.8	8.8	9.8	10.7	11.7	12.7	13.7	14.7	15.7	16.7	17.7	18.7	19.7	20.7	21.7	22.8	23.8
16	7.6	8.7	9.8	11.0	12.2	13.2	14.3	15.4	16.5	17.7	18.8	19.9	21.1	22.2	23.4	24.5	25.7	26.9
17	8.5	9.7	11.0	12.2	13.5	14.7	16.0	17.2	18.5	19.7	21.0	22.3	23.6	24.9	26.2	27.5	28.8	30.1
18	9.4	10.8	12.2	13.6	14.9	16.3	17.7	19.1	20.5	22.0	23.4	24.8	26.2	27.7	29.1	30.6	32.1	33.6
19	10.3	11.9	13.4	14.9	16.5	18.0	19.6	21.1	22.7	24.3	25.9	27.4	29.0	30.6	32.3	33.9	35.6	37.2
20	11.3	13.0	14.7	16.4	18.1	19.8	21.5	23.3	25.0	26.7	28.5	30.2	32.0	33.8	35.6	37.4	39.2	41.0
21	12.3	14.2	16.1	17.9	19.8	21.7	23.6	25.5	27.4	29.3	31.2	33.1	35.1	37.0	39.0	41.0	43.0	45.1
22	13.4	15.5	17.5	19.5	21.6	23.6	25.7	27.8	29.9	31.9	34.1	36.2	38.3	40.5	42.6	44.8	47.0	49.3
23	14.5	16.7	19.0	21.2	23.4	25.7	27.9	30.2	32.5	34.7	37.0	39.3	41.7	44.0	46.4	48.8	51.2	53.6
24	15.7	18.1	20.5	22.9	25.4	27.8	30.2	32.7	35.2	37.6	40.1	42.7	45.2	47.7	50.3	52.9	55.6	58.2
25	16.9	19.5	22.1	24.7	27.4	30.0	32.7	35.3	38.0	40.7	43.4	46.1	48.9	51.6	54.4	57.2	60.1	63.0
26	18.1	20.9	23.8	26.6	29.4	32.3	35.1	38.0	40.9	43.8	46.7	49.7	52.7	55.7	58.7	61.7	64.8	67.9
27	19.4	22.4	25.5	28.5	31.6	34.7	37.7	40.8	43.9	47.1	50.2	53.4	56.6	59.8	63.1	66.4	69.7	73.1
28	20.7	24.0	27.3	30.5	33.8	37.1	40.4	43.7	47.1	50.4	53.8	57.2	60.7	64.2	67.7	71.2	74.8	78.4
29	22.1	25.6	29.1	32.6	36.1	39.6	43.2	46.8	50.3	53.9	57.6	61.2	64.9	68.6	72.4	76.2	80.0	83.9
30	23.5	27.2	31.0	34.7	38.5	42.3	46.1	49.9	53.7	57.6	61.4	65.3	69.3	73.3	77.3	81.4	85.5	89.6
31	25.0	28.9	32.9	36.9	40.9	45.0	49.0	53.1	57.2	61.3	65.4	69.6	73.8	78.1	82.4	86.7	91.1	95.5
32	26.4	30.7	34.9	39.2	43.5	47.8	52.1	56.4	60.7	65.1	69.5	74.0	78.5	83.0	87.6	92.2	96.9	101.6
33	28.0	32.5	37.0	41.5	46.1	50.6	55.2	59.8	64.4	69.1	73.8	78.5	83.3	88.1	92.9	97.9	102.8	107.8
34	29.6	34.3	39.1	43.9	48.7	53.6	58.4	63.3	68.2	73.2	78.1	83.2	88.2	93.3	98.5	103.7	109.0	114.3
35	31.2	36.2	41.3	46.4	51.5	56.6	61.7	66.9	72.1	77.4	82.6	87.9	93.3	98.7	104.2	109.7	115.3	120.9
36	32.8	38.2	43.6	48.9	54.3	59.7	65.2	70.6	76.1	81.7	87.2	92.0	98.5	104.3	110.0	115.9	121.8	127.8
37	34.6	40.2	45.9	51.5	57.2	62.9	68.7	74.4	80.2	86.1	92.0	97.9	103.9	110.0	116.1	122.2	128.5	134.8
38	36.3	42.3	48.2	54.2	60.2	66.2	72.3	78.3	84.5	90.6	96.8	103.1	109.4	115.8	122.2	128.8	135.3	142.0
39	38.1	44.4	50.6	56.9	63.2	69.6	76.0	82.4	88.8	95.3	101.8	108.4	115.1	121.8	128.6	135.4	142.4	149.4
40	39.9	46.5	53.1	59.7	66.4	73.0	79.7	86.5	93.2	100.1	107.0	113.9	120.9	127.9	135.1	142.3	149.6	157.0

Two Variable Cubic Foot Lookup Volume Table

	MERCHANTABLE HEIGHT (FEET)																	
DBH	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**	**62**	**64**	**66**	**68**	**70**	**72**	**74**	**76**	**78**	**80**
5	3.6	3.7	3.9	4.0	4.1	4.2	4.3	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.9	5.0	5.1	5.2
6	4.9	5.1	5.3	5.4	5.6	5.7	5.9	6.0	6.2	6.3	6.5	6.6	6.8	6.9	7.1	7.2	7.4	7.5
7	6.4	6.7	6.9	7.1	7.3	7.6	7.8	8.0	8.2	8.4	8.7	8.9	9.1	9.3	9.5	9.8	10.0	10.2
8	8.2	8.4	8.7	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.4	11.7	12.1	12.4	12.7	13.0	13.3
9	10.1	10.4	10.8	11.2	11.6	12.0	12.4	12.7	13.1	13.5	13.9	14.3	14.7	15.1	15.6	16.0	16.4	16.8
10	12.2	12.7	13.1	13.6	14.1	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.1	18.6	19.1	19.6	20.2	20.7
11	14.5	15.1	15.7	16.2	16.8	17.4	18.0	18.6	19.2	19.8	20.4	21.1	21.7	22.3	23.0	23.7	24.3	25.0
12	17.1	17.7	18.4	19.1	19.8	20.5	21.2	22.0	22.7	23.4	24.2	24.9	25.7	26.5	27.2	28.0	28.9	29.7
13	19.8	20.6	21.4	22.2	23.1	23.9	24.7	25.6	26.4	27.3	28.2	29.1	30.0	30.9	31.9	32.8	33.8	34.8
14	22.8	23.7	24.6	25.6	26.5	27.5	28.5	29.5	30.5	31.5	32.5	33.6	34.6	35.7	36.8	37.9	39.1	40.2
15	25.9	27.0	28.1	29.2	30.3	31.4	32.5	33.7	34.8	36.0	37.2	38.4	39.6	40.9	42.1	43.4	44.7	46.1
16	29.3	30.5	31.7	33.0	34.2	35.5	36.8	38.1	39.4	40.8	42.1	43.5	44.9	46.4	47.8	49.3	50.8	52.3
17	32.8	34.2	35.6	37.0	38.4	39.9	41.4	42.8	44.3	45.9	47.4	49.0	50.6	52.2	53.9	55.5	57.2	59.0
18	36.6	38.2	39.7	41.3	42.9	44.5	46.2	47.8	49.5	51.3	53.0	54.8	56.6	58.4	60.2	62.1	64.1	66.0
19	40.6	42.3	44.1	45.8	47.6	49.4	51.3	53.1	55.0	56.9	58.9	60.9	62.9	64.9	67.0	69.1	71.3	73.4
20	44.8	46.7	48.6	50.6	52.6	54.6	56.6	58.7	60.8	62.9	65.1	67.3	69.5	71.8	74.1	76.4	78.8	81.3
21	49.2	51.3	53.4	55.6	57.8	60.0	62.3	64.5	66.9	69.2	71.6	74.0	76.5	79.0	81.6	84.1	86.8	89.5
22	53.8	56.1	58.5	60.8	63.2	65.7	68.1	70.7	73.2	75.8	78.4	81.1	83.8	86.6	89.4	92.2	95.1	98.1
23	58.6	61.1	63.7	66.3	68.9	71.6	74.3	77.0	79.8	82.7	85.5	88.5	91.4	94.5	97.5	100.7	103.8	107.1
24	63.6	66.4	69.2	72.0	74.9	77.8	80.7	83.7	86.8	89.8	93.0	96.2	99.4	102.7	106.1	109.5	112.9	116.5
25	68.9	71.8	74.9	77.9	81.1	84.2	87.4	90.7	94.0	97.3	100.7	104.2	107.7	111.3	114.9	118.7	122.4	126.3
26	74.3	77.5	80.8	84.1	87.5	90.9	94.4	97.9	101.5	105.1	108.8	112.5	116.4	120.2	124.2	128.2	132.3	136.4
27	79.9	83.4	86.9	90.5	94.2	97.8	101.6	105.4	109.2	113.2	117.1	121.2	125.3	129.5	133.8	138.1	142.5	147.0
28	85.8	89.5	93.3	97.2	101.1	105.1	109.1	113.2	117.3	121.5	125.8	130.2	134.6	139.1	143.7	148.4	153.1	158.0
29	91.8	95.8	99.9	104.1	108.3	112.5	116.8	121.2	125.7	130.2	134.8	139.5	144.3	149.1	154.0	159.0	164.1	169.3
30	98.1	102.4	106.7	111.2	115.7	120.2	124.9	129.6	134.3	139.2	144.1	149.1	154.2	159.4	164.7	170.1	175.5	181.1
31	104.5	109.1	113.8	118.5	123.3	128.2	133.1	138.2	143.3	148.4	153.7	159.1	164.5	170.1	175.7	181.4	187.3	193.2
32	111.2	116.1	121.1	126.1	131.2	136.4	141.7	147.0	152.5	158.0	163.6	169.3	175.1	181.1	187.1	193.2	199.4	205.8
33	118.1	123.3	128.6	134.0	139.4	144.9	150.5	156.2	162.0	167.9	173.9	179.9	186.1	192.4	198.8	205.3	212.0	218.7
34	125.2	130.7	136.3	142.0	147.8	153.7	159.6	165.7	171.8	178.0	184.4	190.8	197.4	204.1	210.9	217.8	224.9	232.0
35	132.5	138.3	144.3	150.3	156.4	162.6	169.0	175.4	181.9	188.5	195.2	202.1	209.0	216.1	223.3	230.7	238.1	245.8
36	140.0	146.2	152.5	158.8	165.3	171.9	178.6	185.4	192.3	199.3	206.4	213.6	221.0	228.5	236.1	243.9	251.8	259.9
37	147.7	154.2	160.9	167.6	174.5	181.4	188.5	195.6	202.9	210.3	217.8	225.5	233.3	241.2	249.3	257.5	265.9	274.4
38	155.6	162.5	169.5	176.6	183.8	191.2	198.6	206.2	213.9	221.7	229.6	237.7	245.9	254.3	262.8	271.5	280.3	289.3
39	163.7	171.0	178.4	185.9	193.5	201.2	209.0	217.0	225.1	233.3	241.7	250.2	258.9	267.7	276.7	285.8	295.1	304.6
40	172.0	179.7	187.5	195.3	203.3	211.5	219.7	228.1	236.6	245.3	254.1	263.1	272.2	281.4	290.9	300.5	310.3	320.2

Cubic Foot Volume of Short Logs										
	Log length (feet)									
DOB midpoint	1	2	3	4	5	6	7	8	9	10
5	.3	.4	.5	.6	.7	.8	.9	1.0	1.0	1.1
6	.3	.5	.6	.8	.9	1.0	1.2	1.3	1.5	1.6
7	.4	.6	.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
8	.5	.7	1.0	1.3	1.5	1.8	2.1	2.4	2.6	2.8
9	.5	.9	1.2	1.6	1.9	2.3	2.6	3.0	3.3	3.6
10	.5	1.0	1.4	1.9	2.4	2.9	3.4	3.9	4.4	4.8
11	.8	1.3	1.8	2.4	2.9	3.4	4.0	4.5	5.0	5.5
12	.8	1.4	2.2	2.9	3.6	4.3	5.0	5.7	6.4	7.1
13	1.1	1.8	2.6	3.4	4.1	4.9	5.6	6.4	7.1	7.8
14	1.1	2.1	3.0	4.0	5.0	5.9	6.9	7.8	8.8	9.7
15	1.5	2.5	3.5	4.5	5.6	6.6	7.6	8.6	9.6	10.6
16	1.6	2.8	4.1	5.3	6.6	7.8	9.1	10.3	11.6	12.8
17	1.9	3.3	4.6	5.9	7.2	8.5	9.9	11.2	12.5	13.8
18	2.1	3.7	5.2	6.8	8.4	10.0	11.6	13.2	14.7	16.3
19	2.5	4.2	5.8	7.5	9.1	10.8	12.4	14.1	15.8	17.4
20	2.7	4.6	6.6	8.6	10.5	12.5	14.4	16.4	18.3	20.3
21	3.1	5.2	7.2	9.2	11.3	13.3	15.4	17.4	19.4	21.4
22	3.3	5.7	8.1	10.5	12.8	15.2	17.6	19.9	22.3	24.6
23	3.8	6.3	8.8	11.2	13.7	16.1	18.6	21.0	23.5	25.9
24	4.1	6.9	9.8	12.6	15.4	18.2	21.0	23.8	26.6	29.4
25	4.6	7.5	10.4	13.4	16.3	19.2	22.1	25.9	27.9	30.8
26	4.9	8.2	11.6	14.9	18.2	21.5	24.8	28.1	31.4	34.6
27	5.4	8.9	12.3	15.7	19.1	22.5	26.0	29.3	32.7	36.1
28	5.8	9.7	13.5	17.4	21.2	25.0	28.9	32.7	36.5	40.3
29	6.4	10.4	14.3	18.3	22.2	26.2	30.1	34.0	38.9	41.9
30	6.8	11.2	15.7	20.1	24.5	28.9	33.2	37.6	42.0	46.4

Board Foot volume of Short Logs

	Log length (feet)									
DOB midpoint	1	2	3	4	5	6	7	8	9	10
7	2	6	10	12	14	16	18	20	20	21
8	4	8	12	16	19	20	22	23	24	26
9	6	10	14	19	23	24	26	28	29	31
10	8	12	16	22	28	31	34	36	39	42
11	10	14	19	23	30	32	36	38	42	44
12	12	18	24	30	36	40	45	49	53	58
13	14	21	29	33	38	42	47	52	56	61
14	16	23	32	40	46	52	58	64	70	77
15	18	25	34	41	48	54	61	68	74	81
16	20	29	41	49	57	66	74	82	91	99
17	23	33	42	51	60	69	77	86	95	104
18	27	38	49	60	70	81	92	103	114	124
19	28	39	51	62	73	85	96	107	119	130
20	31	44	58	72	85	99	112	126	139	153
21	32	46	60	74	89	103	117	131	145	159
22	35	52	69	85	102	118	135	152	168	184
23	36	54	71	88	106	123	140	157	174	192
24	40	60	80	100	120	130	160	180	200	219
25	42	62	83	104	124	145	166	186	207	227
26	46	70	93	117	140	164	187	211	234	257
27	48	72	96	121	145	169	193	218	242	266
28	52	80	107	135	162	189	217	244	271	298
29	54	82	111	139	167	195	223	252	280	308
30	59	91	122	154	186	217	249	280	311	343

NC Appendix 11. Paper Birch Data Collection References

Characteristics of Wiigwaasi-mitig (Paper Birch, *Betula papyrifera* Marsh.), Karen C. Danielsen,Forest Ecologist and Stephen White, Jr.**,** Research Specialist**,** Project Report**,** USDA Forest Service Agreement #01-JV-11231300-OAS**,** April 2003**, Great Lakes Indian Fish & Wildlife Commission,** Biological Services Division**,** P.O. Box 9**,** Odanah, WI 54861**,** (715) 682-6619

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NC Appendix 12. NC PLOT DATA SHEETS (plotsheets)

State/Unit/County/Plot:

Page 1 of 2

Township Range Section Subdivision Cycle Subcycle Intensity Past Date Date (MM/DD/YYYY)

Sample Kind NC Sample Kind P3 Plot Cruiser Name & # Tallier Name & #

Starting Point Description:

Course to Sample Location
Direction: ____________
Distance to subplot: ____________

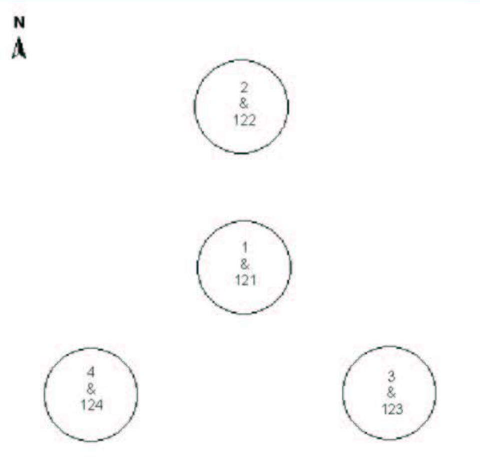
Starting Point Map (include N arrow on map): SP Latitude: ______ ° ______ ' SP Longitude: ______ ° ______ '

State/Unit/County/Plot:

Notes (plot, site tree):

Field:

Office:



Reference Trees:

Sub#	Spp	DBH	Dist	Azm	Mark

Contact name: ____________

Owner name: ____________

Address/phone: ____________

Comment: ____________

Type of contact: Personal _____ Phone _____ Other _____

2nd Annual Inventory Plotsheet c:\plotsheets\programs\version8\pscrw8.rpt Version 1.0 Created on 7/15/2003

State/Unit/County/Plot:

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	Date	Initials
Office edit		
Field edit		

Water Type	Road Distance	QA Status	Crew Type
X (WTYP)	X (RDIS)	X (QAST)	X (CTYP)

Lat/Long Record:

PC Latitude	PC Longitude	Elevation	GPS Unit	Error	Readings
DD MM.MMM(N:)	DDD MM.MMM (W:)	XXXXX (ELEV)	X-XXXXXX	XXX (ERR)	XXX (RDNG)

Plot Location:

PI Latitude o

PI Longitude o

GPS Latitude o

GPS Longitude

Condition Records:

Condition #	NC Land Use	Condition Status	Reserve Status	Physiographic	Regeneration Status	Artificial Regeneration Status	Cond N-Sampled Reason	Forest Type	Stand Size	Stand Age	Tree Density	Owner Group	Owner Class	NC Owner Acres	Industrial Status	Nonf Land Use	Disturbance 1	Disturbance Yr 1	Disturbance 2	Disturbance Yr 2	Disturbance 3	Disturbance Yr 3	Treatment 1	Treatment Yr 1	Treatment 2	Treatment Yr 2	Treatment 3	Treatment Yr 3
CON#	NCLU	STAT	RESV	PHYS				FTYP	STSZ	SAGE	DENS	OWNG	OWNC	NCPA	INDU	CLU	DIS1	DYR1	DIS2	DYR2	DIS3	DYR3	TRE1	TYR1	TRE2	TYR2	TRE3	TYR3
X	XX	X	X	XX	X	XXXX	XX	XXX	X	XXX	X	XX	XX	X	X	XX	XX	XXXX	XX	XXXX	XX	XXXX	XX	XXXX	XX	XXXX	XX	XXXX

Subplot Records:

Subplot #	Subplot/Annular Plot Status	Subplot Ctr Cond	Microplot Ctr Cond	Percent Slope	Aspect	Snow/Water Depth	Subplot N-sampled Reason
		SCEN	MCEN	SLOP	ASP	SWD	
XXX	X	X	X	XXX	XXX	XX	XX

Boundary Records:

Subplot #	Contrasting Cond	Plot Type	Percent Area	Left Azimuth	Right Azimuth	Corner Azimuth	Corner Distance	Boundary Change
	CCON	TYPE	%ARE	LAZM	RAZM	CAZM	CDIS	CHNG
XXX	X	X	XXX	XXX	XXX	XXX	XXX	X

Site Tree Records:

Tree #	DBH	Species	Length	Tree Age	Subplot#	Distance	Azimuth	Condition Nbr.	Next Available Site Tree #
TR#	DBH	SPP	HGHT	AGE	SUB#	DIST	AZM		5
XX	XXXX	XXX	XXX	XXX	XXX	XXX	XXX	XXXXX	XXX

2nd Annual Inventory Plotsheet c:\plotsheets\programs\version8\pscrw8.rpt Version 1.0 Created on 7/15/2003

STATE UNIT COUNTY PLOT# CYCLE SUB-CYCLE DATE

														Phase 3						Phase 3										TREE DAMAGE 1				TREE DAMAGE 2				
SUBPLOT NUMBER 5.1	TREE NUMBER 5.2	NC TREE TYPE 5.2NC	PRESENT TREE STATUS 5.7	DISTANCE 5.5	PRESENT DBH 5.9.2	LENGTH TO DBH 5.22	DIAMETER CHECK 5.10	STANDING DEAD 5.7.2	NC TREE CLASS 5.10NC	RECONCILE 5.7.1	MORTALITY 5.7.3	DECAY CLASS 5.21	COMPACTED CROWN RATIO 5.17	UNCOMPACTED CROWN RATIO	CROWN LIGHT EXPOSURE	CROWN POSITION	CROWN CLASS 5.15	AZIMUTH 5.4	CONDITION NUMBER 5.3	TRANSPARENCY	CROWN DENSITY	CROWN DIEBACK	TOTAL LENGTH 5.12	ACTUAL LENGTH 5.13	LENGTH METHOD 5.14	NC TREE GRADE 5.14NC	PERCENT CULL (ROTTEN/MISSING) 5.11	CAUSE OF DEATH 5.19	MORTALITY YEAR 5.20	LOCATION 5.18.1	DAMAGE TYPE 5.18.2	SEVERITY 5.18.3	NC DAMAGE AGENT 5.18NC	LOCATION 5.18.4	DAMAGE TYPE 5.18.5	SEVERITY 5.18.6	NC DAMAGE AGENT 5.18NC	Use the back of this sheet for any tree notes
XXX	XXX	X	X	XX.X	XXX	XXX	X	X	XX	X	X	X	XX	XX	X	X	X	XXX	X	XX	XX	XX	XXX	XXX	X	XXX	XX	XX	XXXX	X	XX	X	XXX	X	XX	X	XXX	

Balsam			Birch Bark							
NC BOUGHS AVAILABLE 5.26.1	NC BALSAM BOUGHS HARVESTED 5.26.2	NC BOUNGHS HARVESTING GUIDELINES 5.26.3	NC LOWER TRUNK CURVATURE 5.27.1	NC LOWER BARK HARVESTED 5.27.2	NC LOWER SURFACE FEATURES 5.27.3	NC LOWER BARK CHARACTER 5.27.4	NC UPPER TRUNK CURVATURE 5.27.5	NC UPPER BARK HARVESTED 5.27.6	NC UPPER SUFACE FEATURES 5.27.7	NC UPPER BARK CHARACTER 5.27.8
X	X	X	X	X	XXXXXX	XX	X	X	XXXXXX	X