

TREE AND SAPLING-LEVEL VARIABLES

Sampling Methods for Various Sizes and Types of Trees

1/24-Acre Subplot (Trees 5.0 Inches DBH and Larger)

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 forestland 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 growth, mortality, removals; coarse woody debris; wildlife habitats; forest structure and composition; biomass; and carbon sequestration.

6.8-Foot Radius Microplot (Trees 1.0-4.9 Inches DBH)

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 forestland 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 distance taken) to the subplot center.

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

Once tallied, dead trees over 5.0 inch diameter are tracked until they fall down. **Working around dead trees is a safety hazard – crews should exercise extreme caution! Trees that are deemed unsafe to measure should be noted as such and left alone.**

To qualify as a standing dead tally tree, dead trees must be standing (LEAN ANGLE = 0 or 1) with no part of the bole touching the ground, at least 4.5 feet in length and be at least 5.0 inches in diameter. **Broken portions of trees that are completely separated from their base are not treated as separate trees.**

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

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

Item 124 – Entry Number

The entry number is pre-printed on tally sheets (automatically created in PDRS). If an entry is crossed out or omitted for any reason subsequent entry numbers should be manually recorded over printed numbers for hard copy. (Field width: 3 digits, MQO: No errors 100% of the time, Values: 001 to 999)

Item 125 – Subplot Number (CORE)

Record the **subplot** number where the tree occurs (Field width: 1 digit; MQO: No errors, 100% of the time; Values: 1-4)

Subplot Codes	
<u>Code</u>	<u>Location</u>
1	Center
2	North
3	Southeast
4	Southwest

Item 126 – Tree Record Number (CORE)

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 edge. On remeasured plots, use the tree number assigned at the previous visit. 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. (Field width: 3 digits; MQO: No errors, 100% of the time; Values: 000, 001-999)

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. If the tree has grown into the plot since the previous field visit (not on the list), record 000.

Item 127 – Remeasurement Point #/Tree #

Record the 1 digit **point** number and the unique two-digit **tree** number that was recorded in the previous survey. **Never change the old point number or old tree number. Record two zeros (00) for tree number along with the point number when no remeasurement tally trees are present.** (Field width: 3 digits, MQO: No errors 100% of the time, Values: 100-599)

Item 128 – Condition Class (CORE)

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 (see figure below). (Field width: 1 digit, MQO: No errors 100% of the time, Values: 1-9)

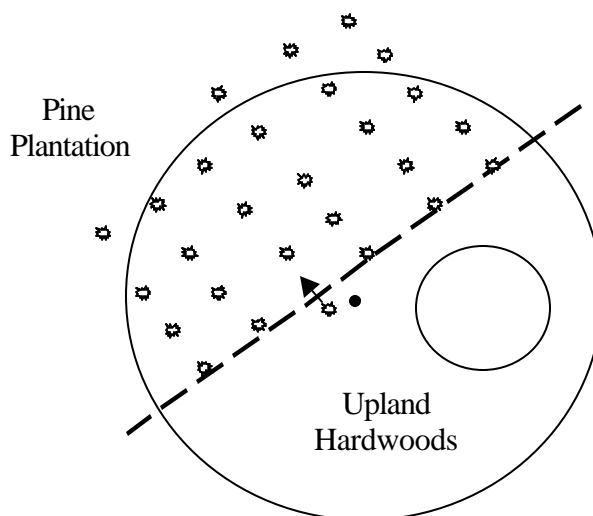


Figure: Ragged condition class boundary and tree condition class designation.

Item 129 – Azimuth (CORE)

Record the azimuth from the subplot center (for trees greater than or equal to 5.0 inches DBH) or the microplot center (for trees greater than or equal to 1.0 inch and less than 5.0 inches DBH), sight the center of the base of each tree with a compass. Trees (less than 5.0 inches) that are referenced to the microplot need to be re-referenced to the subplot when they become 5.0 inches DBH or larger. Record azimuth to the nearest degree. Use 360 for north. Begin tallying trees at an azimuth of 001 degree from subplot center and continue clockwise around the subplot or microplot. (Field width: 3 digits, MQO: +/- 3 degrees at least 90% of the time, Values: 001-360)

Item 130 – Horizontal Distance (CORE)

Record the measured horizontal distance, to the nearest one-tenth foot, from the subplot center (for trees greater than or equal to 5.0 inches DBH) or the microplot center (for trees greater than or equal to 1.0 inch and less than 5.0 inches DBH) to the pith of the tree at the base. Distance will be taken to any tree with an azimuth. Trees (less than 5.0 inches) that are referenced to the microplot need to be referenced to the subplot when they become 5.0 inches DBH or larger. (Field width: 3 digits, MQO: microplot +/-0.1 feet at least 90% of the time and subplot +/-0.2 feet at least 90% of the time, Values: microplot 000-068 and subplot 000-240)

Item 131 – Tree Status (CORE)

Record a current 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. (Field width: 2 digits; MQO: No error, 100% of time; Values: 01-13)

The following codes are used on new, replacement, and remeasured plots:

- 10 New Live tree - any live tree (1.0 to 4.9 inches DBH on microplots and 5.0 inches DBH and larger on subplots).
- 20 Dead tree – any standing dead tree (regardless of cause of death)

The following codes are only used on remeasured (sample kind 2) plots:

- 11 Survivor Tree – remeasured live tree (1.0 inch DBH and larger) where the tally tree is still in a forested condition.
- 12 Volume ingrowth – live tree 5.0 inches DBH and larger on the microplot tally (6.8 foot radius) and not recorded as a live tree 1.0 inch or larger in the previous survey. Make sure these trees have grown enough to fit this category and were not “missed” trees last survey. Use only on prism points 1 through 3. These trees have gone from seedlings to 5.0 inches.
- 21 Remeasured Dead Tree – remeasured dead tree (5.0 inches DBH and larger) where the tally tree is still in a forested condition.
- 30 Nonsalvable dead tree – nonsalvable dead tree 1.0 inch DBH or larger still in a forested condition recorded as a live tree on the previous survey.
- 31 Salvable dead tree – salvable dead tree 5.0 inches DBH or larger in a forested condition recorded as a live tree on previous survey.
- 32 Salvaged mortality – dead tree 1.0 inch DBH or larger in a forested condition recorded as a live tree on the previous survey and harvested for a product.

- 40 Timber Removal - a tree that has been cut or killed by direct human activity related to harvesting, or silvicultural activity. The tree may, or may not have been utilized. Only code trees killed by fire as removals if it was a prescribed burn.
- 41 Land-clearing removal – tree removed from forestland as a result of land-clearing activity. Tree may be standing (and alive) or cut and removed. The location of the tree will determine the tree status code.
- 42 Status-change removal – trees removed from timberland as a result of the reclassification of timberland to “reserved” or “other” forestland status.
- 50 Missed live tree - live at time of previous inventory, live now and should have been tallied by the previous cruiser.
- 51 Missed mortality tree - live at time of previous inventory, dead now and should have been tallied by the previous cruiser.
- 52 Missed dead tree - dead at time of previous inventory, dead now and should have been tallied by the previous cruiser.
- 60 No history - tree is not presently in the sample. Tree was incorrectly tallied at the previous survey, was physically moved off the plot (natural causes such as a landslide), or currently is not tallied due to definition or procedural change.

Note: For microplot trees (saplings) that become trees, crews must collect new azimuth and distance information from the subplot center.

Tree Status 70, 80, and 90 codes are used when unable to remeasure a plot or part of a plot.

- 70 Access denied - Any tree not remeasured due to denied access. No damage/death required
- 80 Inaccessible/hazardous conditions - Any tree not remeasured due to conditions that make occupying the subplot impossible, or conditions that might endanger crewmembers. No damage/death required.
- 90 Lost plot / Lost subplot - Any tree not remeasured because the subplot established in the previous survey could not be found. No damage/death required.

Item 132 – Lean Angle (CORE)

Record the code that describes the angle of lean of the live/dead tree (5.0 inches DBH or larger ONLY). Trees supported by other trees or by their own branches are considered standing.

Broken portions of trees that are completely separated from their base are not treated as separate trees. (Field width: 1 digit, MQO: No errors, 100% of the time, Values: 0-2)

- 0 Standing (less than 45 degrees of lean) live and dead trees.
- 1 Standing (more than 45 degrees of lean but not touching the ground) live and dead trees.
- 2 Down (some part of the bole touching the ground) live trees only.

Determination of lean angle can be calculated by hanging the cruiser stick plumb to the pith center of the tree base and estimating the angle between the top of the cruiser stick and the pith center of tree at that height.

Item 133 – Species (CORE)

Record the appropriate **tree species** code from the list in the Appendix. If you encounter a species not listed in the Appendix 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 the generic species code only when you encounter a tree where you know tree species but the species is not on the species list. Do not remeasure any shrubs recorded as trees on the previous survey. (Field width: 3 digits, MQO: No errors for genus 100% of the time, no errors for species at least 95% of the time, Values: see appendix)

Item 134 – Current Diameter (CORE)

Record the actual diameter for each tallied tree to the last 0.1 inch, at 4.5 feet, for all live trees 1.0 inch and larger and for standing dead trees 5.0 inches and larger. (Field width: 4 digits, MQO: +/-0.1 inch per 20.0 inches of diameter on trees with a measured diameter, at least 95% of the time. For example: a tree with a diameter of 41.0 inches would have a tolerance of plus or minus 0.3 inches; Values: 0010-9999)

For example, a 9.1 inch tree will be coded 0091.

It is important that DBH be accurately measured, as volume for trees will be calculated using DBH and Total Length.

Remeasurement trees:

The diameter measurement must be taken at the same point on the tree as the previous measurement, if possible. The point of diameter measurement should not be moved unless the crew cannot physically remeasure that point (e.g., forks converge, tree buried by mudslide).

If there was an obvious recording error in the previous measurement (e.g., past crew measured 31.0 but recorded 13.0), crews should estimate and record the appropriate past diameter in the “Tree Notes” item.

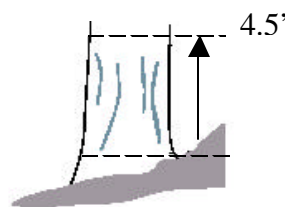
For trees on the 24.0 foot radius subplot, measure single-stemmed trees 5.0 inches in diameter or larger. For trees on the 6.8-foot radius microplot, measure single-stemmed trees between 1.0 inch and 4.9 inches in diameter.

Each cruiser will use a cruising stick (stick marked at 4.5 feet used to locate DBH) to measure DBH. Measure DBH at 4.5 feet above the ground unless one of the special DBH situations listed below is present.

Special DBH situations:

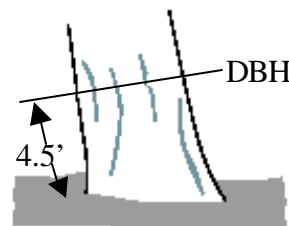
On slopes

Measure DBH at 4.5 feet from the ground along the bole on the *u* side of the tree.



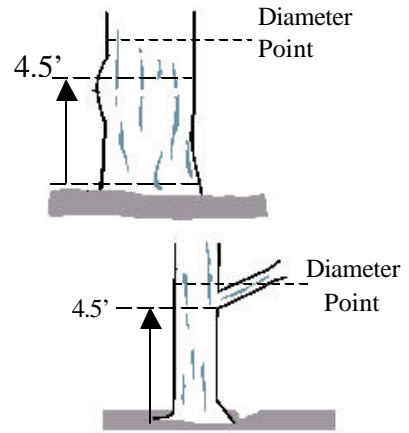
Leaning Trees

Measure diameter at 4.5 feet from the ground along the bole. The 4.5 feet distance is measured along the underside face of the bole.



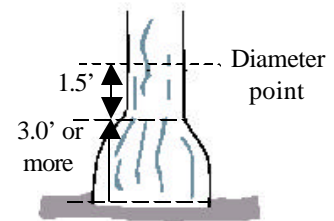
Tree with irregularities at DBH

On trees with swellings, bumps, depressions, branches, etc. at DBH, diameter will be measured immediately above the irregularity at the place where it ceases to affect the normal stem form. Record a diameter check code "1". Fence line trees containing or suspected of containing wire will be measured for diameter at the normal 4.5-foot height. For partially buried trees due to disturbance, some excavation may be necessary to determine the correct location for measuring DBH.



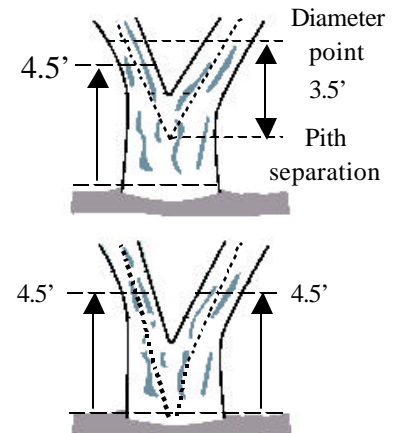
Swell-butted and bottleneck trees

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. If the measurement point cannot be reached, use a BAF prism or Penta-Prism to determine diameter outside bark (DOB). Aim the prism at the measurement point and move forward or backwards until a perfect split image is observed. Measure horizontal distance to the center of the tree at ground level. Look up the distance in the table of "variable plot limiting distances radii" to determine DOB of the tree and record diameter check code "1". When the measurement point is above 4.5 but can be reached on a fluted, flanged, swell-butted or bottleneck tree, measure the DBH and record the appropriate distance in "length to DBH". This procedure will usually be used for cypress and tupelo.



Forked trees

If the point of pith separation is at or above 4.5 feet, consider the tree as one tree. Measure the diameter below the swell, as near as possible to 4.5 feet above the ground on the uphill side and estimate DBH. If the point of pith separation is below 4.5 feet above the ground, but above 1.0 foot, consider each fork a separate tree. If more than two forks exist, use the two lower forks. For diameter measurement, measure up 3.5 feet above the point of pith separation. Use best judgment in estimating the DBH where a D-tape cannot be put around the bole. If DBH is estimated, record a diameter check code of "1". If the piths fork below 1 foot, both forks are treated as individual trees (DBH is taken at 4.5 feet).



To differentiate between a fork and limb, use the following guidelines:

Fork: 0-45 degree angles from the growing axis of the tree and must be at least 1/3 or greater diameter of the main stem.

Limb: >45-degree angle or diameter is less than 1/3 of the main stem.

Turpentine trees

On trees with turpentine faces extending above 4.5 feet, estimate the diameter at 10 feet above the ground and multiply by 1.1 to convert to DBH.

Trees missing bark or portion of bole

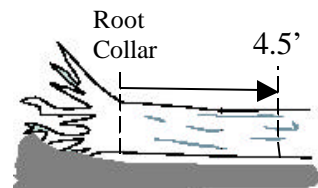
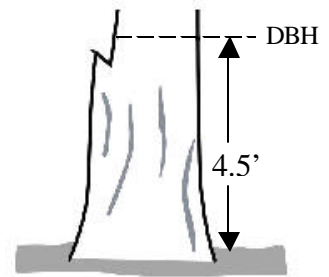
Measure and record to the nearest 0.1-inch the tree as it actually exists (i.e., do not “reconstruct” the bole).

Standing dead trees

Measure DBH to nearest one-tenth inch as it is. Do not estimate for rotten or missing wood.

Trees on the ground

Tree is still alive and its roots are attached to the ground. DBH is taken 4.5 feet from the root collar on the topside of the tree.



Item 135 – Past Diameter

Record the previous DBH off the old tally sheet for the sample tree. Do not change the old DBH. Dash this item if measuring DBH for the first time. (Field width: 4 digits, MQO: No errors 100% of the time, Values: 0010-9999)

Item 136 – Diameter check (CORE)

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. (Field width: 1 digit, MQO: No errors 100% of the time, Values: 0-2)

Code

- 0 Diameter is measured accurately.
- 1 Diameter is estimated. Include cases where vines are excessive.
- 2 Diameter measured at different location than previous measurement (remeasurement trees only).

Item 137 – Length to Diameter Measurement Point (CORE)

Record this item when tree diameter measurement locations are not monumented. For those trees measured directly at 4.5 feet above the ground, dash this item. 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. (Field width: 3 digits, MQO: +/-0.3 feet 90% of the time, Values: 001-150)

Item 138 – Percent Rotten/Missing Cull (CORE)

Record the percent rotten or missing cubic-foot cull for all live tally trees 5.0 inches DBH and larger. (Field width: 2 digits, MQO: +/-10% 90% of the time, Values: 00-99)

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.

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

- * Cankers or fruiting bodies.
- * Swollen or punky knots.
- * Dull, hollow sound of bole.
- * Large dead limbs, especially those with frayed ends.
- * Sawdust around the base of the tree.
- * Metal objects, e.g., fences, spikes, military projectiles, etc. Cull entire sections (4 feet) or sections less than 4 feet in length between metal objects.

See Appendix, for cull calculation methods.

Item 139 - Board Foot Cull

Board-foot cull is the volume within the *entire* sawlog portion of all live trees that cannot be recovered for use as lumber because of rot, sweep or crook, or other defect. Cull volume includes the entire volume of sections that do not meet minimum log grade requirements. This includes all sections less than 8 feet in length and the cull volume within sawlogs. Board foot cull is assigned for those trees receiving a tree grade, according to the section length (in feet), from a 1-foot stump to a 7-inch top in softwood or 9 inch top in hardwood. (Field width: 2 digits, MQO: +/- 10% 90% of the time, Values: 00-99)

<u>Code</u>	<u>Board foot Cull in 5% increments</u>
05	3 to 7 percent cull
10	8 to 12 percent cull
15	13 to 17 percent cull and so on.

Do not code percent cull if less than 3 percent.

Sweep and Crook

Estimate the length, small-end DIB, and sweep or crook departure of the affected section. If the length is 6 feet or less, treat as crook. To determine board-foot deduction, see the tables for sweep and crook in the appendix. If sweep or crook is so excessive that the section is cull, record the entire volume of the section as cull. This is the area within the heavy black lines of the sweep/crook tables in the appendix.

Other Board-Foot Cull

Determine the length and the small-end DIB of the section containing decay, missing wood, fork, etc. Estimate the percentage of the section that is unusable for lumber, ties, or timber, ignoring cull defect that could normally be removed in slabbing. Apply this percentage to the total volume contained in the section, as shown in the board foot cull table in the Appendix.

NOTE: Board-foot cull can be given to any log-sized tree with a tree grade 1-5 and is dashed on cull trees (tree class 3 or 4)

Sawlog Stoppers

Measure the main stem to the point above which no sawlog can be produced to meet log grade standards (size and soundness) and to a minimum top of 7.0 inches DOB for softwoods and 9.0 inches DOB for hardwoods.

Sawlog should not extend above a point where taper becomes excessive as evidenced by:

- (1) A fork with less than 8 foot sawlog above it (12 feet if this is the only log in the tree)
- (2) A limb with a base diameter equal to one half or more of the stem diameter below the limb, or a group of smaller limbs 2.0 inches or larger within a 1 foot section with equivalent diameter which collectively influence taper to the same degree.

Sawlog length should not extend above a sawlog section that does not meet minimum log grade specifications and which has less than 8 feet of sawlog length above it (12 feet if this is the only log in the tree).

Board Foot Cull Deductions

Board foot cull deductions are taken from the top of each sawlog section. Any section less than 8 feet in length between sawlog stoppers must be totally culled out. Sawlog stoppers include but are not limited to the following guidelines:

- 1) Any section with double pith.
- 2) Any section with a single limb or whorl of limbs 2.0 inches DOB or larger at the collar (see examples in the appendix for info on where to measure the limb collar for softwoods and hardwoods) which equal or exceed 1/2 of the diameter of the main stem below the point of occurrence or 1/3 the diameter for hardwood grade 4. **See grading tables for grade 4 rules.**
- 3) Any section that exceeds the allowable sweep and crook deduction in the grading tables. NOTE: Boxed areas for the tables are culled for hardwoods and sound for softwoods. Any section landing in the dashed sections is culled for both hardwoods and softwoods.
- 4) Any section containing metal in the sawlog portion of the tree must be culled. If you are able to get 8 foot or longer logs between the metal objects, only cull the section of the tree with the metal objects. NOTE: Disregard anything that can be slabbed off and aluminum tags or aluminum nails placed into the trees. These items are not considered stoppers because aluminum can be milled without damaging the saw blades and will be taken to the mill for processing.
- 5) Any rotten, punky or missing wood is always a board foot cull deduction.

NOTE: Lacking any evidence of excessive taper disregard healthy looking healed over knots even if they as an aggregate reach the ~~1/2~~ the diameter rule.

Item 140 – Tree Class

Record a one-digit code indicating the tree class of the sample tree (1.0 inches DBH and larger). Tree class of removals is based on its tree class at time of death. All palm species are coded 3. (Field width: 1 digit, MQO: No errors 100% of the time, Values: 2-4)

<u>Code</u>	<u>Description</u>
2	<i>Growing stock</i> — Trees with one-third or more of the gross board foot volume in the <i>entire</i> sawlog section with commercial logs meeting grade, soundness, and size requirements or the potential to do so for poletimber-sized trees. Remember that a tree class 2 tree must have one 12-foot log or two 8-foot logs, now or prospectively, for poletimber-sized trees to qualify as growing stock.
3	<i>Rough cull</i> — Trees that do not contain at least one 12-foot sawlog or two 8-foot logs now or prospectively primarily because of roughness or poor form, and less than 1/3 of its gross board-foot volume meets size, soundness, and grade requirements.
4	<i>Rotten cull</i> — Trees that do not contain at least one 12-foot sawlog or two 8-foot logs now or prospectively and/or do not meet grade specifications for percent sound primarily because of rot. All species not having 1/3 or more of its gross board-foot volume meeting size, soundness, and grade requirements, and over 1/2 of the cubic foot cull volume is rotten or unsound.

Item 141A – Tree Grade

Tree grade and tree classes are directly linked. Any sawlog size tree with a tree class of 2 must have a tree grade assigned to it. The following write-up defines the necessary size, soundness and surface requirements needed in sawlog-sized hardwoods and softwoods in combination with the specific tree grading table. Dash this item if not applicable. (Field width: 1 digit, MQO: No errors 100% of the time, Values: 1-5)

HARDWOOD GRADES

Tree grade has been used in the Southern Survey for several cycles. Some adjustments have been made through time so every hardwood of sawlog size (11.0 inches DBH) must be checked to see if it is a tree class 2 and then be assigned a quality assessment or tree grade. Always follow current grading specifications and do not rely too heavily on past tree grades. Periodic training by FIA staff combined with lumber graders from the National Hardwood Lumber Association will aid us in tree grading. This is vital for trend analyses and volume by grade assessments in the current survey.

Hardwood trees are sawlog sized when reaching a DBH of 11.0 inches and the top of the sawlog section ends with a DOB of 9.0 inches. When looking for upper logs, do not go beyond the 9.0-inch DOB limit. Tree grade for hardwoods is designed to fully assess the best 12-foot section in the butt 16-foot log (grades 1-4).

In practice, log sections are visually squared up into four sides or faces. The face with the greatest distribution of defects is disregarded. Grade determination is based upon DBH, scaling diameter, and length without defect on the poorest of the three remaining faces.

Code hardwood tree grades as follows:

- 1) Measure DBH to the nearest inch.
- 2) Establish the location of all defect indicators – “stoppers”, - on the surface of the butt 16-foot log, and then locate the best 12-foot section.
- 3) Estimate inside bark diameter at top of the 12-foot section to the nearest inch.
- 4) Estimate scalable defect in the 12-foot section selected previously.
- 5) 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.

Tree Grade Code	Minimum length of clear feet in a 12 foot section	Minimum length of clear feet in a 14 foot section	Minimum length of clear feet in a 16 foot section
1	10	12	13
2	8	9	11
3	6	7	8
4	No Clear Surface Required		
5 ¹	Not Gradable		

Remember that the tree grade 4 requirements are more stringent than those for grades 1-3 because grade 4 logs are not used for appearance but for strength. Tree grade 4 may not contain any internal rot.

¹ Tree grade 5 with upper logs not gradable. Any tree not having a gradable log 12 feet in length in the 16-foot section but possessing 2 non-contiguous 8-foot logs or a 12-foot log in an upper section meeting all requirements in the hardwood grading table will receive a grade of 5.

Log abnormalities that are defects in factory logs include the following:

Adventitious bud clusters	Limb
Bulge, butt or stem	Knots
High bumps	Knot overgrowths
Burl	Low bumps
Butt scar	Overgrowths following insect damage or bird peck
Canker	Seams, if not superficial
Conk	Wounds extending into the bole
Flutes, if not superficial	
Holes extending into the bole	
Embedded metal (fence)	

Four or more old bird pecks per square foot is considered a defect in grade 1 and 2.

Abnormalities not ordinarily limiting cuttings are butt swell, flanges and surface rise.

Hardwood Tree Grades for Factory Lumber

Grade Factor	1	2	3	Tie and timber logs Log grade 4
Length of grading zone (feet) ^a	Butt 16	Butt 16	Butt 16	Butt or Upper
DBH, minimum (inches)	16 ^b	13	11	No Requirements. Not graded on cutting basis. Sound defects permitted: <i>Single Knots</i> - any number, if none has an average collar diameter exceeding 1/3 log diameter at point of occurrence. <i>Whorled knots</i> - any number, if sum of collar diameters does not exceed 1/3 log diameter at point of occurrence. <i>Holes</i> - any number not exceeding knot specifications, if do not extend over 3 inches into contained tie or timber. Unsound defects are not permitted.
Diameter, minimum inside bark at top of grading section	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 by excluding shake, minimum 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 larger 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, d.i.b. at top of grading section must be 12 inches and d.b.h. must be 15 inches.

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

^d A clear cutting is a portion of a face free of defects, extending the width of the face. A face is 1/4 the surface of the grading section as divided lengthwise.

^e Unlimited.

^f Fifteen percent crook and sweep or 40 percent total cull deduction is 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's grade to 3 unless the cull deduction for rot is greater than 40 percent.

SOFTWOOD GRADES (includes southern pine, red cedar and cypress)

Softwood trees are sawlog size when DBH is 9.0 inches or larger and the sawlog section extends to a 7.0 inch DOB. Softwood tree grades are based on number of clear faces rather than the number of clear feet in each face.

Also, softwood grades are based on the number of clear faces in the first 16- foot log or shorter lengths down to 12 feet if a 16-foot log is not present. **Always grade the butt 16-foot log if that length is present. A face is one-fourth of the circumference in width extending the full length of the log.**

Code softwood logs grades as follows:

<u>Code</u>	<u>Number of Clear Faces</u>
1	3 or 4
2	1 or 2
3	0
*4	See Softwood Grading Table
5 ²	Not Gradable

* Only the following species can receive a grade of 4: Balsam fir (012), Fraser fir (016), Atlantic white cedar (043), Black spruce (095), Red spruce (097), Eastern white pine (129), Northern white cedar (241), Eastern hemlock (261), and Carolina hemlock (262).

Note: Other tropicals (006) and Florida torreyia (252) will be graded the same as Southern yellow pines and receive grades of 1-3 & 5. The list includes the following species: Southern red cedar (067), Eastern red cedar (068), Sand pine (107), Shortleaf pine (110), Slash pine (111), Spruce pine (115), Longleaf pine (121), Ponderosa pine (122), Table mountain pine (123), Pitch pine (126), Pond pine (128), Loblolly pine (131), Virginia pine (132), Bald cypress (221), and Pond cypress (222).

² Tree grade 5 with upper logs not graded because the ability to see knots, etc. at heights above 16 feet isn't reliable.

Additionally, a log will be degraded one grade for each of the following, except no log can be degraded below grade 3:

1. Sweep – Degrade any 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 of the log. This is the final grade if there is no evidence of heart rot.
2. Heart rot – Degrade any 1 or 2 log one grade if conk, massed hyphae, or other evidence of advanced heart rot is present.

Other softwood grades

Refer to White Pine grade Table when assigning tree grades for other softwoods.

Southern Pine Log Grades

Grade	Number Clear Faces	Definitions	Exceptions
1	3,4	A Face is 1/4 of the circumference extending full length of the log.	a. Lower one grade a log not grade 3 having 3 inches or more of sweep if sweep is 1/3 or more of log diameter. b. Lower one grade any log not grade 3 if heart-rot fruiting has occurred or is imminent, as indicated by conk or visible, massed, heart-rot hyphae.
2	1,2	Clear faces are those free of: Knots measuring more than one-half inch in diameter, overgrown knots of any size, holes more than one-fourth inch in diameter.	
3	None		

Spruce, Fir, White Cedar, Tamarack & Hemlock Logs Minimum Merchantability Specifications for Grade One Logs

DIB (small end)	Length (without trim)	Total Deduction	Sweep Permitted	Other Requirements
6 -12 inches	12 - 16 feet in 2-foot multiples	50%	25%	Sound knots not over 2 * inches diameter permitted.
13 inches +	12 - 16 feet in 2-foot multiples	50%	25%	Sound knots not over 3 * inches diameter permitted.

* One branch or sound knot that exceeds the diameter limitation is permitted in the grading section to meet grade 1 specifications.

EASTERN WHITE PINE GRADES

The specifications for the approved tree-grading system apply to merchantable unpruned eastern white pine trees. Grades are based on external characteristics in the butt 16-foot section of the tree and visual indications of weevil damage in the upper merchantable stem. Trees must have a DBH of at least 9 inches and have at least one-third of the gross volume in sound wood suitable for manufacture into standard yard lumber.

The grading system is designed to stratify trees into distinct value classes and to predict differences in lumber-grade yield of trees sawed into standard yard lumber. The lumber-grading rules of the Northeastern Lumber Manufacturer's Association and the Northern Hardwood and Pine Manufacturer's Association define the grades of standard yard lumber.

Grading Factors and Definition of Terms

The following description of grading factors and definitions of terms are presented in the same descending order as listed in the specifications.

- (1) **Tree diameter.** – A tree must have at least a 9-inch DBH to be graded.
- (2) **Weevil injury in the grading section.** - Evidence of weevil injury can be recognized by moderate to severe crook at the point of injury. At the point of injury, limbs are usually large and acute-angled. Grading sections showing none of these characteristics are considered free of weevil injury.
- (3) **Minimum Face Requirements on the grading section** - A face is one-fourth the circumference of the surface for the full length of the grading section. A good face is free of knots of any type larger than 1/2 inch in diameter, overgrowths indicating larger knots, and conks or punk knots. A half face is one-half the length of the section. Good half faces must be either the butt or top half of the grading section.

Sound red knots are any visible branches, stubs, or sockets that resulted from living branches or branches that have been dead for a short time. They are intergrown with the surrounding wood and contain no rot. The average diameter of sound red knots is measured at the point where the limb would normally be trimmed from the main stem. Knot size is determined by measuring only the diameter of the red heartwood portion of the knot.

Dead or black knots are visible branches, stubs, or sockets that do not conform to the definition of sound red knots. The average diameter of dead knots is measured at the same point as the sound red knots; however, the total limb diameter is considered rather than just the red heartwood portion.

Overgrown knots are identified by a distinctive circular or elliptical pattern in the bark and are treated the same as dead knots. The size of a branch stub underlying the overgrowth is estimated by observing the adjacent visible knots.

White Pine Collar Diameter Limits for Red and Black Knots

Scaling Diameter (DIB) in inches	Black Knots 1/12 (inches)	Black & Red Knots 1/6 (inches)	Red Knots 1/3 (inches)
7	7/12	1 1/6	2 1/3
8	2/3	1 1/3	2 2/3
9	3/4	1 1/2	3
10	5/6	1 2/3	3 1/3
11	11/12	1 5/6	3 2/3
12	1	2	4
13	1 1/2	2 1/6	4 1/3
14	1 1/6	2 1/3	4 2/3
15	1 1/4	2 1/2 Black Max	5 Max
16	1 1/3	2 2/3	5
17	1 5/12	2 5/6	5
18	1 1/2 Max	3 Red Max	5

- (4) **Maximum sweep or crook allowance in the grading section.** – Sweep is the gradual deviation in inches of the longitudinal axis from a straight line connecting the centers of each end of the grading section. Crook is an abrupt curve or bend deviating from the straight longitudinal axis of the section. Although sweep and crook are normally considered as scaling deductions, they also may cause lumber degrade and therefore must be treated as grading factors. For grading purposes, the amount of sweep or crook present in the grading section is calculated by the following two formulas:

$$\text{Percent sweep} = \frac{\text{Sweep (inches) minus 2}}{\text{Section scaling diameter (inches)}} \times 100$$

$$\text{Percent crook} = \frac{\text{Deviation (inches)}}{\text{Section scaling diameter}} \times \frac{\text{Section affected length (feet)}}{16} \times 100$$

- (5) **Maximum total scaling deduction in the grading section.** – The total scaling deduction includes sweep and crook deductions as well as deductions for other scalable defects in the grading section. For grading purposes, the amount of scalable defect must be expressed as a percent of gross volume.
- (6) **Conks, punk knots, and borer damage on the grading section.** – A conk is a fruiting body of a wood rotting fungus (generally *Fomes pini* in eastern white pine). A punk knot is completely rotten, and the brown mycelial mass of the rot fungus is visible within the knot. Pine borer damage can be recognized by entrance channels (holes 3/16 to 1/4 inch in diameter) on the bark surface.
- (7) **Weevil damage in the upper merchantable stem.** – Weevil injuries in the upper stem are recognized by severe crook and large acute-angled branches at the point of injury.

Application Procedure

Trees are graded in one or two steps. First, a tentative grade is established for the butt 16-foot section, using factors 1 through 6 of the tree grade specifications. If the tentative grade of the grading section is grade 4, no further examination is necessary; the tree is a grade 4. However, if the tentative grade of the butt 16-foot section is 1, 2, or 3, examine the upper merchantable stem for weevil injuries. If the total apparent weevil injuries exceed three, degrade the tree one grade below that of the tentative grade.

Eastern White Pine Sawlog Grade Specifications

Grade Factor	1	2	3	4
(1) MINIMUM DBH (inches)	9	9	9	9
(2) MAXIMUM WEEVIL INJURY IN BUTT 16-FOOT SECTION (number)	None	None	2 injuries	No limit
(3) MINIMUM FACE REQUIREMENTS ON BUTT 16-FOOT SECTION	Two full length or four 50% length good faces. ¹ (In addition, knots on balance of faces shall not exceed size limitations of Grade 2 sections.)	NO GOOD FACES REQUIRED. Maximum diameter of knots on three best faces:		Includes all trees not qualifying for Grade 3 or better and judged to have at least one-third of their gross volume in sound wood suitable for manufacture into standard lumber.
		SOUND RED KNOTS not to exceed 1/6 scaling diameter and 3 inch maximum. ²	SOUND RED KNOTS not to exceed 1/3 scaling diameter and 5 inch maximum. ²	
		DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/12 scaling diameter and 1½ inch maximum. ²	DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/6 scaling diameter and 2½ inch maximum. ²	
(4) MAXIMUM SWEEP OR CROOK IN BUTT 16-FOOT SECTION (percent)	20	30	40	No limit
(5) MAXIMUM TOTAL SCALING DEDUCTION IN BUTT 16-FOOT SECTION (percent)	50	50	50	No limit
(6) After the tentative grade of the section is established from face examination, the section will be reduced in grade whenever the following defects are evident:				
CONKS, PUNK KNOTS, AND PINE BORER DAMAGE ON SURFACE OF SECTION ³				
Degrade one grade if present on one face.				
Degrade two grades if present on two faces.				
Degrade three grades if present on three or four faces.				
(7) If the final grade of the grading section is 1, 2, or 3, examine the tree for weevil injuries in the merchantable stem above 16 feet. If the total apparent weevil injuries exceed three, degrade the tree one grade below the section grade ³ . Otherwise the tree grade is the same as the final section grade.				

¹ Trees under 16 inches DBH require four full length faces.

² Scaling diameter is estimated at the top of the 16-foot grading section.

³ No tree will be degraded below Grade 4 unless net tree scale is less than one-third of gross tree scale, then the tree would be a tree class 3.

Item 141B – Southern Pine Tree Value

Southern Pines: Loblolly, slash, longleaf, shortleaf (include Virginia, Scotch, sand, spruce, pond, pitch, table mountain)

Softwood trees are sawlog size when DBH is 9.0 inches or larger and the sawlog section extends to a 7.0-inch diameter outside bark (DOB). Softwood tree *values* are based on visual quality indicators that are easily seen and evaluated. Trees are placed into *values* without examining for overgrown knots or bark distortions. The timber *valuator* examines the butt 33-foot log for presence and size of branches, cankers and seams. (Field width: 1 digit, MQO: No errors 100% of the time, Values: 1-3)

Tree Valuation Table for Southern pine

Characteristics ^a	Value 1 Above Average	Value 2 Average	Value 3 Below Average
DBH	≥ 11.0 inches	≥ 9.0 inches	≥ 9.0 inches
Sawlog merchantable height	≥ 33 feet	≥ 17 feet	≥ 17 feet
Live branches ≤ 3 inches DOB ^{b, c}	None in butt 33 feet	No limit in butt 33 feet	No limit in butt 33 feet
Dead branches ≤ 2 inches DOB	4 or less in butt 33 feet	No limit	No limit
Live or dead branches > 3 and < 4 inches DOB	None in butt 33 feet	None in trees ≤ 13.0 inches DBH; no limit in trees ≥ 13 inches	No limit
Live or dead branches ≥ 4 inches DOB	None in butt 33 feet	2 or less in each log of trees ≥ 13.0 inches DBH; none in trees < 13.0 inches DBH	No limit
Straightness	Able to buck 10 feet minimum log with ≤ 1 inch sweep per log (2 cuts)	Able to buck 8 feet minimum log with ≤ 3 inches sweep per log	Able to buck 8 feet minimum log with < 5 inches sweep per log
Seams and cankers	None in butt 33 feet	1, ≤ 3 inches wide in butt 33 feet	> 1, or > 3 inches wide in butt 33 feet
Decay or rot	None	None	Permitted
^a Value butt 33 feet or to sawlog merchantable top if less than 33 feet; sawlog merchantable height is: 1) height to local minimum DOB top; or 2) where a whorl of three or more branches, whose diameter are equal to or greater than the diameter of the stem occurs within a 1-foot section if there is not a minimum of 8 feet of clear stem above the whorl.			
^b Disregard branches < 0.5 inches dob			
^c Measure branch DOB across grain.			

Item 142 – Total Length (CORE)

Record the total length for all live tally trees (one inch DBH and larger), to the nearest 1-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, estimate what the total length would be if there were no missing or broken top. Forked trees should be treated the same as unforked trees. (Field width: 3 digits, MQO: +/-10% of true length, at least 90% of the time, Values: 005-400)

On naturally swell-buttressed trees (cypress and tupelo), if the DBH is taken above 4.5 feet, the length is measured from a point 4.5 feet below DBH to the point where the stem terminates.

Always use the clinometer for lengths and periodically check it on a known height and make sure the clinometer is not “sticking” on the sharper angles. Take extra time in thick stands and rounded crowns where visibility to the tip of the vertical stem is difficult to observe.

Forked trees – consider the tallest stem as the main stem.

Leaning trees – always go perpendicular to the lean and use the Pythagorean theorem when a lean makes the use of the clinometer impractical by itself.

For dead trees that qualify as standing dead (5.0 inches DBH or larger, minimum height of 4.5 feet, and still attached to the ground) record total length from ground level to the top of the main stem.

Item 143 – Actual Length (CORE)

(Only entered if Length Method is coded 2)

For all live (1.0 inch DBH and larger) and standing dead (5.0 inches DBH and larger) tally trees with broken or missing tops. Record the actual length of the tree 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. (Field width: 3 digits; MQO: +/- 10% of true length, at least 90% of the time; Values: 005-400)

Item 144 – Length Method (CORE)

Record the code that indicates the method used to determine tree lengths. (Field width: 1 digit; MQO: No errors, 100% of the time; Values: 1-3)

<u>Code</u>	<u>Description</u>
1	Total and actual lengths are field measured with a measurement instrument (e.g., clinometer, tape)
2	Total length is visually estimated; actual length is measured with an instrument.
3	Total and actual lengths are visually estimated.

Item 145 – Crown Class (CORE)

Rate tree crowns in relation to the sunlight received and proximity to neighboring trees (see figure). Base the assessment on the position of the crown at the time of observation. Example: a formerly suppressed tree, which is now dominant due to tree removal, is classified as dominant. (Field width: 1 digit; MQO: No errors at least 85% of the time, Values: 1-5)

Code Crown Class

- 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 cover 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.

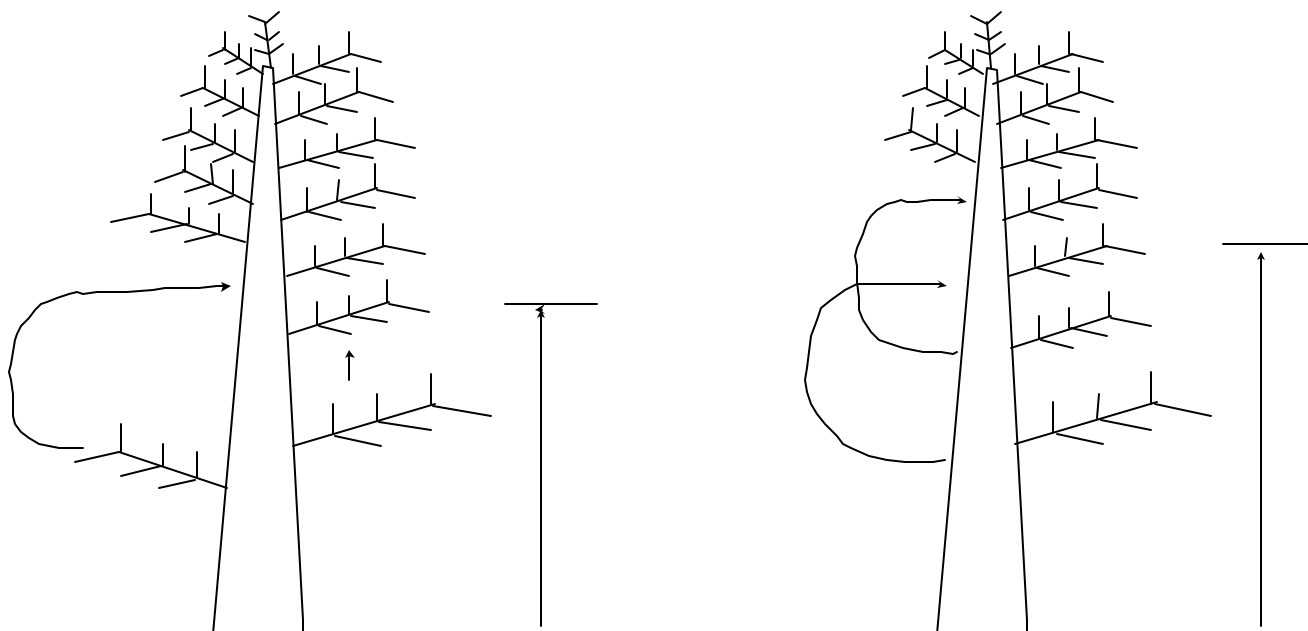
Also, trees whose crowns have received full light from above and from all sides during early development and most of their life. Their crown form or shape appears to be free of influence from neighboring trees.

- 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 crowded and are crowded on the sides.
- 4 Intermediate - Trees are shorter than dominants and co-dominants, 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, intermediates 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.

Item 146 – Compacted Crown Ratio (CORE)

Record the compacted crown ratio for each live tally tree, 1.0 inch and larger. Compacted crown ratio is that portion of the tree supporting live foliage and is expressed as a percentage of the actual tree height. To determine compacted crown ratio, ocularly transfer lower live branches to fill holes in large holes in the upper portion of the tree until a full, even crown is visualized. (Field width: 2 digits, MQO: +/- 10% at least 80% of the time, Values: 00-99)

Aid for Determining Compacted Crown Ratio



Item 147 - Fusiform Rust and Dieback Incidence

Record the incidence of Fusiform Comandra Rust and Dieback using the following 1-digit codes and thresholds (Field width: 1 digit; MQO: No errors 100% of the time; Values: 0-2)

<u>Code</u>	<u>Agent</u>	<u>Species</u>	<u>Description/Threshold</u>
0	None		
1	Fusiform, Comandra Rust	Slash & Loblolly pines	These rusts typically cause the formation of spindle-shaped galls on the stem or branches. Many older galls appear as cankers with sunken rotten centers encircled by callus ridges. Witches broom is common at galls. The fungus produces masses of yellow-orange spores in the spring on the galls and canker margins. Record only those cankers that occur on the main stem or on a live branch within 12 inches of the stem.
2	Dieback	Hardwoods	Branches dieback from the tips. Just a few branches are affected at first with whole branches dying in the advanced stages. Tree mortality may result. Dieback is frequently associated with stress caused by unfavorable environment, especially drought. If 10% or more of the crown area is affected, the tree should be recorded. Do not code for overtopped trees.

Item 148 – Dieback Severity

Record the severity of hardwood crown dieback in 10% increments. This item is recorded only if “Dieback Incidence” is coded. Otherwise dash this item. (Field width: 1 digit; MQO: +/- one class 90% of the time; Values: 0-9)

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

Tree Damage (CORE)

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 DAMAGE SEVERITY) in order to be recorded.

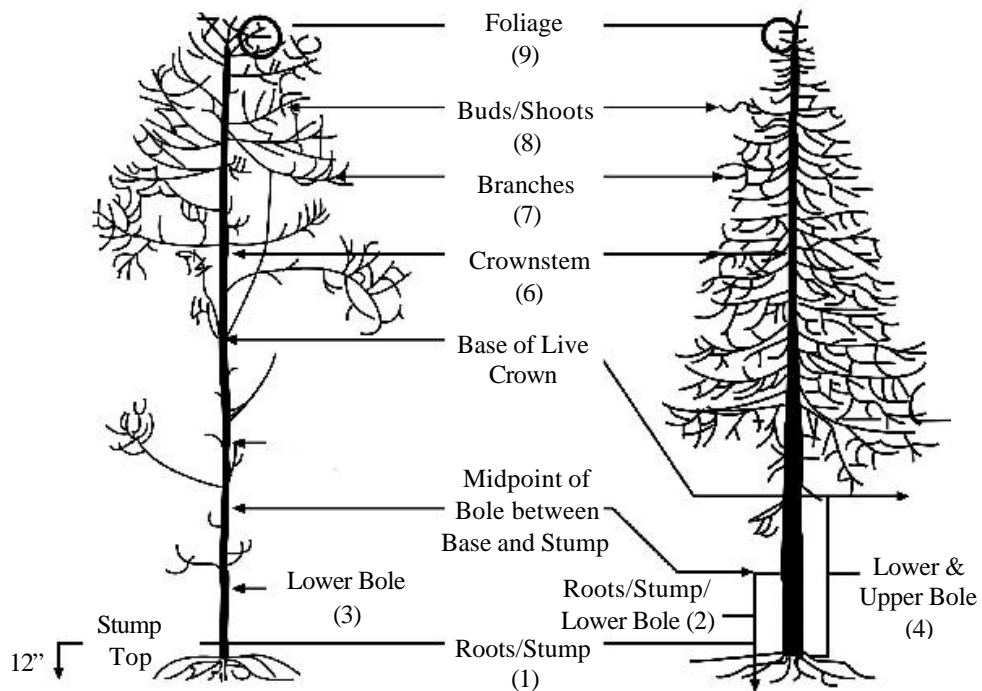
The tree is observed from all sides starting at the roots. Damage signs and symptoms are prioritized and recorded based on location in the following order: roots, roots and lower bole, lower bole, lower and upper bole, upper bole, crown-stem, and branches recorded as location code 0 (for no damage),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

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

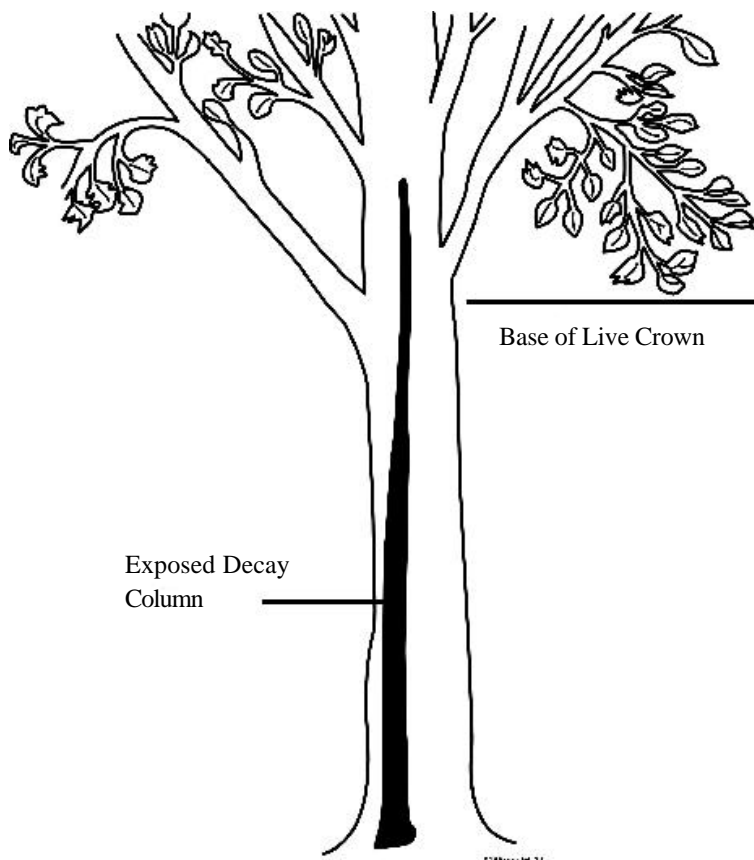
When multiple damages occur in the same place, the most damaging is recorded. For example, a canker, DAMAGE TYPE 02, meets the threshold and has a conk growing in it, record only the canker. Another example: if an open wound meets threshold and also has resinosis, record only the open wound.

Item 149 – Damage Location 1 (CORE)

Record the location on the tree where DAMAGE TYPE 1 is found. If the same damage continues into two or more locations, record the appropriate code listed below, or if the combination of locations does not exist (damage extends from crownstem to roots), record the lowest location that best describes the damage. 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. (Field width: 1 digit, MQO: +/- 1, at least 80% of the time, Values: 0-9)



Location codes for damages.



Damage runs from stump to crownstem. Code here should be 2 (roots & “stump” & lower bole) which represents the lowest locations of this multi-location damage.

<u>Code</u>	<u>Description</u>
0	No damage
1	Roots (exposed) and stump (12 inches in height from ground level)
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 inch 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

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.

Item 150 – Damage Type 1 (CORE)

Record the first damage 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. (Field width: 2 digits, MQO: No errors, at least 80% of the time, Values: 01-31)

Codes

- 01 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).

- 02 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.

- 03 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.

- 04 Resinosis or gummosis. The origin of areas of resin or gum (sap) exudation on branches and trunks.
- 05 Cracks and seams. Cracks in trees are separations along the radial plane. 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 of 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 of bole that are broken or dead.
- 20 Vines in the crown. Kudzu, grapevine, ivy, dodder, etc. smothers tree crowns. Vines are rated as a percent 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.
- 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 percent affected, on at least 30 percent of foliage, buds or shoots. Also includes herbicide or frost-damaged foliage, buds or shoots.
- 25 Discoloration of foliage. At least 30 percent of the foliage is more than 50 percent 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 comments section of PDR for "tree notes". 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, 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 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 of 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 of 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 occurrence.
- 31 Other.

Location 7: Branches >1 inch 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.
- 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 percent of buds and shoots damaged more than 50 percent.
- 31 Other.

Location 9: Foliage

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

Item 151 – Damage Severity 1 (CORE)

Record a code to indicate the amount of affected area (above threshold) in DAMAGE LOCATION 1 recorded for TREE DAMAGE1. Severity codes vary depending on the type of damage recorded. (Field width: 2 digits, MQO: No errors at least 80% of the time; Values: 2-9)

The codes and procedures for SEVERITY 1 values are defined for each DAMAGE TYPE 1:

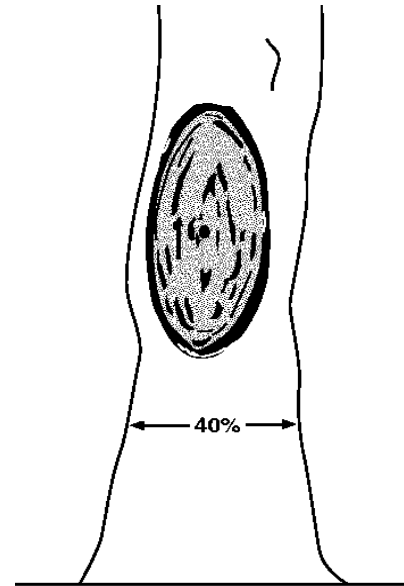
DAMAGE TYPE Code 01 - Canker, gall

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 example below:

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

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

Example: A canker that 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

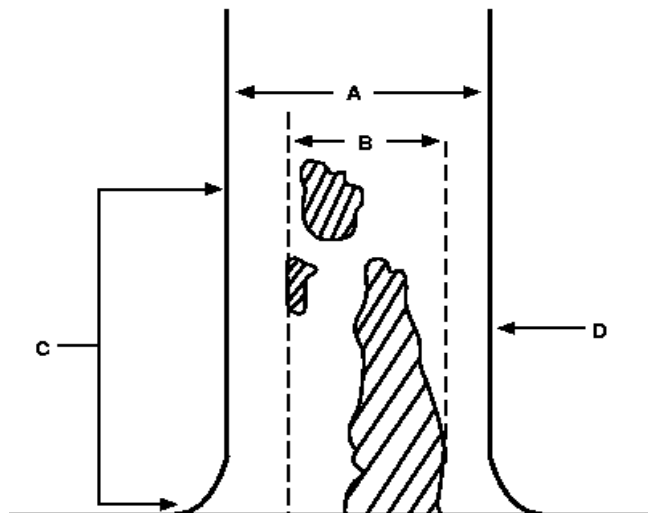
Severity classes for code 02: **None**. Enter code 0 regardless of severity, except for roots > 3 feet from the bole, or number of branches affected - 20%.

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 example below:

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

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



Example: 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 3 feet; D = midpoint of occurrence 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):

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

DAMAGE TYPE Code 05 - Cracks and seams

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 of bole that are broken or dead.

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

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

DAMAGE TYPE Code 20 - Vines in crown

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

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

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 class in the area or look for the detached portion of 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:

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

DAMAGE TYPE Code 22 - Broken or dead branches (>1inch 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.

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

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

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):

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

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:

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

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):

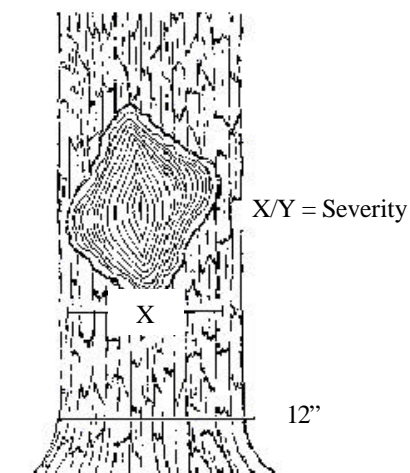
Code	Class	Code	Class
2	20-29	6	60-69
3	30-39	7	70-79
4	40-49	8	80-89
5	50-59	9	90-99

DAMAGE TYPE Code 31 - Other

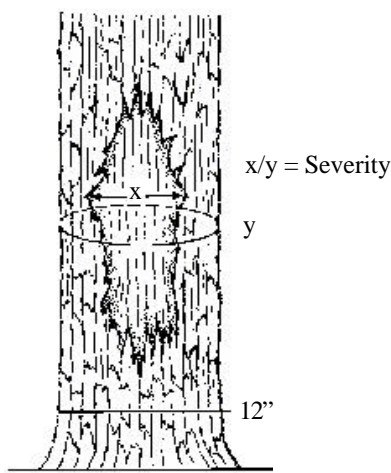
Severity classes for code 31:

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

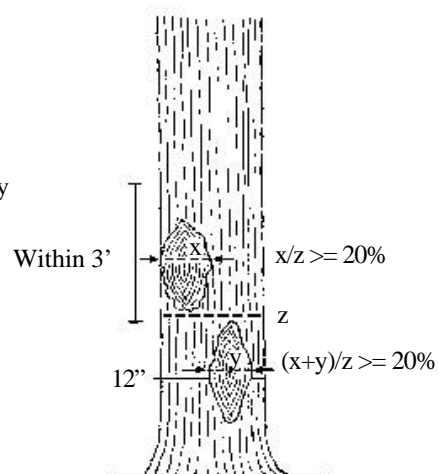
Examples of Damage Coding:



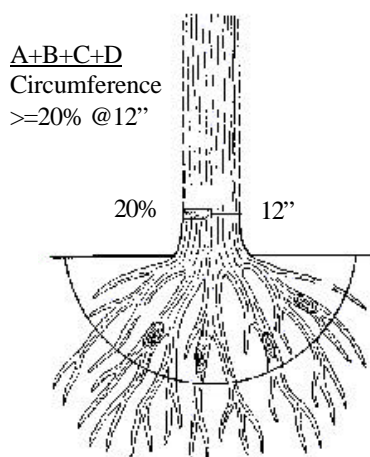
01 – Canker measured as widest distance between the outside of canker swelling (3,01,3)



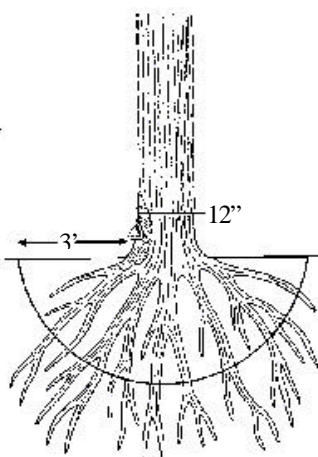
03 – Open wound measured at widest point inside of wound margins (3,03,2)



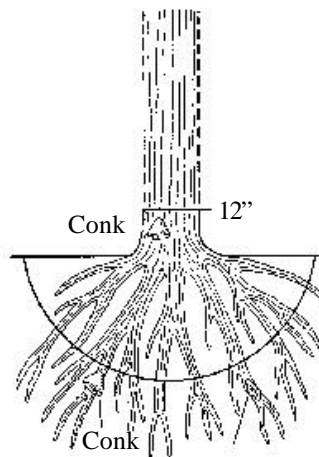
01 – Additive cankers within 3' in roots and lower bole (2,01,3)



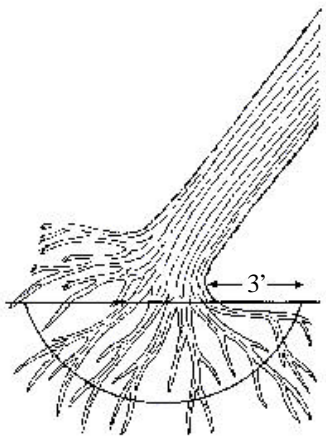
01 – Canker/gall on roots (within 3' of bole) (1,01,2)



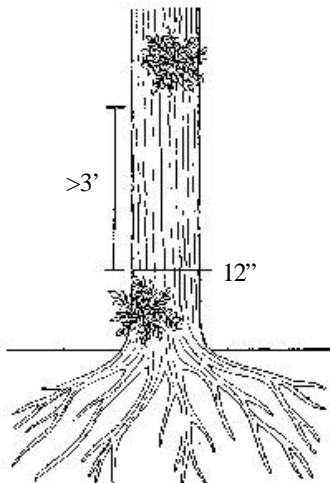
02 – Decay indicator on roots and lower bole (2,02,0)



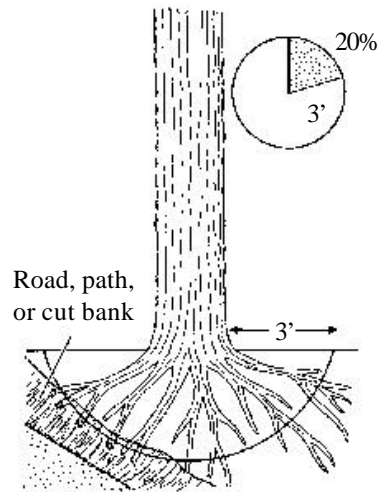
02 – Indicator of decay within 3' of bole. Beyond 3'' of bole, indicators must affect >= 20% of roots (1,02,0)



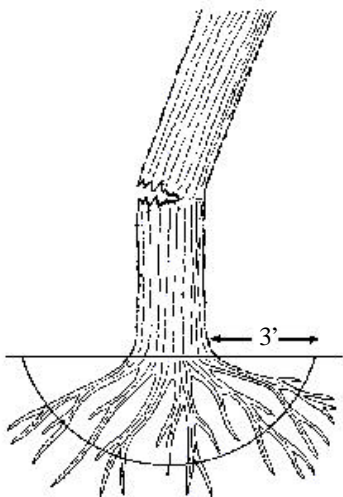
11 – Broken bole or roots < 3' from bole, broken roots must be visible
(1,11,0)



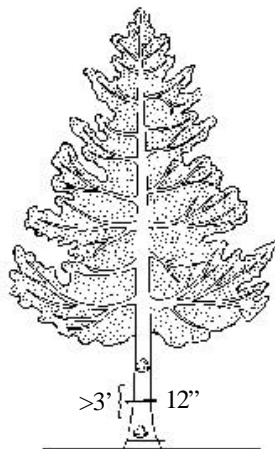
12 – Brooms on roots or bole
(1,12,0 or 3,12,0)



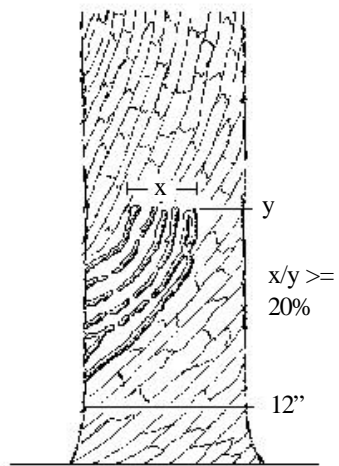
13 – Broken or dead roots > 3' from bole
(1,13,2)



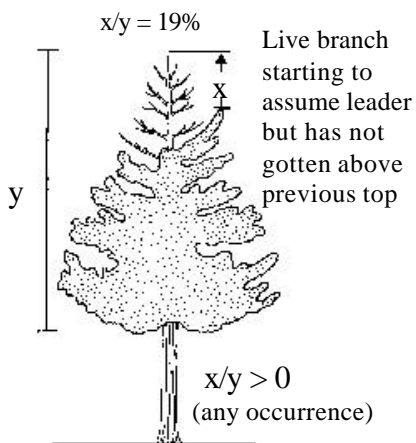
11 – Broken bole or roots < 3' from bole
(3,11,0)



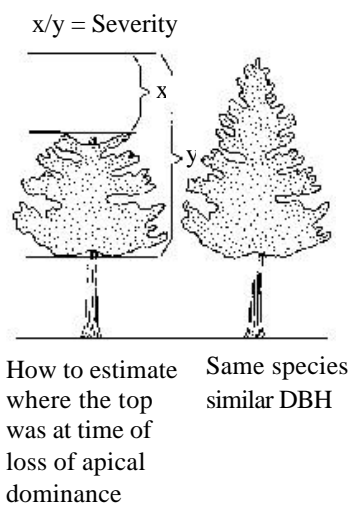
02 – Conks separated by > 3';
2 damages
(3,02,0) (5,02,0)



04 – Origin of resinosis in lower bole
(3,04,2)

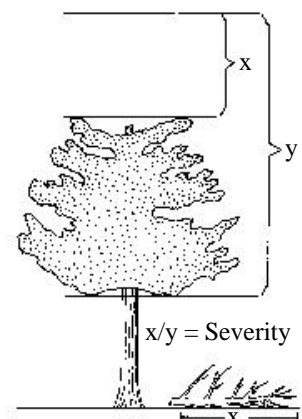


21 – Loss of apical dominance
(6,21,1)



How to estimate where the top was at time of loss of apical dominance
Same species similar DBH

21 – Loss of apical dominance, look for same species of similar DBH
(6,21,3)



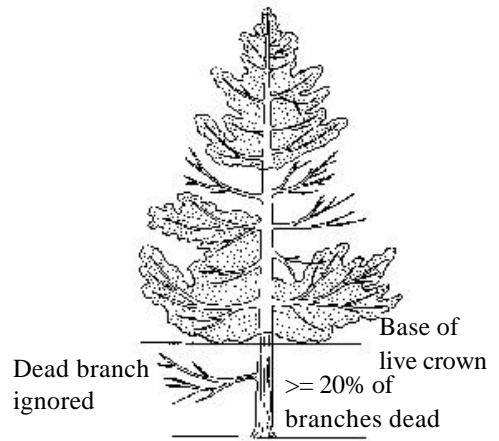
21 – Loss of apical dominance, look for old top to estimate the top of x & y
(6,21,3)



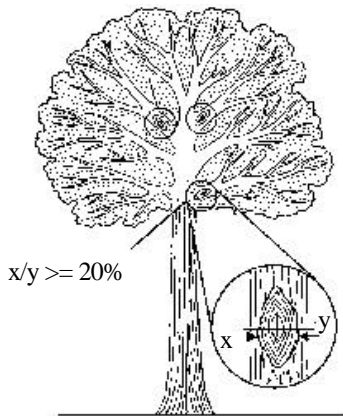
01 – Cankers above the threshold on $\geq 20\%$ of branches
(7,01,2)



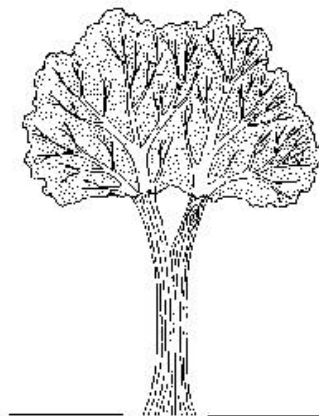
02 – Cankers on $\geq 20\%$ of branches
(7,02,2)



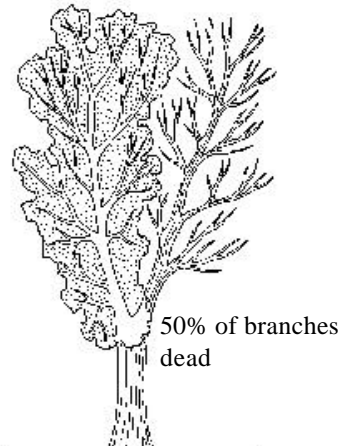
22 – Dead branches within the live crown area. If branches cannot easily be counted, estimate % area of live crown affected
(7,22,2)



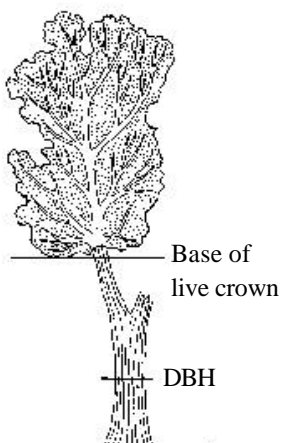
01 – Cankers above threshold on $\geq 20\%$ of branches
(7,01,3)



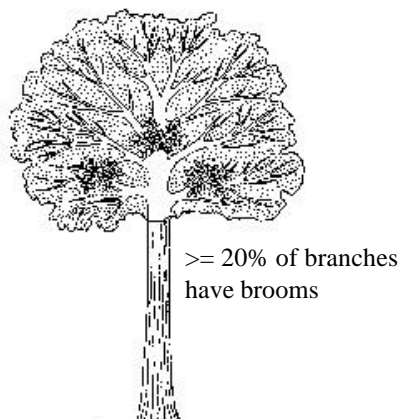
01 – Canker; no crown stem & only 2 branches present
(7,01,5)



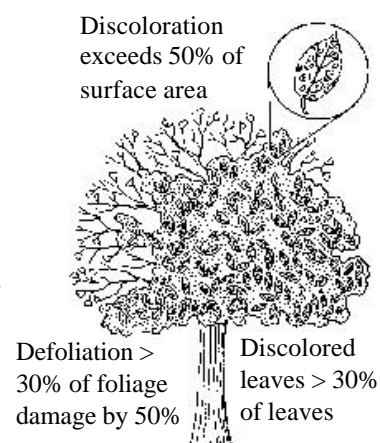
22 – Dead branches; only 2 branches present and $\geq 20\%$ of branch dead
(7,22,5)



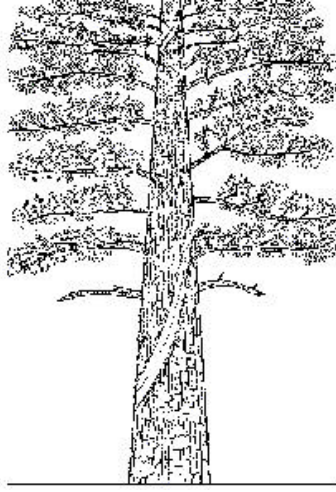
No damage – base of live crown is above old fork, stub is a snag branch
(no damage)



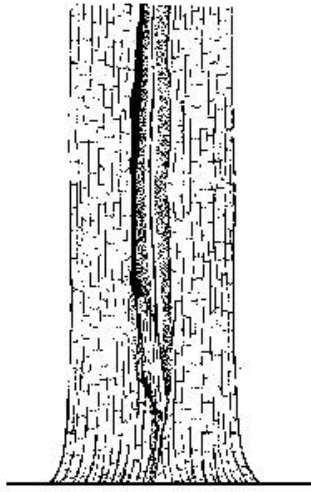
23 – Excessive branching or brooms in crown
(7,23,3)



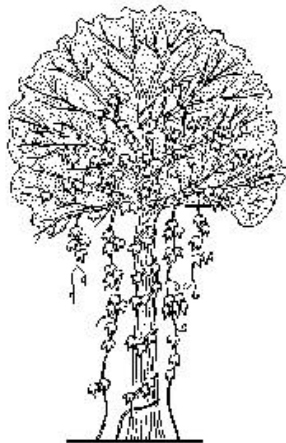
24 – Defoliation, 25 – Discoloration
(9,24,3) (9,25,3)



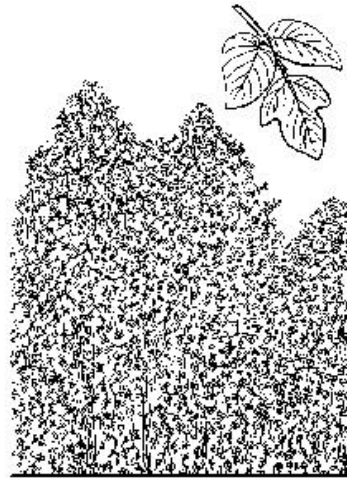
05 – Lightning strike
(5,05,0)



05 – Cracks & seams
(2,05,0)



20 – Vines in crown
(7,20,2)



20 – Vines in crown
(7,20,9)

Procedure to Record Multiple Occurrences of the Same Damage (CORE)

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.

Procedures to Measure Circumference Affected (CORE)

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

Item 152 – Damage Location 2 (CORE)

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

Item 153 – Damage Type 2 (CORE)

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.

Item 154 – Damage Severity 2 (CORE)

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

Item 155 - Cause of Death/Removal (CORE)

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. **Trees removed from timberland as a result of a land use change will always be assigned codes 87 or 88.** If the tree was alive at time of land use change use code 88. (Use code 87 for all trees that were cut or died as a result of land use change). (Field width: 2 digits, MQO: at least 80% agreement, Values: 10-90)

<u>Code</u>	<u>Cause</u>
10	Insect damage
20	Disease damage
30	Fire damage
40	Animals damage
50	Weather damage
60	Vegetation (Suppression, competition, vines/kudzu)
70	Unknown/Not sure/Other
80	Human Caused damage (cultural, accidental damage, etc., except TSI, logging, land clearing and conversion to Non-forest)
82	Timber Stand Improvement
86	Logging
87	Land clearing (cut)
88	Conversion to non-forest (Live standing in a non-forest condition)
90	Physical (hit by falling tree)

Item 156 – Mortality Year (CORE)

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 non-forest land use, if it can be determined that a tree died before the land was converted. (Field width: 4 digits, MQO: +/-1 year at least 70% of the time for remeasurement cycles of 5 years, +/-2 years, 70% of the time for remeasurement cycles greater than 5 years; Values: 1985 or higher)

Characteristics useful for estimating time of cutting include:

- (a) Sprouts: age of sprouts on stumps or damaged trees.
- (b) Annual rings: completeness; comparison of annual rings on stumps with those of standing trees.
- (c) Cut face of stump and top: color, condition of resin if present; stage of decay.
- (d) Bark: tightness.
- (e) Color or condition of leaves, needles, and twigs; development stage of acorns, nuts, pods, etc.—on felled trees.
- (f) Occurrence of fungi and extent of their development.

In considering sprout development, the time of year when cutting occurred as well as ages of sprouts should be considered. For example, sprouts on stumps or on trees damaged in the spring will likely show full growth for the first year; late summer cuttings may exhibit small or winter-killed sprouts; and fall or winter cuttings will be followed by no sprouting until the next growing season.

NOTE: Mortality year cannot predate the last survey.

Item 157 – Decay Class (CORE)

Record for each standing dead tally tree, 5.0inches in diameter and larger, the code indicating the tree’s stage of decay. Dash if not applicable. (Field width: 1 digit, MQO: ±1 class, at least 90% of the time, Values: 1-5)

Decay 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.

Item 158 – Utilization Class (CORE)

Record the code to identify cut trees that have been removed from the site. Dash this item if not applicable. (Field width: 1digit, MQO: No errors 100% of the time, Values: 0-2)

<u>Code</u>	<u>Utilization</u>
0	Not utilized – can still be found on the site.
1	Utilized – some portion of the tree cannot be found on the site, assumed to have been removed for commercial purposes.
2	Utilized for fuelwood - some portion of the tree cannot be found on the site, assumed to have been removed for non-commercial purposes. Non-commercial uses could include firewood, barn poles, domestic landscaping, rough slabs, etc.

Utilization code 2 will be used for trees utilized for Domestic Fuelwood. Most often these will be one or two trees, of any size, removed from a small wood lot near a road.

Item 159 – Tree Notes (CORE)

Record notes pertaining to an individual tree as called for to explain or describe another variable. (Field width: Alphanumeric character field; MQO: n/a; Values: English language words, phrases and numbers)