Long-term Ecosystem Monitoring Program Protocol – Finger Lakes

Last Updated 7/7/2017 by John Truong and Jim Duncan, Forest Ecosystem Monitoring Cooperative

Contents

TREES

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 subplot and referenced (new AZIMUTH and HORIZONTAL DISTANCE taken) to the subplot center.

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

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 as measured from the base of the tree to 4.5 feet.

The portion of a bole on dead trees that are separated greater than 50 percent (either above or below 4.5 feet), are considered severed and may qualify as Down Woody Material (DWM). See DWM procedures for tally criteria.

For 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 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.

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. Give one of the tree data lines a PRESENT TREE STATUS = 0, RECONCILE = 27, and a TREE NOTE. The remaining tree data line receives PRESENT TREE STATUS = 1 or 2 with DIAMETER CHECK = 2, and a TREE NOTE.

- 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 missed tree. Use the existing tree data line to represent one of the stems. PRESENT TREE

STATUS = 1 or 2, DIAMETER CHECK = 2, and a TREE NOTE. The second stem would get PRESENT TREE STATUS = 1 or 2, RECONCILE 3 or 4, and a TREE NOTE.

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.

(5.1) SUBPLOT NUMBER

Record the subplot number where the tree occurs.
Values:

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

(5.2) TREE RECORD NUMBER

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.

(5.3) CONDITION CLASS NUMBER

Record the CONDITION CLASS NUMBER in which each tree is located. Often, a referenced boundary is approximate, and trees selected for tally are assigned to the actual condition in which they lie regardless of the recorded approximate boundary (Figure 17).

Values: 1 to 9

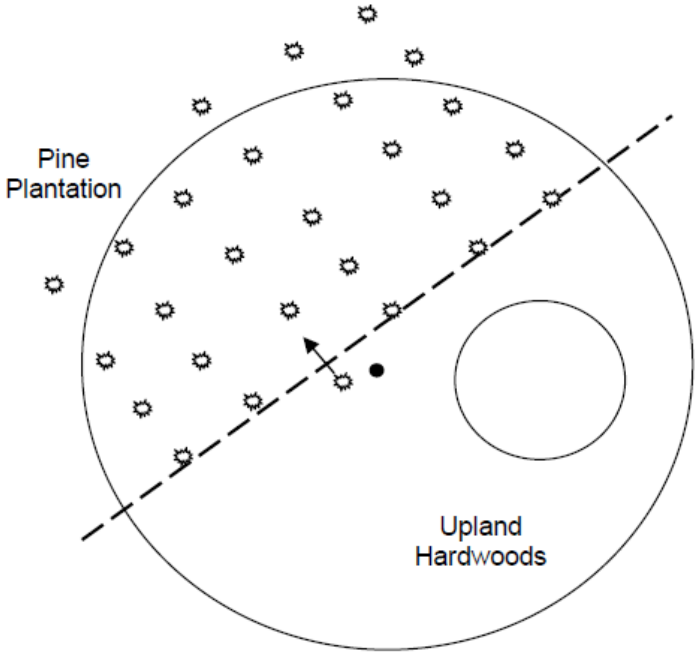


Figure 17. Ragged CONDITION CLASS boundary and tree condition class designation.

(5.4) AZIMUTH

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 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.

Values: 001 to 360

(5.5) HORIZONTAL DISTANCE

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 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.

Values: Microplot: 00.1 to 06.8
Subplot: 00.1 to 24.0
Annular plot: 24.1 to 58.9

(5.6) PREVIOUS TREE STATUS

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.

Values:

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

(5.7) PRESENT TREE STATUS

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.

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 = 5-9.

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.

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

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

Values:

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

1 Ingrowth or reversions – either a new tally tree not qualifying as through growth or a

new tree on land that was formerly nonforest and now qualifies as forest land (reversion or encroachment).

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 5-9 are valid for remeasured trees that no longer qualify as tally:

5 Shrank – live tree that shrank below threshold diameter on microplot/subplot/ macroplot.

6 Missing (moved) – tree was correctly tallied in previous inventory, but has now moved beyond the radius of the plot due to natural causes (i.e., small earth movement, hurricane). Tree must be either live before and still alive now or dead before and dead now. If tree was live before and now dead, this is a mortality tree and should have PRESENT TREE STATUS = 2 (not 0).

7 Cruiser/Technician 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.

9 Tree was sampled before, but now the area where the tree was located is nonsampled. All trees on the nonsampled area have RECONCILE = 9.

Code 5 is used to indicate live trees that shrink below the diameter threshold on the microplot/subplot/macroplot. 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. Use the tree coding guide in Appendix 8 to determine the national coding method for remeasurement trees.

(5.7.2) STANDING DEAD

Record the code that describes whether or not a tree qualifies as standing dead. 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 as measured from the base of the tree to 4.5 feet. 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 Material (DWM) if they otherwise meet DWM tally criteria.

For 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 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)

Values:

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

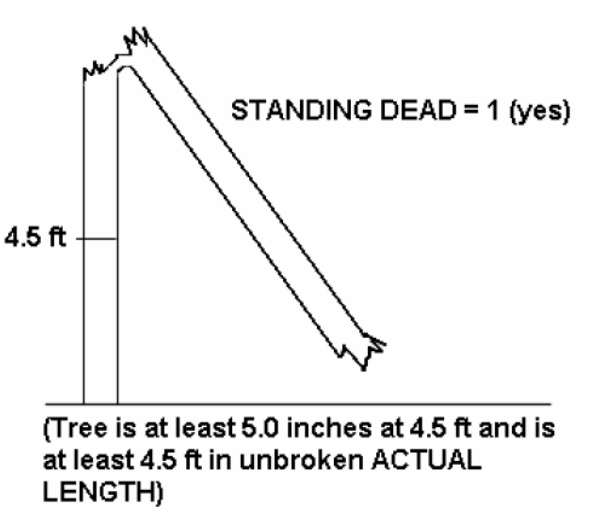


Figure 18. Example of an unbroken bole to 4.5 feet.

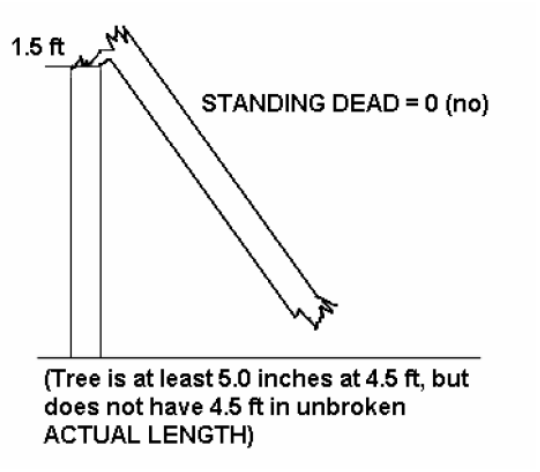


Figure 19. Example of an unbroken length of < 1.5 feet.

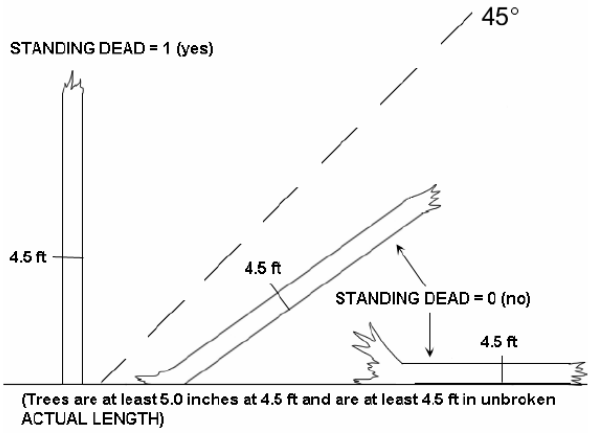


Figure 20. Other examples of dead trees.

(5.7.3) MORTALITY (FIA CORE OPTIONAL)

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).

Values:

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

(5.8) SPECIES

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, 0998 for unknown dead hardwood when the genus or species codes cannot be used, and 0999 for other or unknown live tree. 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. The species code list in Appendix 3 includes all tree species tallied in the Continental U.S. and Alaska. Species designated East/West are commonly found in those regions, although species designated for one region may occasionally be found in another. Species marked as Woodland designate species where DRC is measured instead of DBH. Species that have an "X" in the Core column are tallied in all regions. All other species on the list are "core optional."

Values: See Appendix 3

(5.9) DIAMETER

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. DBH is measured from ground on the uphill side of the tree being measured.

REMEASUREMENT TREES

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.

(5.9.1) PREVIOUS DIAMETER AT BREAST HEIGHT

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.

(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:

- 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.

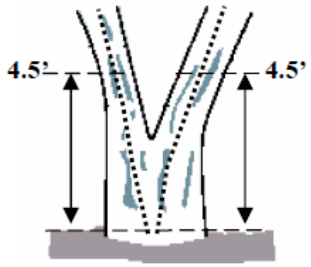


Figure 21. Forked below 1.0 ft.

  - Trees forked below 1.0 foot. Trees forked below 1.0 foot 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 between 1.0 foot and 4.5 feet are also counted as separate trees (Figure 22), but only one distance and azimuth (to the central stump) is recorded for each stem (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.

    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).

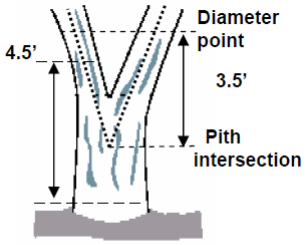


Figure 22. Forked between 1.0-4.5 ft.

  - Trees forked at or above 4.5 feet. Trees forked at or above 4.5 feet 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.

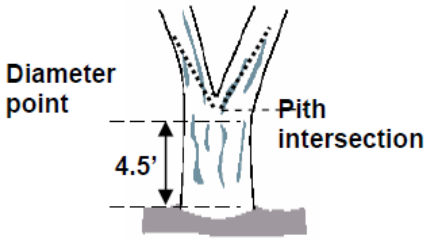


Figure 23. One tree.

- 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.

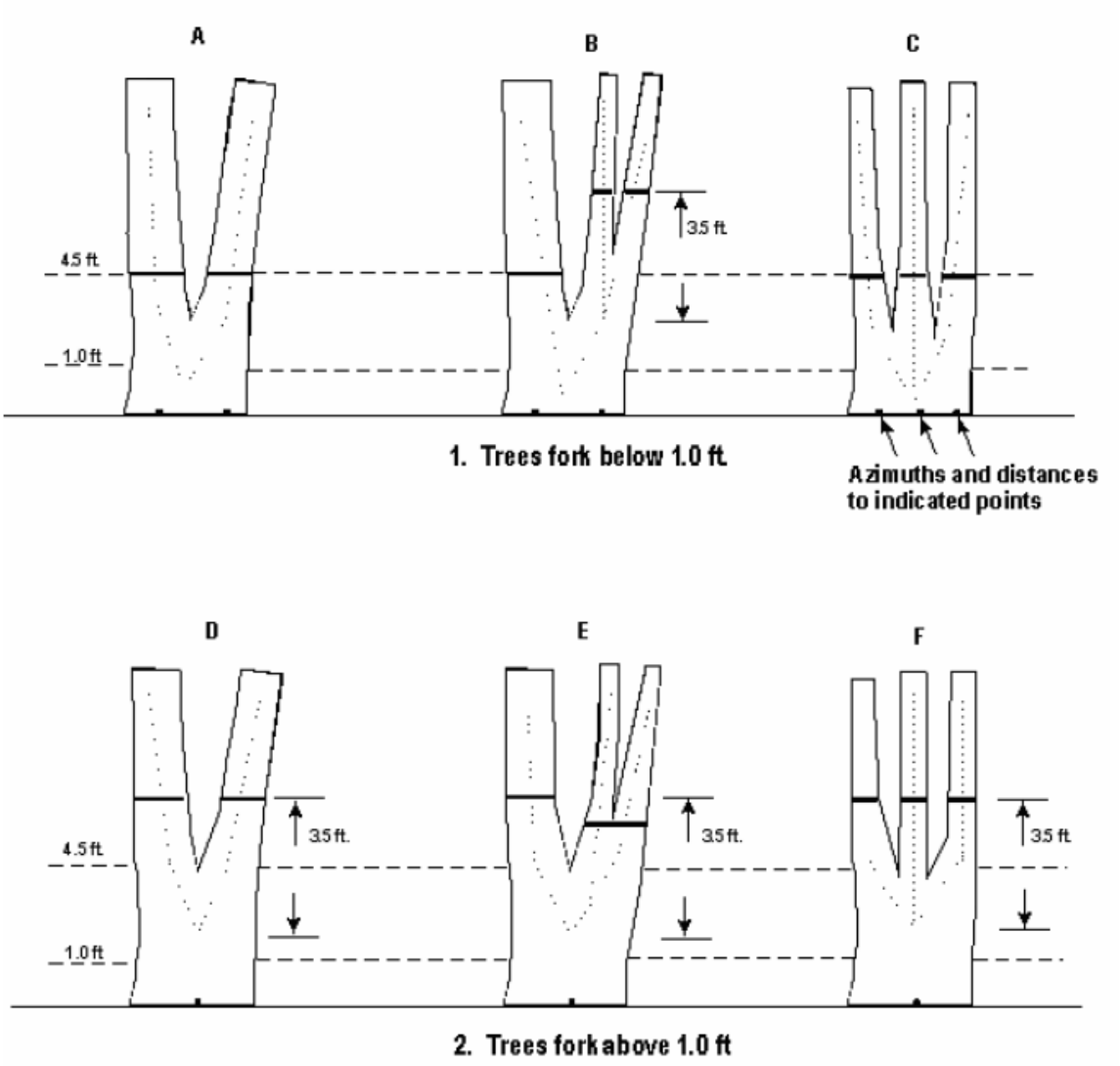


Figure 24. Summary of where to measure DBH, distance, and azimuth on forked trees.

- Tree with butt-swell or bottleneck: 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).

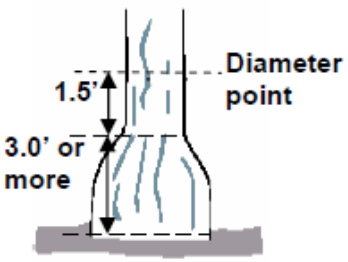


Figure 25. Bottleneck tree.

- 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.

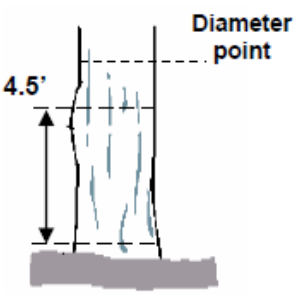


Figure 26. Tree with swelling.

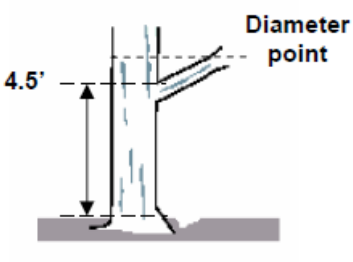


Figure 27. Tree with branch.

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

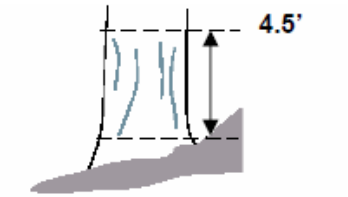


Figure 28. Tree on a slope.

- 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).

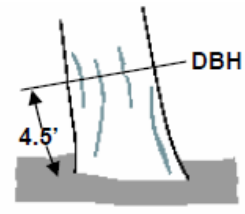


Figure 29. Leaning tree.

- Turpentine tree: 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.

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

- Missing wood or bark: Do not reconstruct the DBH of a tree that is missing wood or bark or at the point of measurement. Record the diameter, to the nearest 0.1 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).

- Live windthrown tree: Measure from the top of the root collar along the length to 4.5 feet (Figure 31).

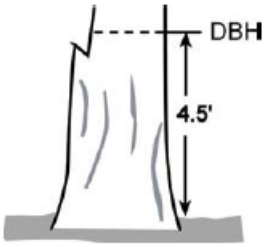


Figure 30. Tree with part of stem missing.

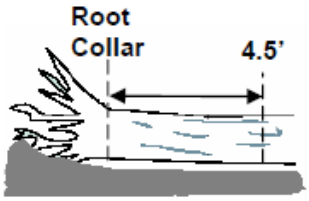


Figure 31. Tree on the ground.

- Down live tree with tree-form branches growing vertical from main bole: When a down live tree, touching the ground, has vertical (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.

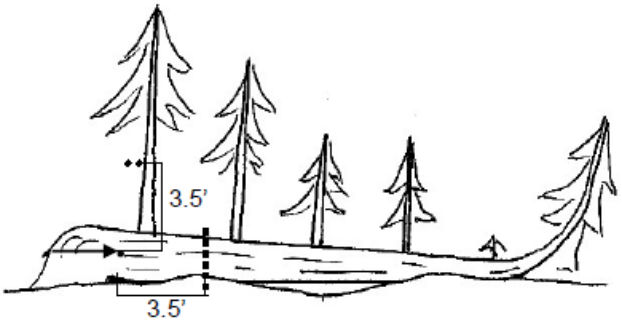


Figure 32. Down tree above duff.

    - 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).

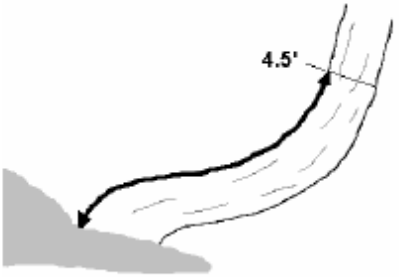


Figure 34. Tree with curved bole (pistol butt tree).

(5.10) PAST NUMBER OF STEMS

If the PAST NUMBER OF STEMS does not equal the CURRENT NUMBER OF STEMS, **do not** change the preprinted value. Make a note in TREE NOTES suggesting the possible reason for the difference.

(5.11) CURRENT NUMBER OF STEMS

Record the total number of stems that were measured for DRC (e.g., record 1 stem as 01; record 12 stems as 12). Count only the number of qualifying stems used to calculate DRC. Qualifying stems are those that are at least 1.0 foot in length and at least 1.0 inch in diameter, 1 foot up from the measurement point.

(5.12) DIAMETER CHECK

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.

Values:

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

(5.13) ROTTEN/MISSING CULL

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 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.
- Metal imbedded in the wood.

Values: 00 to 99

(5.14) TOTAL LENGTH

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

(5.15) ACTUAL LENGTH

Record 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.

(5.16) LENGTH METHOD

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

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.

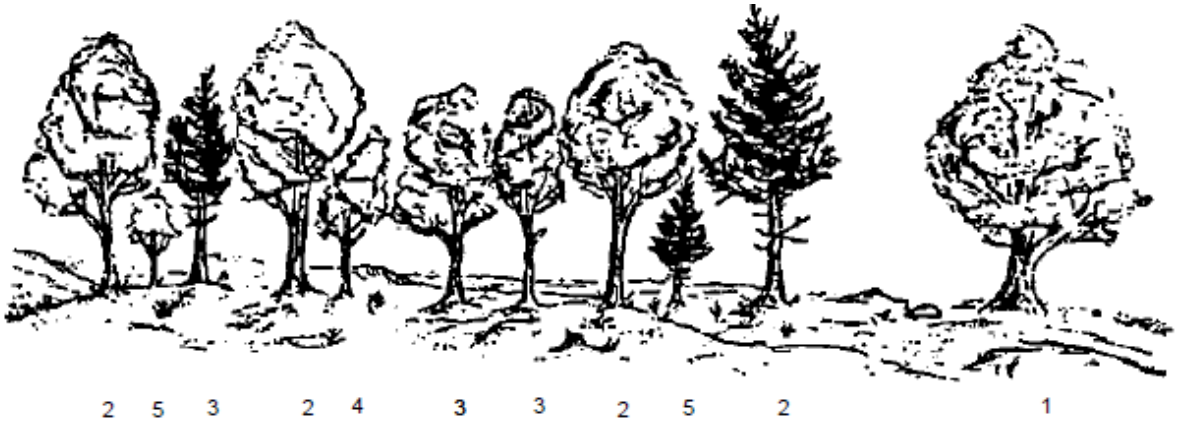
3 Total and actual lengths are visually estimated.

(5.17) CROWN CLASS

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.

Values:

1	Open Grown
2	Dominant
3	Co-dominant
4	Intermediate
5	Overtopped



(5.19) COMPACTED CROWN RATIO

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.

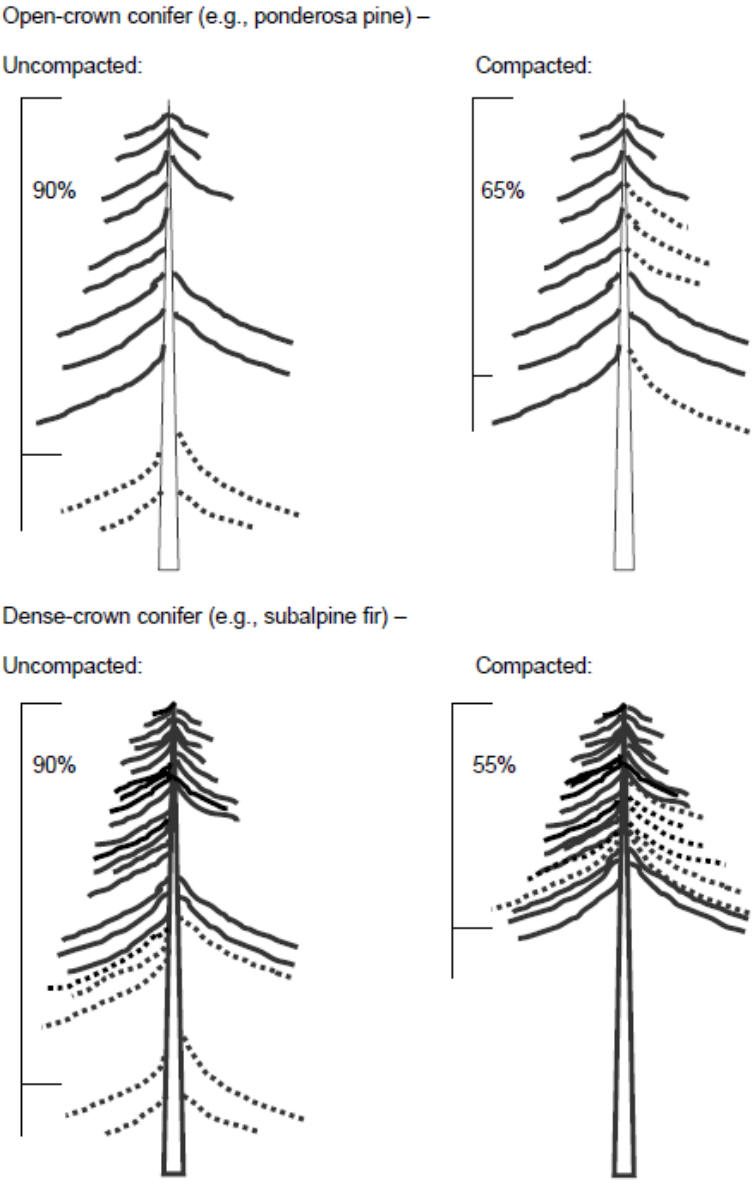


Figure 39. Examples of and comparison between COMPACTED CROWN RATIO and UNCOMPACTED LIVE CROWN RATIO of conifers.

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

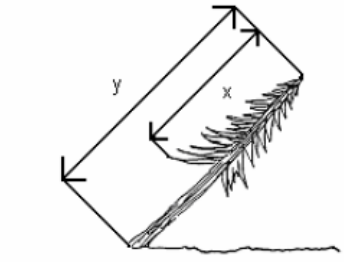


Figure 40. COMPACTED CROWN RATIO on a leaning tree. CROWN RATIO = (x/y)100.

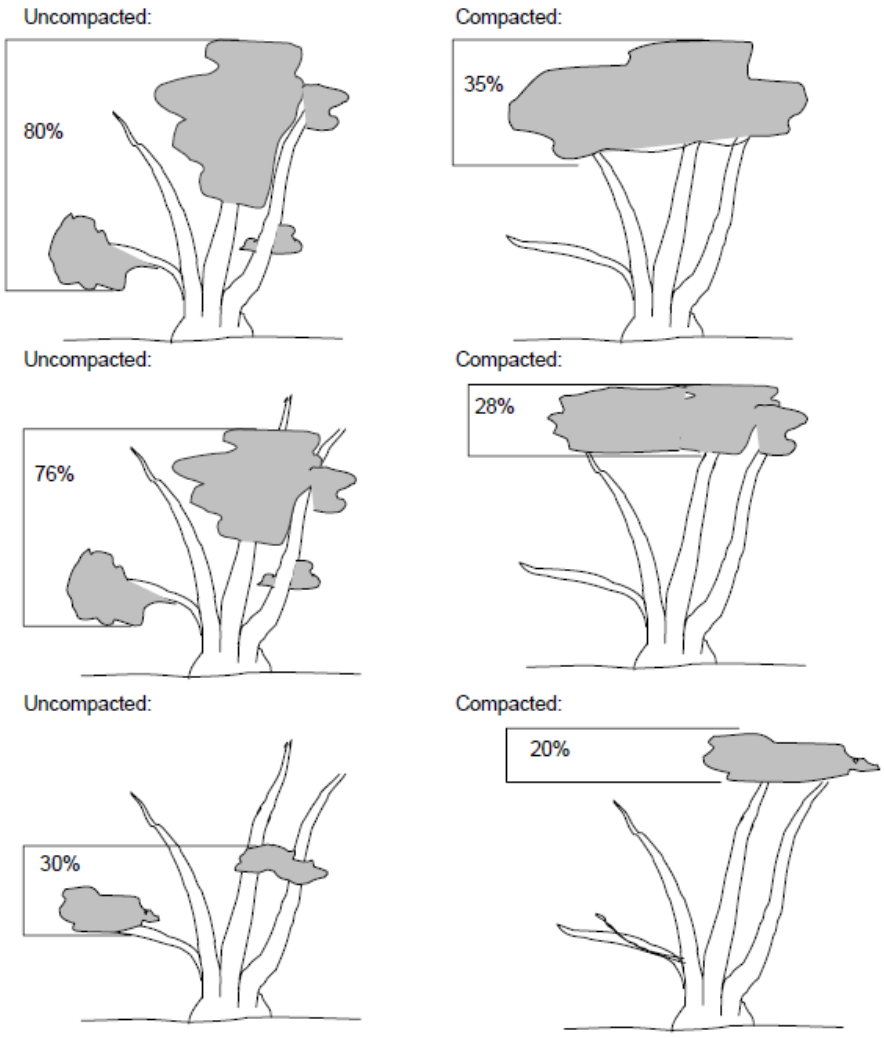


Figure 41. Examples of and comparison between COMPACTED CROWN RATIO and UNCOMPACTED LIVE CROWN RATIO of woodland species.

(5.20) 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 5.20.3, 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.

(5.20.1) DAMAGE LOCATION 1 (CORE OPTIONAL)

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 5.18 (UNCOMPACTED LIVE CROWN RATIO) for more details.

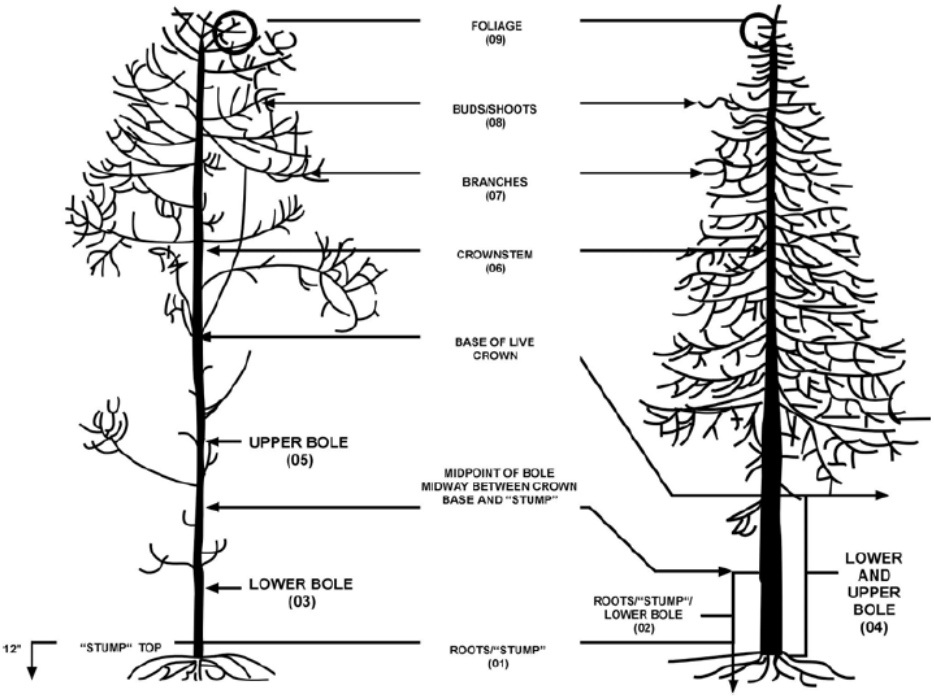


Figure 42. Location codes for damage.

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.

(5.20.2) DAMAGE TYPE 1 (CORE OPTIONAL)

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.

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 from either 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 5.20.3, DAMAGE SEVERITY.

Location 1: Roots and stump

1 Canker, gall -- exceeds 20% of circumference of stump
2 Conks, fruiting bodies, and signs of advanced decay -- any occurrence
3 Open wounds -- exceeds 20% of circumference of stump
4 Resinosis or gummosis -- origin of flow width exceeds 20% of circumference of stump
5 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 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

1 Canker, gall -- exceeds 20% of circumference at the point of occurrence
2 Conks, fruiting bodies, and signs of advanced decay -- any occurrence
3 Open wounds -- exceeds 20% of circumference at the point of occurrence
4 Resinosis or gummosis -- origin of flow width exceeds 20% of circumference at the point of occurrence
5 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
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.
06

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

1 Canker, gall -- exceeds 20% of circumference on at least 20% of branches
2 Conks, fruiting bodies and signs of advanced decay -- more than 20% of branches affected
3 Open wounds -- exceeds 20% of circumference at the point of occurrence on at least 20% of branches
4 Resinosis or gummosis -- origin of flow width exceeds 20% of circumference at the point of occurrence on at least 20% of branches
5 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.

(5.20.3) DAMAGE SEVERITY 1 (CORE OPTIONAL)

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.

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

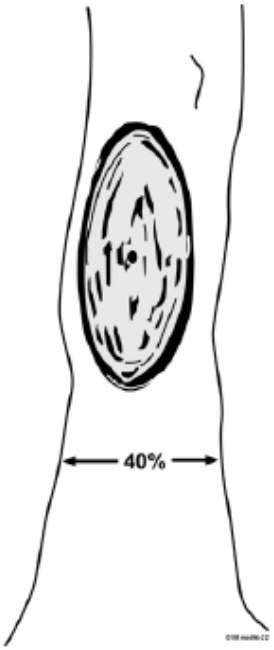


Figure 44. A canker which exceeds threshold. Since 40% of circumference is visible from any side, and since over half the visible side is taken up by the canker, it obviously exceeds the 20% minimum circumference threshold.

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

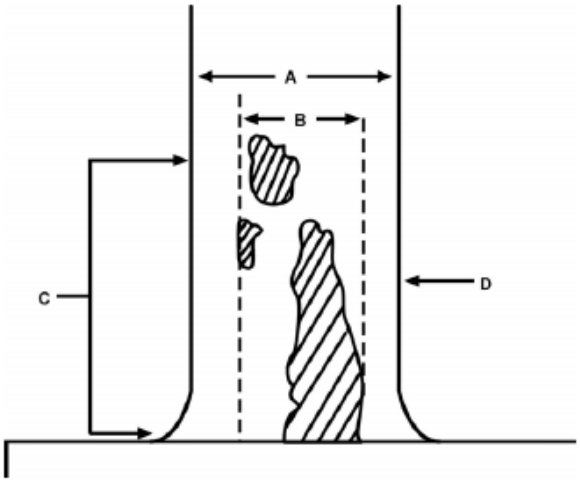


Figure 45. Multiple damage in "stump" and lower bole. A=approximately 40% of tree circumference; B=portion of tree circumference affected by damage; C=vertical distance within one meter; D=midpoint of occurrence at which circumference is measured.

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):

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.

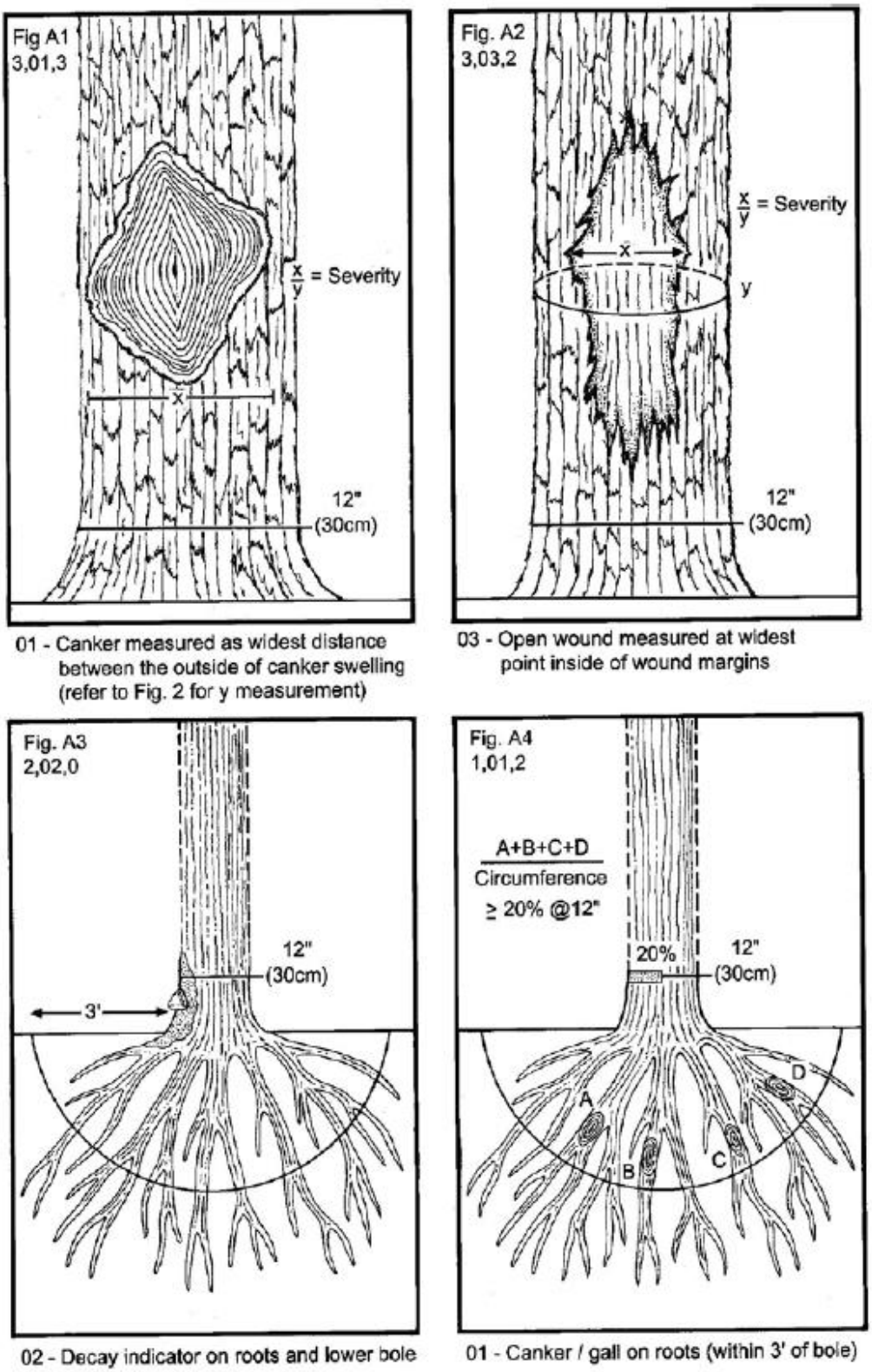
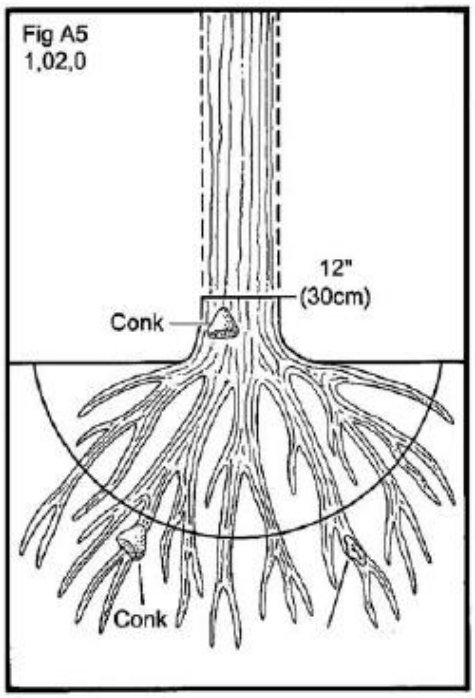
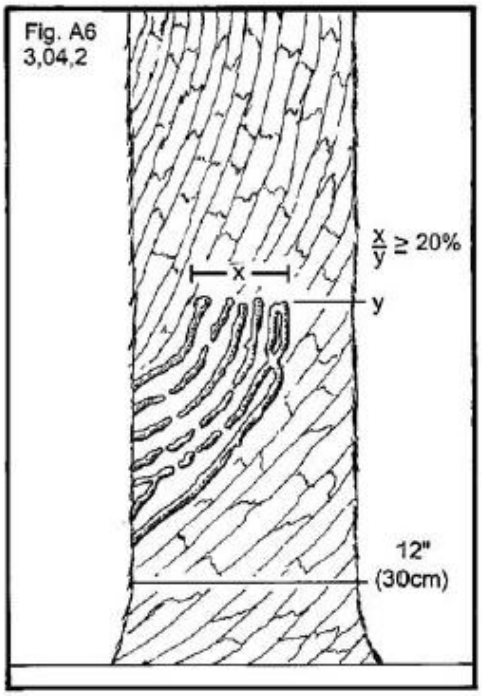


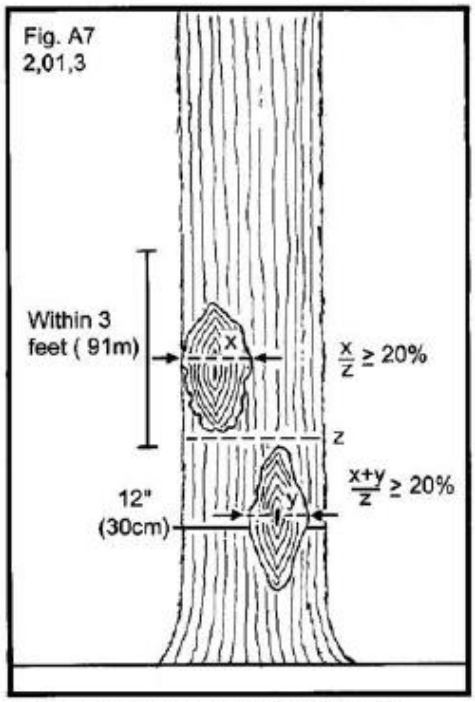
Figure 46. Examples of damage coding.



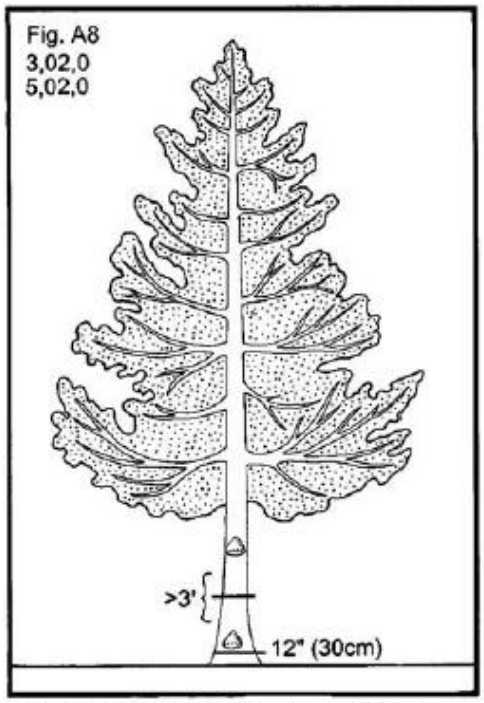
02 - Indicator of decay within 3' of bole. Beyond 3" of bole, indicators must affect ≥ 20% of roots (see fig. 12)



04 - Origin of resinosis in lower bole

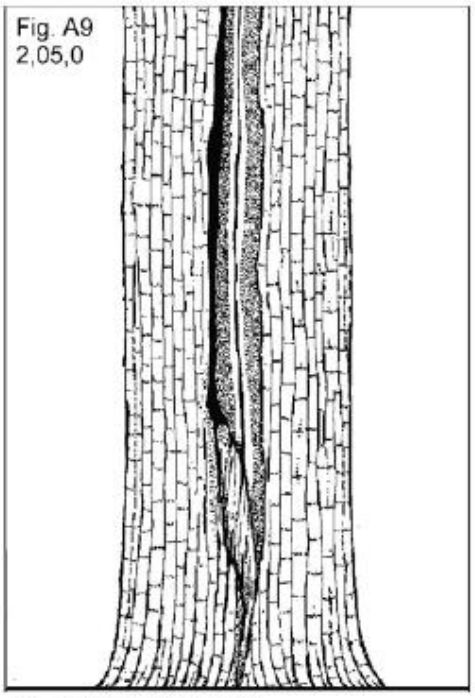


01 - Additive cankers within 3' in roots and lower bole

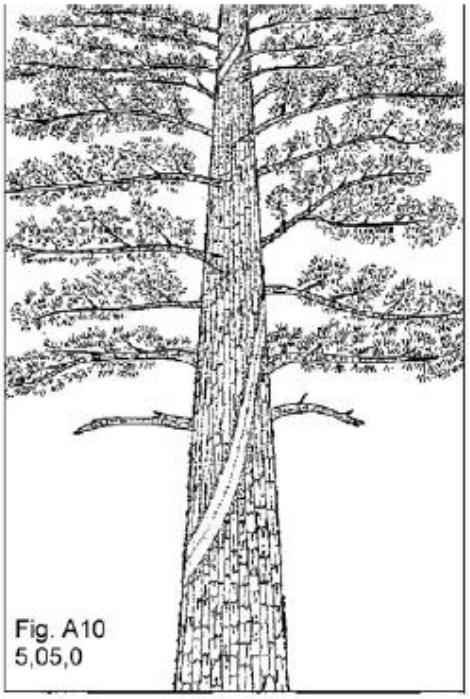


02 - Conks separated by >3'; 2 damages

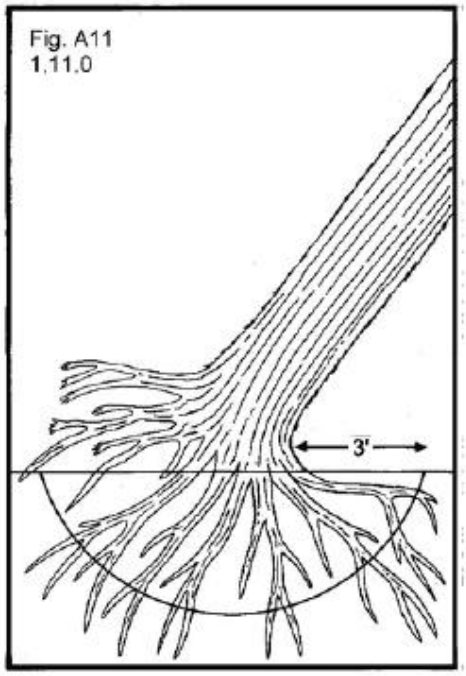
Figure 47. Examples of damage coding.



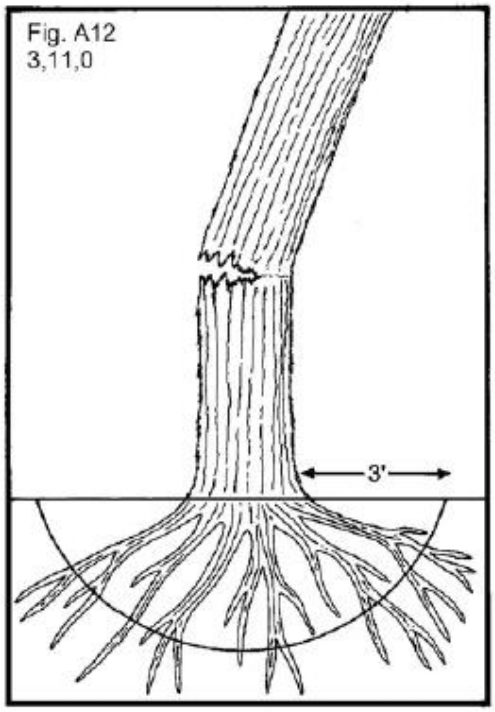
05- Cracks and seams



05 - Lightning strike

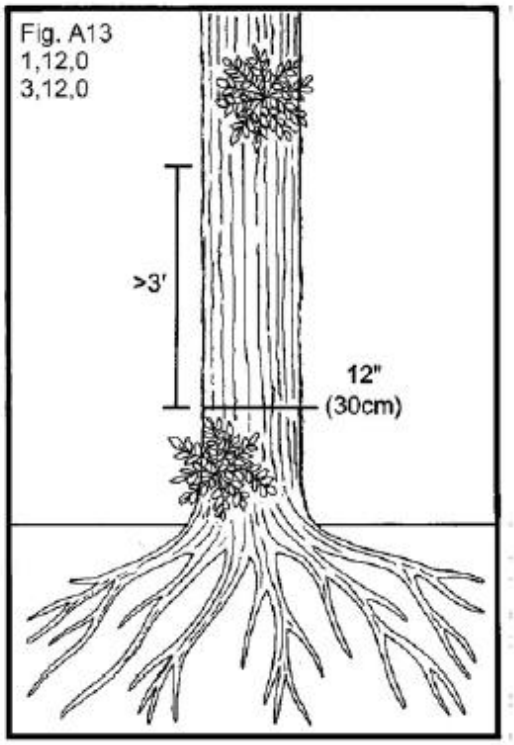


11 - Broken bole or roots <3' from bole, broken roots must be visible

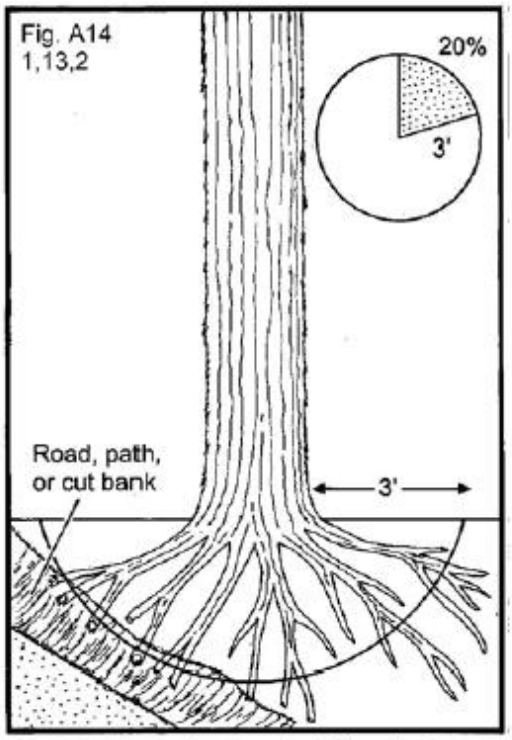


11 - Broken bole or roots <3' from bole

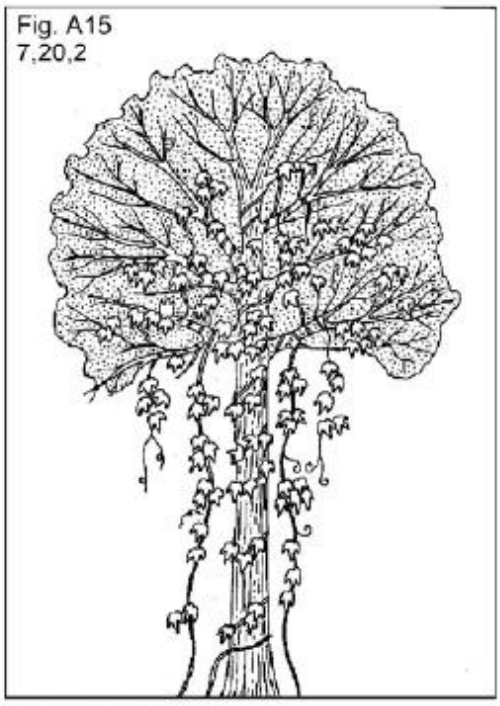
Figure 48. Examples of damage coding.



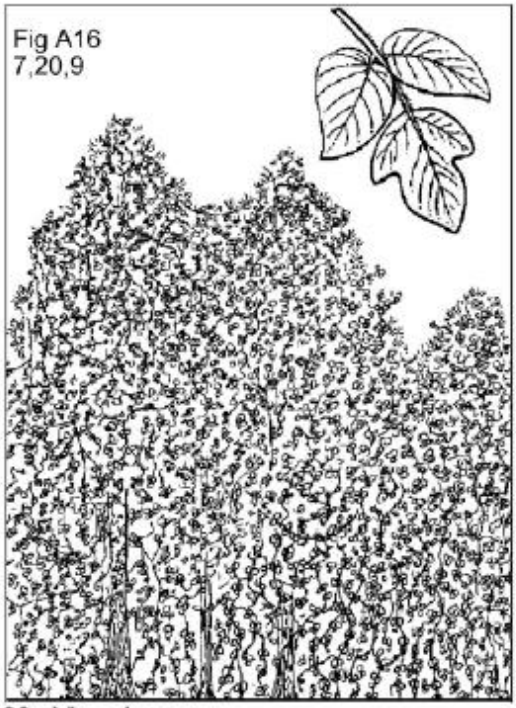
12 - Brooms on roots or bole



13 - Broken or dead roots >3' from bole

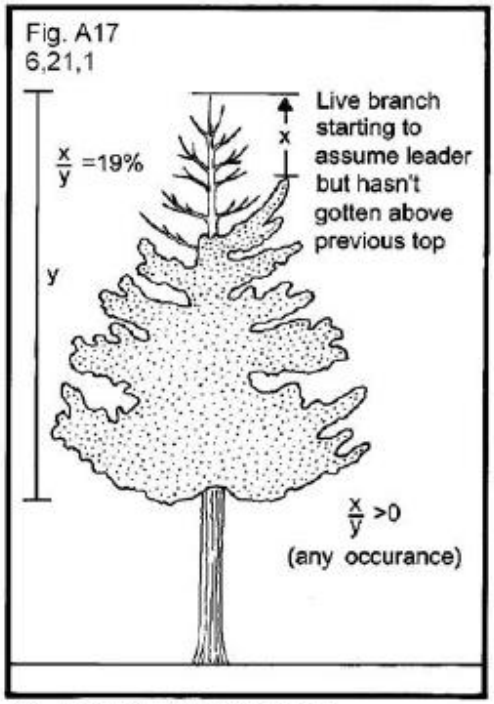


20 - Vines in crown

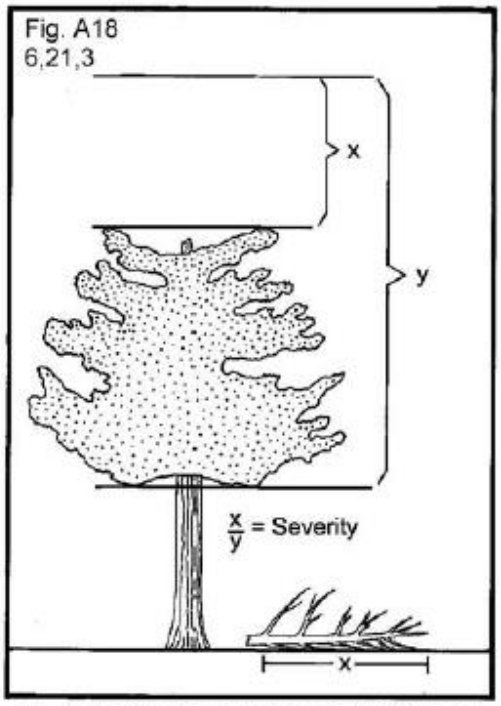


20 - Vines in crown

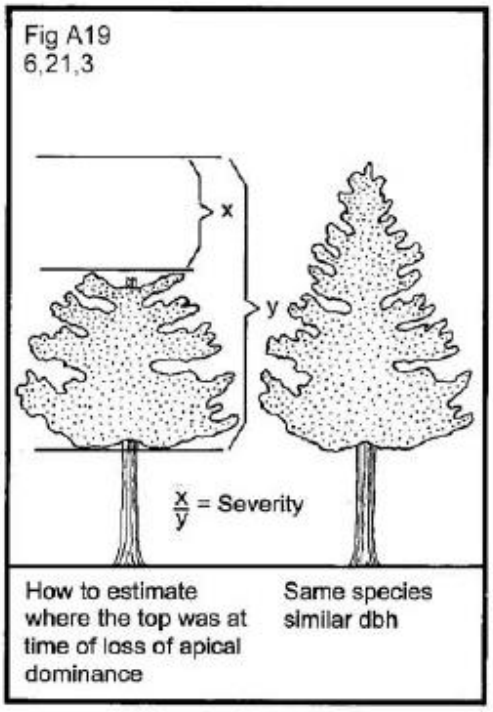
Figure 49. Examples of damage coding.



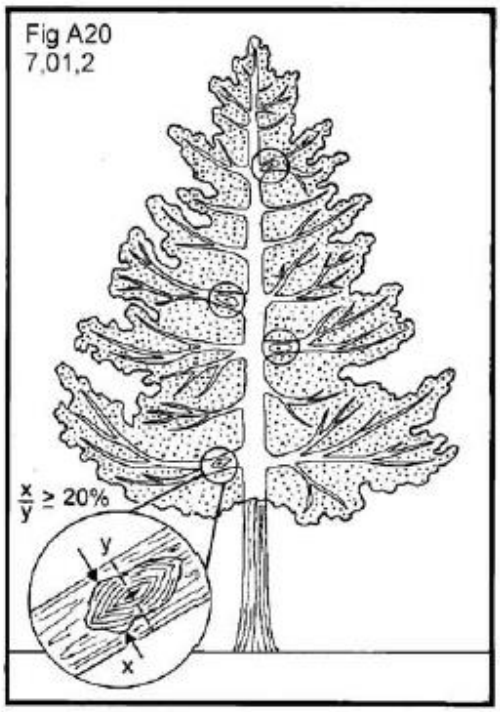
21 - Loss of apical dominance



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



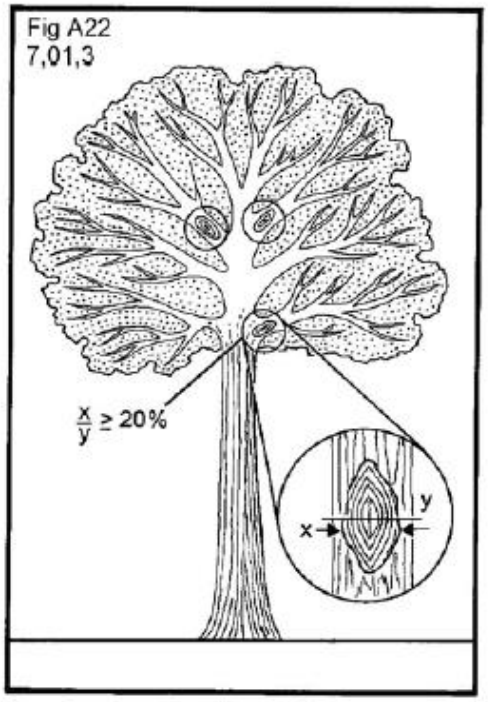
21 - Loss of apical dominance, look for same species of similar dbh



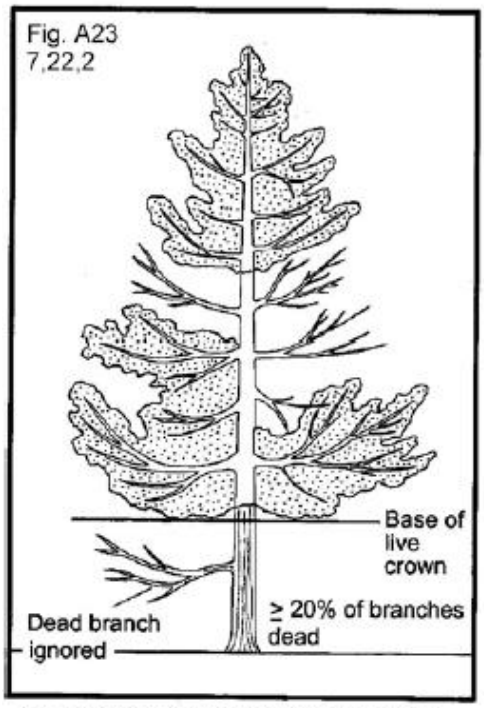
01 - Cankers above the threshold on ≥ 20% of branches

Figure 50. Examples of damage coding.

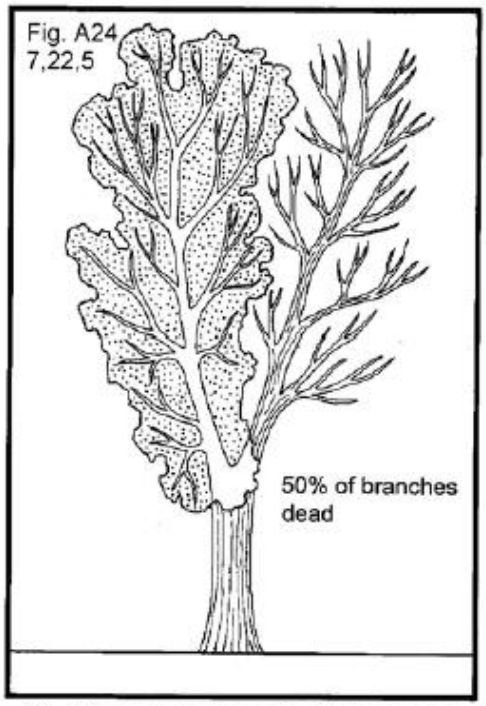
02 - Conks on ≥ 20% of branches



01 - Cankers above threshold on ≥ 20% of branches

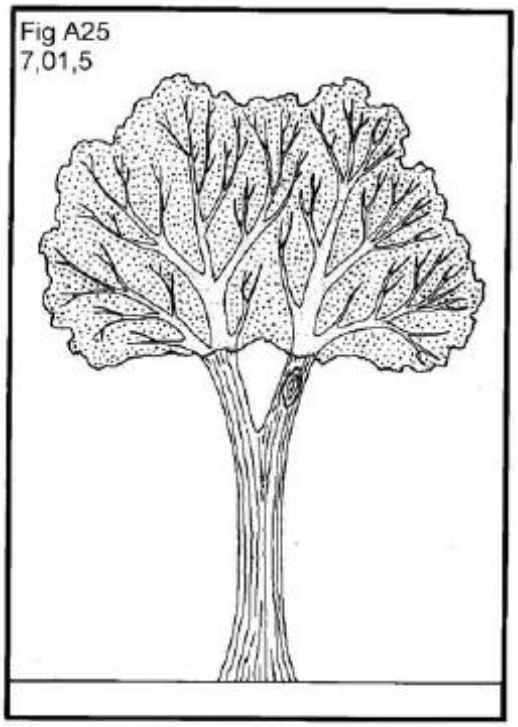


22 - Dead branches within the live crown area. If branches cannot easily be counted, estimate % area of live crown affected

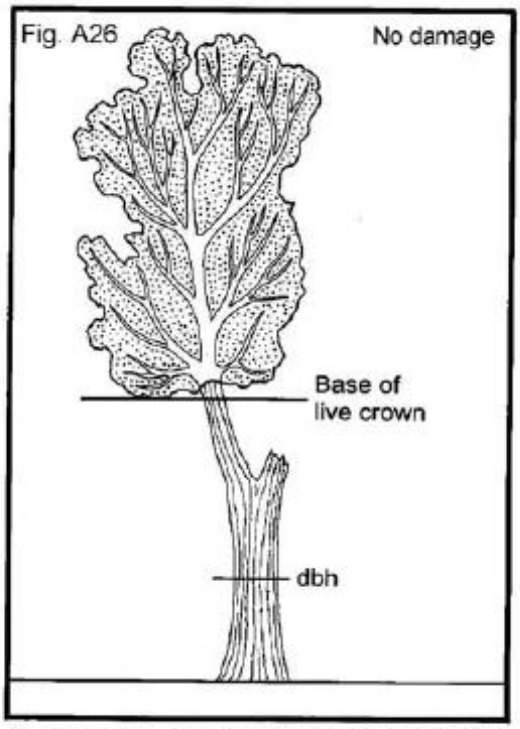


22 - Dead branches; only 2 branches present within live crown area, fines present and ≥20% of branch dead

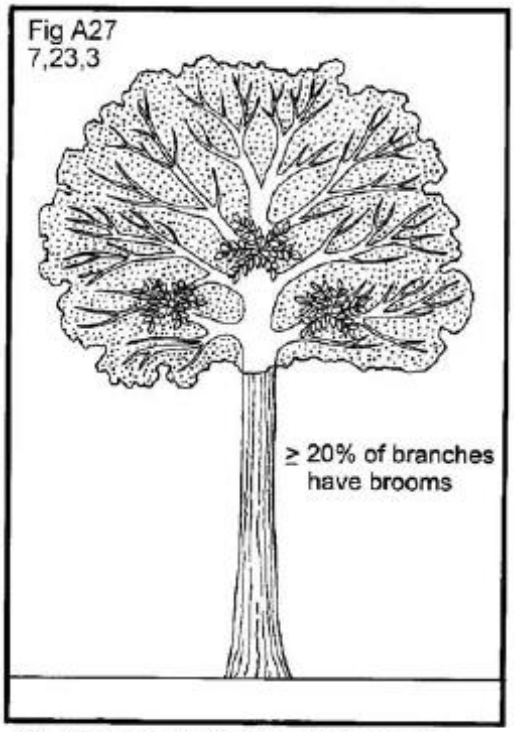
Figure 51. Examples of damage coding.



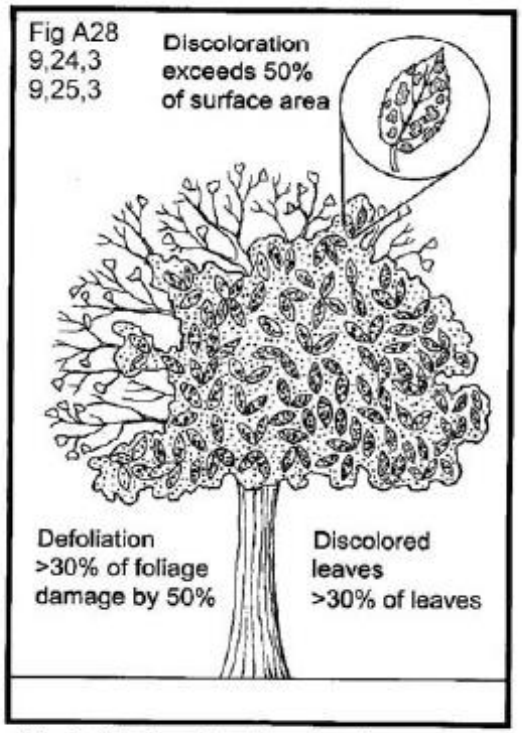
01 - Canker; no crown stem and only 2 branches present



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.

(5.21) CAUSE OF DEATH

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

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)

(5.22) MORTALITY YEAR (CORE OPTIONAL)

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.

(5.23) DECAY CLASS

Record for each standing dead tally tree, 5.0 inches in diameter and larger, the code indicating the tree's stage of decay.

Decay class stage (code)	Limbs and branches	Top	% Bark Remaining
1	All present	Pointed	100
2	Few limbs, no fine branches	May be broken	Variable
3	Limb stubs only	Broken	Variable
4	Few or no stubs	Broken	Variable
5	None	Broken	Less than 20

(5.24) LENGTH TO DIAMETER MEASUREMENT POINT (CORE OPTIONAL)

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 foot, at which the diameter was measured for each tally tree, 1.0 inch DBH and larger. Leave this item blank for woodland species measured for diameter at root collar.

(5.25) 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 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.

(5.26) DWARF 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.

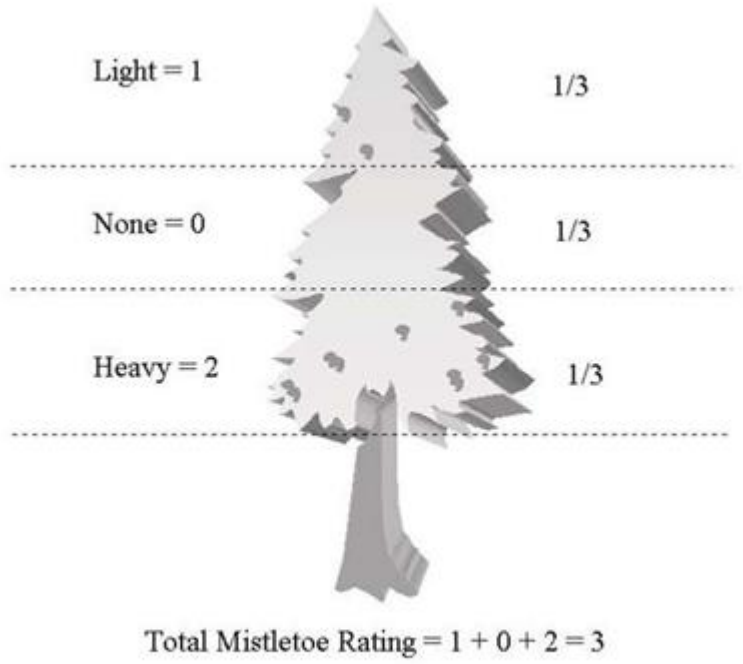


Figure 53. Example of the Hawksworth six-class rating system.

Seedlings

(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 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 same procedures described in section 5.1

(6.2) SPECIES

Use the same procedures described in Section 5.8. Refer to Appendix 3.

(6.3) CONDITION CLASS NUMBER

Use the same procedures described in Section 2.0.

(6.4) SEEDLING COUNT

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 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.

Tree Crowns

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.

Note: This indicator is CORE OPTIONAL for all phase 2 plots.

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.

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.

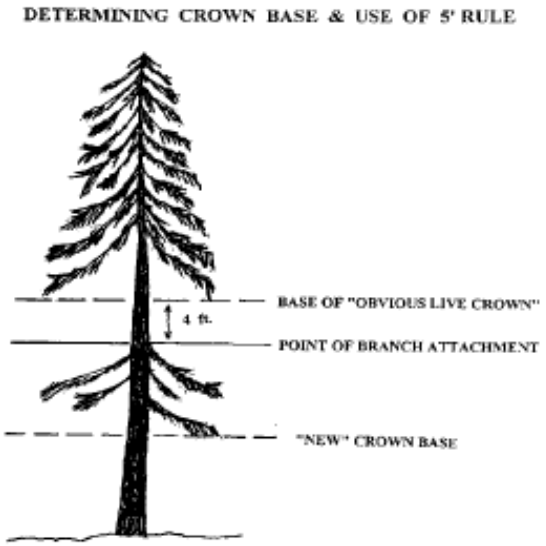
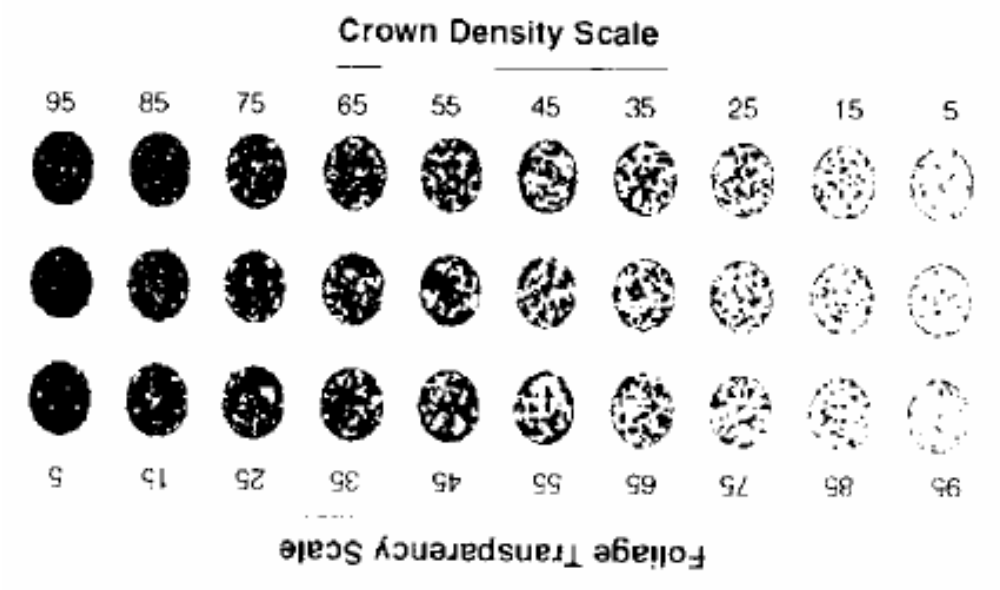


Figure 12-1. Determining the base of the live crown.

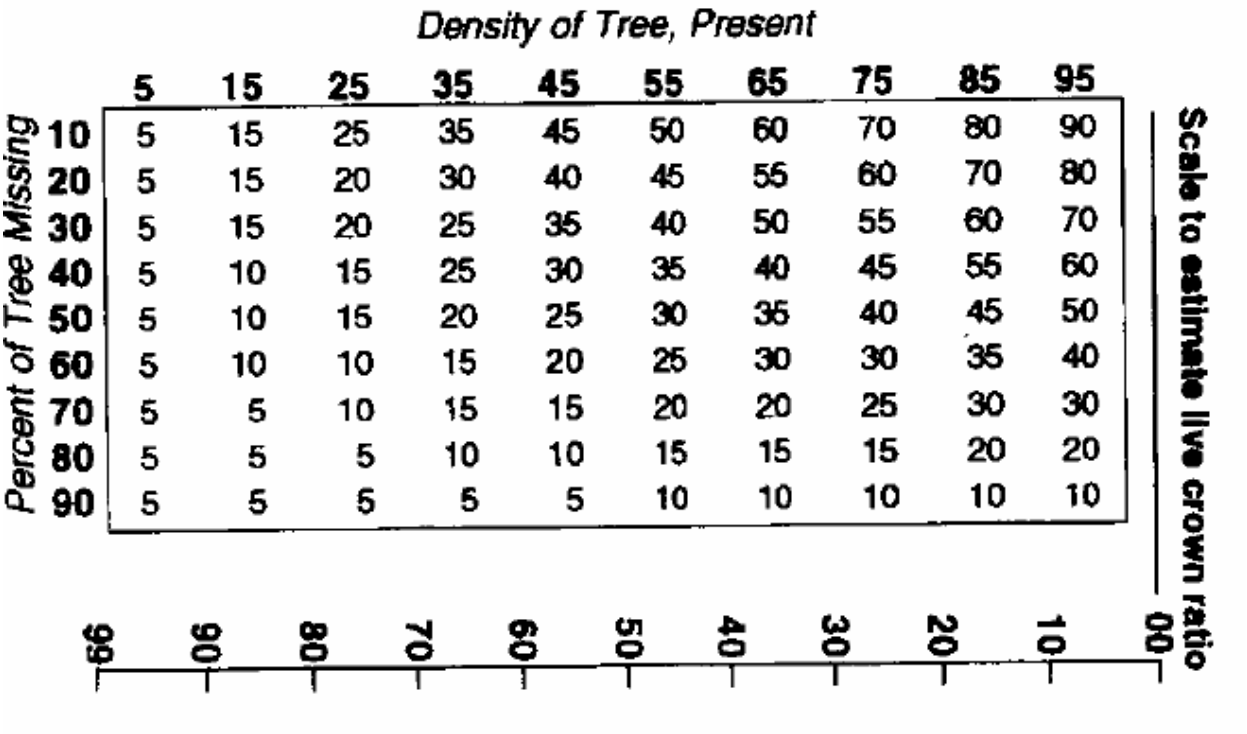
Twig
Any woody lateral growth, with secondary branching, less than 1.0 inch in diameter at the base above the swelling at the point of attachment to a branch or crown stem.

(12.3) CROWN DENSITY-FOLIAGE TRANSPARENCY CARD

Front



Back



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.

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 -
So that crown dimensions are measured consistently on both leaning and upright trees, UNCOMPACTED LIVE CROWN RATIO and CROWN DENSITY for leaning and down trees must be rated in relation to the actual length of the tree bole (as opposed to height above the ground). CROWN POSITION and CROWN LIGHT EXPOSURE should still be estimated relative to the tree’s actual location in the canopy. FOLIAGE TRANSPARENCY will rarely be affected by lean angle. Place a note in the PDR TREE NOTES

field that the tree is leaning if it is leaning more than 45 degrees from vertical.

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. The following combination of codes is a flag for trees with no crowns:

- UNCOMPACTED LIVE CROWN RATIO = 00
- CROWN LIGHT EXPOSURE = 0
- CROWN POSITION = 3
- CROWN DENSITY = 00
- CROWN DIEBACK = 99
- FOLIAGE TRANSPARENCY = 99

After a sudden release or damage, a sapling may have very dense foliage, but no crown as it only has sprigs. The following combination of codes is a flag for saplings with no crowns:

- UNCOMPACTED LIVE CROWN RATIO = 00
- CROWN LIGHT EXPOSURE = 0
- CROWN POSITION = 3
- VIGOR = 3

(12.5) UNCOMPACTED LIVE CROWN RATIO

UNCOMPACTED LIVE CROWN RATIO is a percentage determined by dividing the live crown length by the actual tree length (Figure 12-5). UNCOMPACTED LIVE CROWN RATIO for leaning and down trees must be rated in relation to the actual length of the tree bole (as opposed to height above the ground.) Record the UNCOMPACTED LIVE CROWN RATIO to the nearest 1%.

Saplings

Determine sapling UNCOMPACTED LIVE CROWN RATIO by dividing the live crown length by actual tree length, then enter the appropriate code into the PDR. Live crown length 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 38). When the two estimates do not agree, follow the guidelines listed at the end of section 12.1 *Overview.*

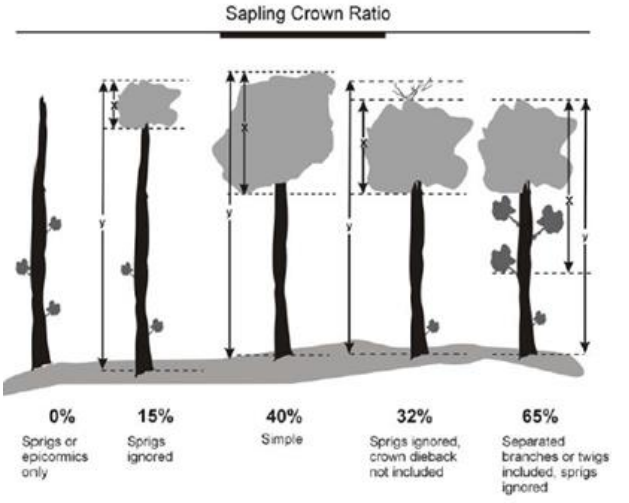


Figure 38. Sapling ratio determination examples.

Trees

Live crown length 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. A clinometer can also be used to verify the UNCOMPACTED LIVE CROWN RATIO by determining the values of both lengths 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*.

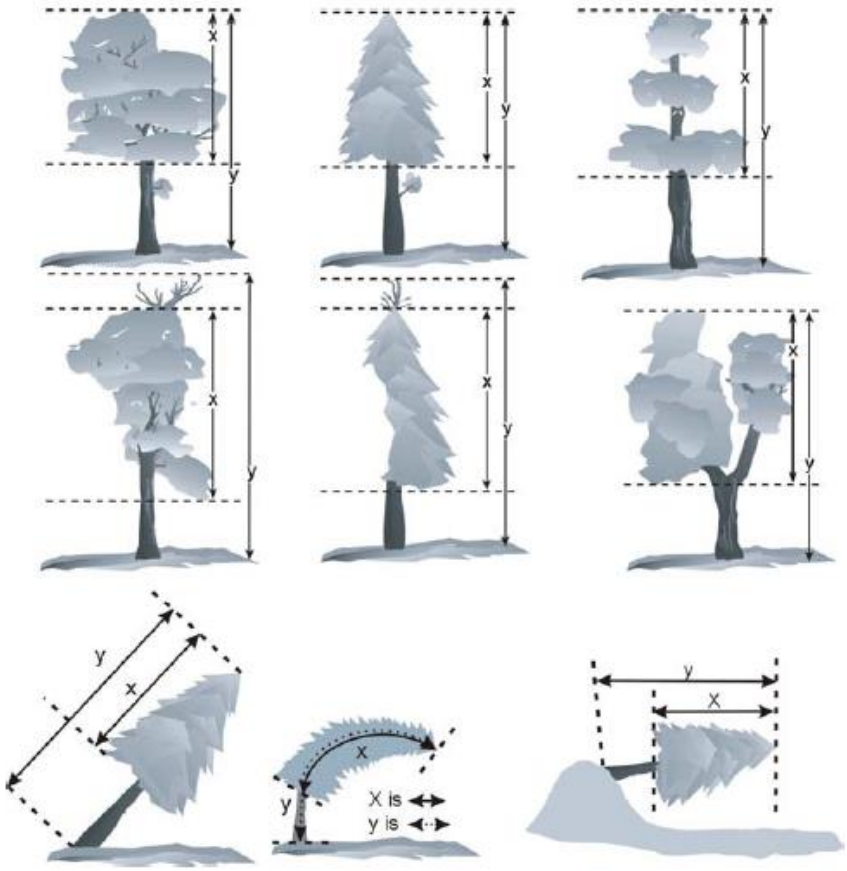


Figure 12-5. UNCOMPACTED LIVE CROWN RATIO examples.

(12.6) CROWN LIGHT EXPOSURE

As illustrated in Figure 12-7, visually divide the crown vertically into four equal quarters (25 percent of the crown circumference.) Rate the UNCOMPACTED LIVE CROWN RATIO for each quarter separately using the criteria for estimating total UNCOMPACTED LIVE CROWN RATIO. In order for an individual quarter to be tallied, that quarter must have an uncompacted live crown ratio of at least 35 percent. Additionally for a quarter to be counted as receiving full light, a continuous portion of live crown (at least 35 percent of the actual tree length) would be completely exposed to direct light if the sun were directly above the tree. Try to divide the crown in such a way that as many quarters as possible receive full light. Count the number of quarters that qualify as receiving full light. Add one if the tree receives direct light from the top.

For this measurement, crown shape cannot result in a tree shading itself (e.g., umbrella-shaped trees.) For down trees or trees with severe lean, do not count any quarters that face the ground.

Note: A sliver of a quarter receiving light does not qualify (Figure 12-8). Trees with all quarters having less than a 35 percent UNCOMPACTED LIVE CROWN RATIO can have a maximum crown exposure of one. Individual quarters with less than 35 percent UNCOMPACTED LIVE CROWN RATIO should not be counted (Figure 12-8).

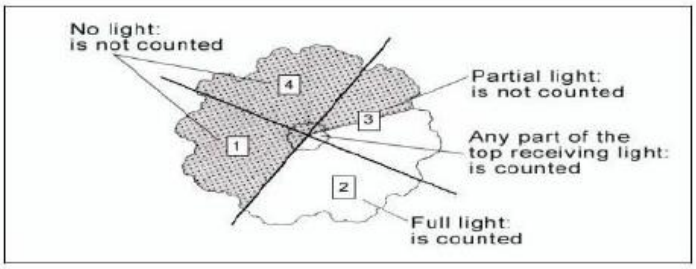


Figure 12-8. CROWN LIGHT EXPOSURE.

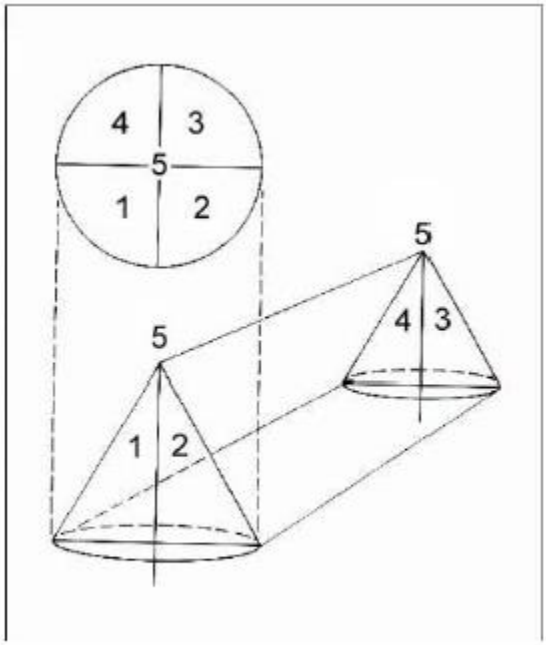


Figure 12-7. Dividing the crown.

Values:

Code	Definition
0	The tree receives no full light because trees, vines, or other vegetation shades it; the tree has no crown by definition.
1	The tree receives full light from the top or 1 quarter.
2	The tree receives full light from the top and 1 quarter (or 2 quarters without the top).
3	The tree receives full light from the top and 2 quarters (or 3 quarters without the top).
4	The tree receives full light from the top and 3 quarters.
5	The tree receives full light from the top and 4 quarters.

(12.7) CROWN POSITION

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 (see 'Trees with no crown by definition…' in section 12.4). 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. For a leaning tree, CROWN POSITION should be estimated relative to the tree's actual location in the canopy.

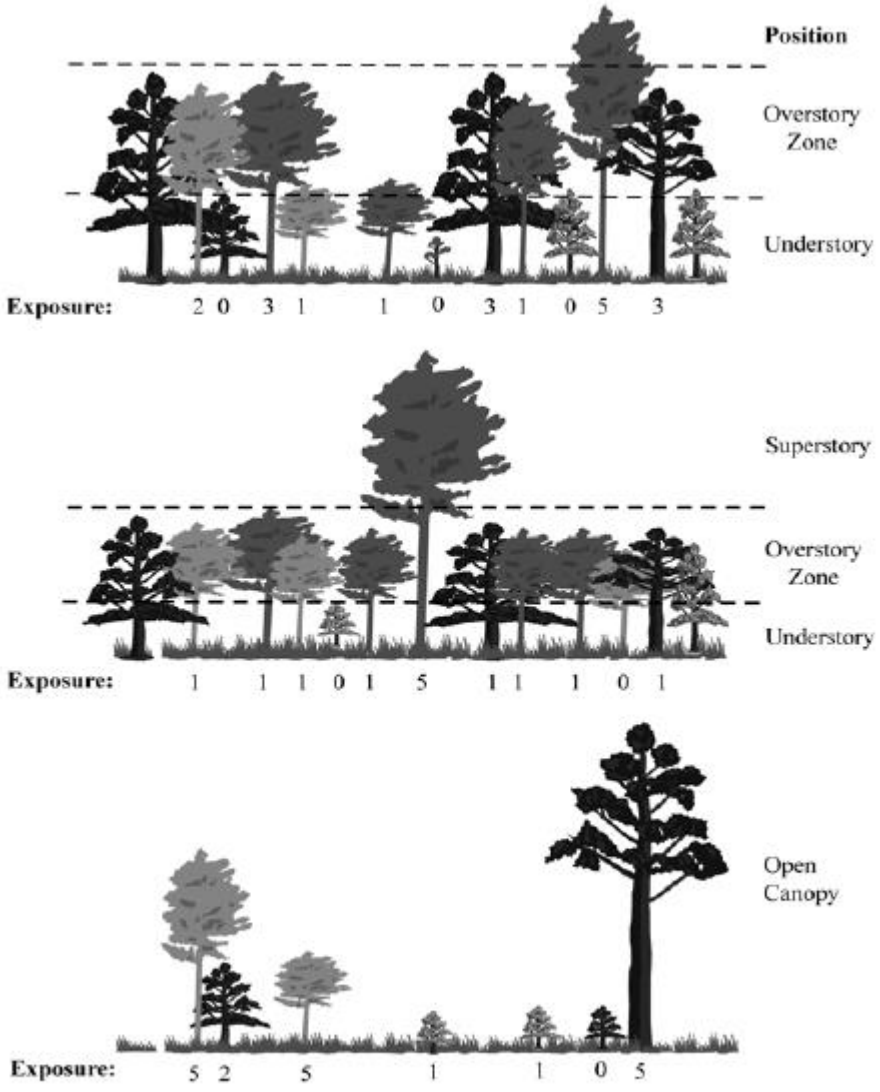


Figure 12-9. CROWN LIGHT EXPOSURE and CROWN POSITION.

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

Values:

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

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" around the central axis of the main crown stem 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). The central axis of the crown usually runs along the length of the tree bole for leaning trees. This axis may be bowed for trees with severe sweep.

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.

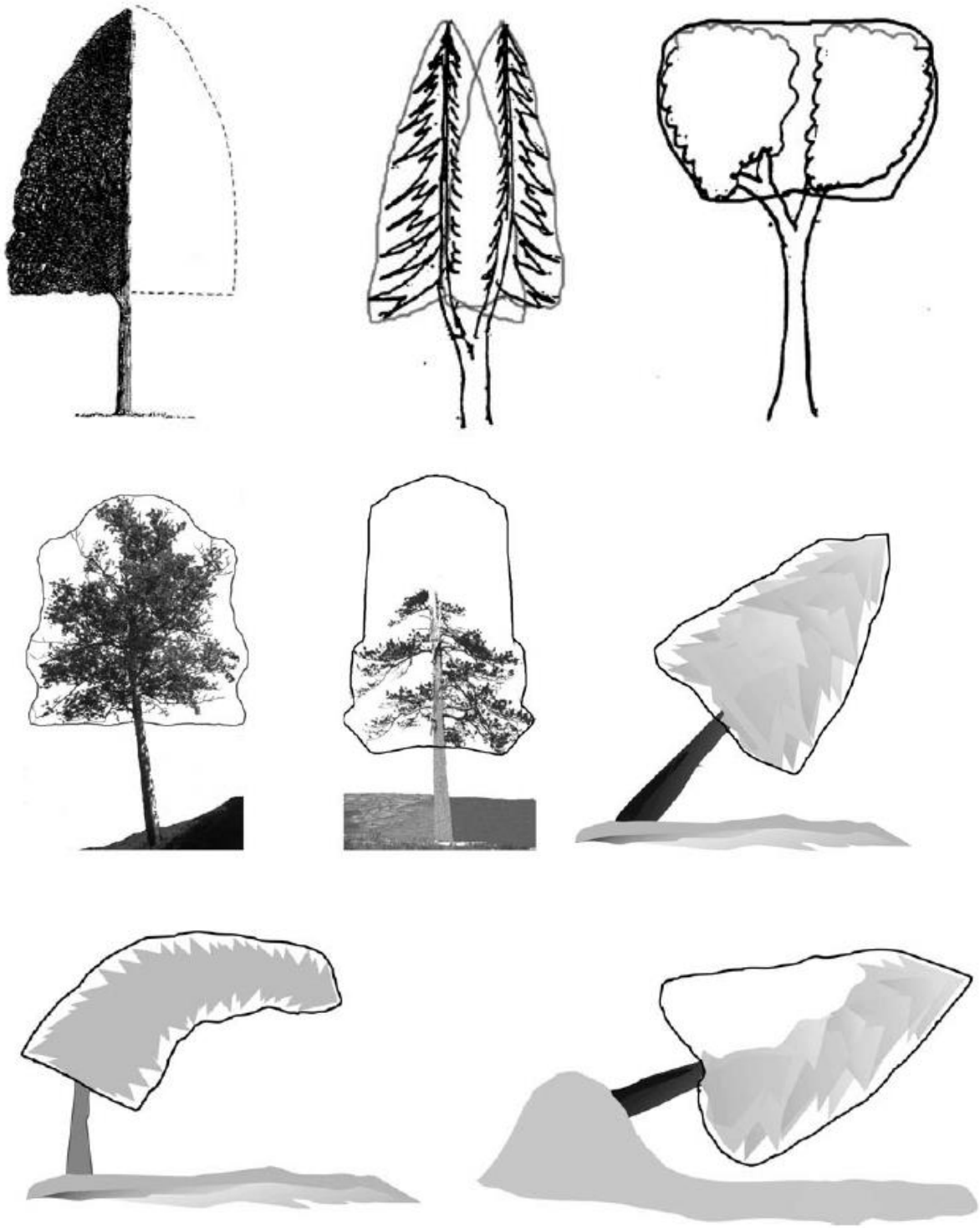


Figure 12-11. CROWN DENSITY rating outline examples.

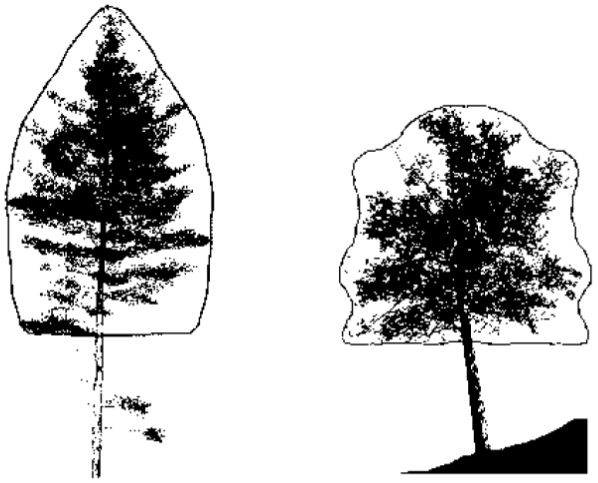


Figure 12-12. Crown density outline and rating examples

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

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.

Values:

Code	Definition	Code	Definition	Code	Definition
0	0%	35	31-35%	70	66-70%
5	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

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!! (See coding for 'Trees with no crown by definition…' in section 12.4.) 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.

Values:

Code	Definition	Code	Definition	Code	Definition
0	0%	35	31-35%	70	66-70%
5	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.

Vegetation Diversity and Structure

The Vegetation Diversity and Structure protocol measures the type, relative abundance, and vertical position of all trees, shrubs, herbs, graminoids, ferns, and fern allies within each LEMP plot. We will use this information to assess forest ecosystem health in terms of diversity and rates of change of community structure for both native and non-native vascular plant species. Changes in the composition and spatial arrangement of vascular plants in a forest may indicate the presence of chronic stresses such as discrete site degradation, climate change, and pollution, as well as forest succession in response to land use history and other disturbances such as ice storms and wind throw.

Sampling is based on a nested plot design known as multi-scale sampling. This method is necessary because different communities have different spatial patterns of species richness, so that a single plot size is an arbitrary sample of species diversity. Sampling at two or more scales provides a better comparison among communities and over space and time.

Data will be collected by crew members that have had previous botanical training and/or experience in Vermont or northern New England, and experience with establishing and measuring cover within vegetation plots at multiple scales

Veg Sample Design and Layout

LEMP Vegetation data are collected on all four subplots of each LEMP plot (Figure 1). Subplot 1 is the Center subplot; Subplot 2 is the North subplot; Subplot 3 is the Southeast Subplot; and Subplot 4 is the Southwest Subplot. The boundaries of the subplot are 24 feet, horizontal distance, from the subplot center. Data are collected on two plot sizes on each subplot: three $1m^2$ quadrats, and the 24-foot radius subplot (Figure 2). From the subplot center, the quadrats are located on the right sides of transects at azimuths 30^o, 150^o, and 270^o (from true north).

When arriving at a subplot, use survey pins or stakes to layout the transects and mark the corners of each quadrat. Use a stake to hold a tape at the subplot center, and measure out each transect along the required azimuth. Mark the 24 foot radius with flagging and a stake, then mark the two corners of the quadrat along the transect at 15 feet and 18.3 feet. Once all three transects are laid out and their 24 foot endpoints flagged, use flagging to mark a minimum of three additional points along the 24 foot radius so that the perimeter is visible from the subplot center.

Once the subplot is laid out, fill out information on the VEG Plot and Subplot Information form. Natural community is determined based on Thompson and Sorenson's 2000 Guide to the Natural Communities of Vermont (as updated on the Vermont Nongame and Natural Heritage Program's website). Estimate total cover of all vascular vegetation foliage in four height layers (0-2, >2-6, >6-16, and >16 feet) on the entire 24 foot radius subplot, and then estimate ground variable cover on the subplot (this can be done in either order and may be easier to reverse, doing the ground variable cover first before it is too trampled). Once this is complete, assess each quadrat for status and trampling using the VEG Quadrat and Subplot Species form.

A species matrix is compiled for each subplot as the vegetation specialist visits each sample unit – quadrats and subplot. A species code is recorded when a species is first encountered. When discovered on subsequent quadrats or in the entire subplot, information is added to the original species record.

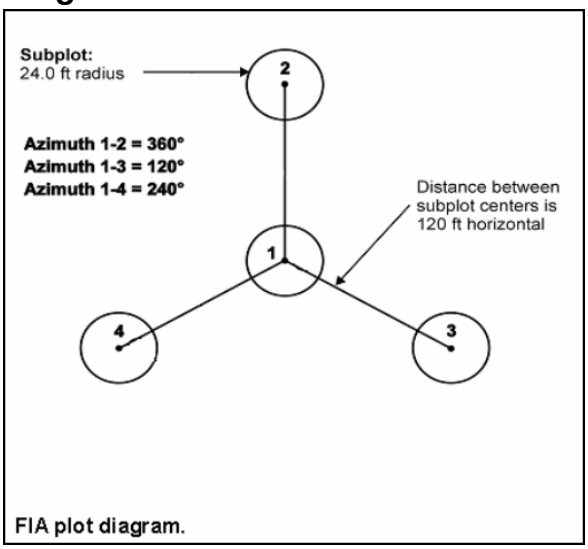
Assess quadrats first by identifying all vascular plant species rooted in the quadrat or with overhanging foliage or live material within 6 feet above the ground above the quadrat. After the quadrats are assessed, a time-constrained search of all vascular plant species on the subplot is conducted. Once all species are recorded, the vegetation specialist will estimate total canopy cover of each individual species, and then the canopy cover within each of three height layers (0-6, >6-16, and >16 feet), over the entire subplot. Most species will have canopy cover in one layer only, in which case the total canopy cover and layer canopy cover will be the same.

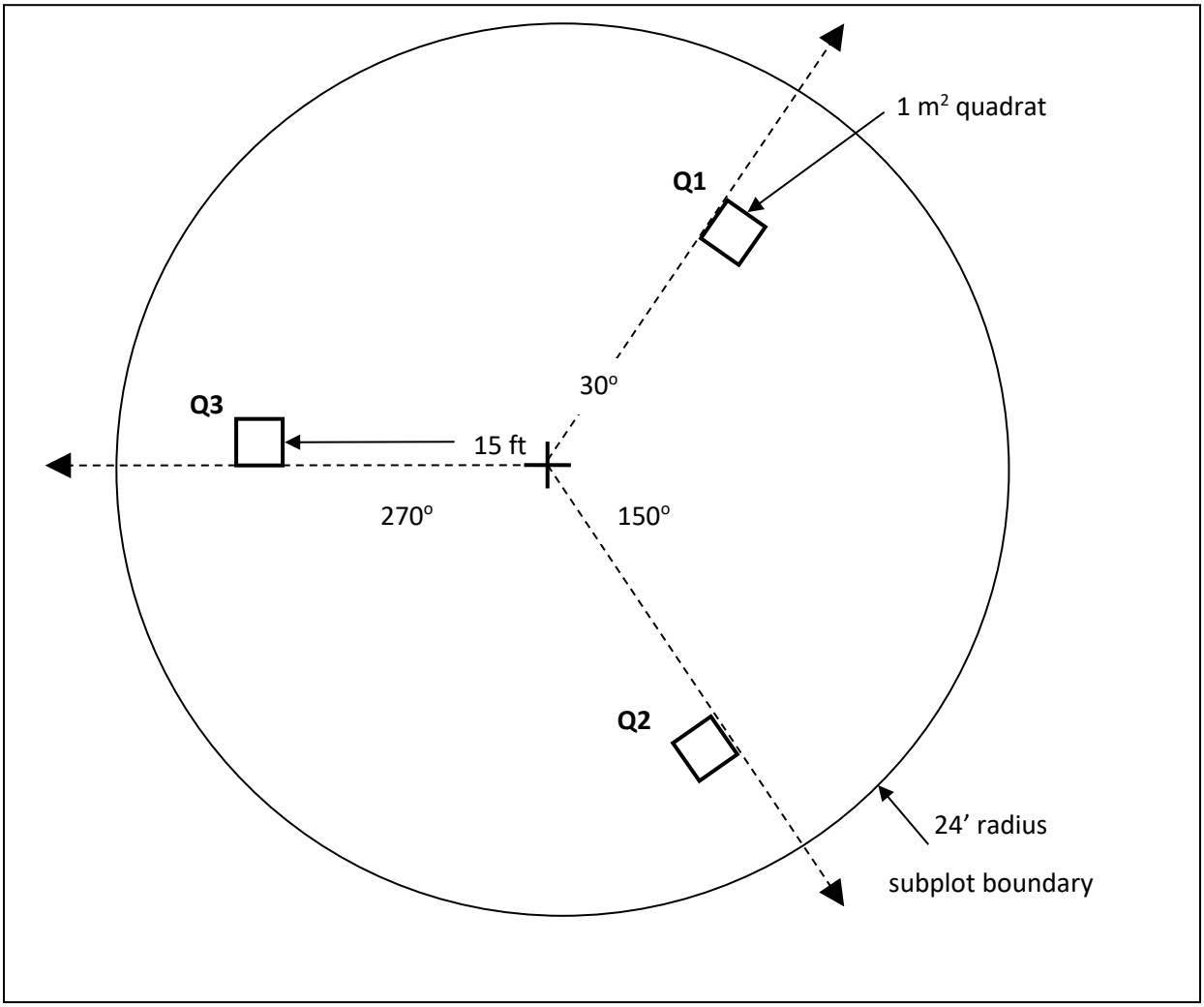
Specimens of all measured plants that cannot be confidently identified to species, but include identifiable material, are collected off-plot and preserved for future identification by the specialist or another more knowledgeable botanist.

Veg Suggested Field Gear

- GPS unit with plot centers entered to navigate to plots
- 2-way radio for communication and safety (and cell phone if available)
- Hardhat
- Compass with declination and azimuths for laying out transects
- Measuring tape at least 24 feet long for laying out transects (loggers tape, roller tape)
- 10 Chaining pins and/or temporary pin flags to mark transects and quadrat corners (3 for each transect plus the center); leather chaining pin "quiver"
- Flagging to mark the subplot perimeter (to be removed when subplot completed)
- 2, 2-meter folding rulers for making the quadrat frame (or use 4, ½-inch, 1-m PVC pipes with elbows); folding rulers can also be used for height measurements
- LEMP VEG Plot and Subplot Information forms (1 per plot)
- LEMP VEG Quadrat and Subplot Species forms (at least 4, often 8, per plot)
- Pencils and knife or sandpaper for sharpening
- LEMP VEG Plot Cheat Sheet for converting m^2 to cover class and listing other codes
- PLANTS Plant code cheat sheet for plants previously found in the LEMP plots
- Local flora keys and species lists (e.g. Newcomb's, Peterson's ferns, fern allies, trees and shrubs)
- Hand lens
- 1-gallon plastic bags for unknown plant specimens
- Sharpee for marking plant bags with plot and specimen information
- Cooler with cold packs for storing plant specimens until return to office
- Access to a plant press or cardboard and newspaper to press specimens until they can be ID'd
- Access to dissecting scope (or to a person with one who is willing to ID specimens)
- Access to a PLANTS code dictionary to look up species not seen before on plots and add to cheat sheet.

VEG Design Layout Diagrams





LEMP VEG PLOT AND SUBPLOT INFORMATION FORM INSTRUCTIONS

STATE

Record the unique FIPS code identifying the State where the plot center is located.
VT = 50, NY = 36

COUNTY

Record the unique FIPS code identifying the County where the plot center is located.

Code	Location	Code	Location	Code	Location
36	***NY (state)***	41	Hamilton	83	Rensselaer
1	Albany	43	Herkimer	85	Richmond
3	Allegany	45	Jefferson	87	Rockland
5	Bronx	47	Kings	89	St. Lawrence
7	Broome	49	Lewis	91	Saratoga
9	Cattaraugus	51	Livingston	93	Schenectady
11	Cayuga	53	Madison	95	Schoharie
13	Chautauqua	55	Monroe	97	Schuyler
15	Chemung	57	Montgomery	99	Seneca
17	Chenango	59	Nassau	101	Steuben
19	Clinton	61	New York	103	Suffolk
21	Columbia	63	Niagara	105	Sullivan
23	Cortland	65	Oneida	107	Tioga
25	Delaware	67	Onondaga	109	Tompkins
27	Dutchess	69	Ontario	111	Ulster
29	Erie	71	Orange	113	Warren
31	Essex	73	Orleans	115	Washington
33	Franklin	75	Oswego	117	Wayne
35	Fulton	77	Otsego	119	Westchester
37	Genesee	79	Putnam	121	Wyoming
39	Greene	81	Queens	123	Yates

PLOT NUMBER

Record the unique plot identification number assigned by LEMP team.

VEG SAMPLE KIND: Record sample kind.

Values:

1 Initial LEMP VEG plot establishment

2 Remeasure of previously established LEMP VEG plot

3 Replacement LEMP VEG plot

VEG CREW

Record the initials of the crew members measuring vegetation diversity and structure.

YEAR: Record the year that the plot was completed.

Month: Record the month that the plot was completed. (Months are numbered ie. Jan = 01, June = 06)

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

VEG PLOT NOTES

Use this field 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.

Veg Subplot Information

VEG SUBPLOT STATUS

Record the code corresponding to how the subplot was sampled.

When collected: Each subplot

Values:

1	Sampled
2	Nonsampled (provide reason in the VEG Plot Notes)

NATURAL COMMUNITY

Record the natural community code for the subplot based on the Guide to the Natural Communities of Vermont (Thompson and Sorenson 2000; as updated at http://www.vtfishandwildlife.com/wildlife_nongame.cfm)

NY go to http://www.dec.ny.gov/docs/wildlife_pdf/ecocomm2014.pdf

When collected: All subplots where SUBPLOT STATUS = 1

Values: See LEMP VEG Plot Cheat Sheet

Subplot Total Canopy Cover By Layer

Estimate the total canopy cover of the foliage of all vascular plants by layer above the ground surface within the subplot. A rapid canopy cover estimate is made, ignoring overlap among species. It may help to visualize canopy cover by collapsing each layer into a 2-dimension space and using the polygon method (canopy cover is based on a vertically-projected polygon described by the outline of the foliage, ignoring any normal spaces occurring between leaves of plants). It is also useful to use the square meter quadrat as the polygon, and estimate how many square meters of foliage exist in a given layer. This area estimate can then be converted to percent cover using the LEMP VEG Plot Cheat Sheet. For tree canopies, it is also useful to imagine the polygons as circles of a particular radius, again using meters because that is the scale of the quadrats. The LEMP VEG Plot Cheat Sheet also provides conversions of various size circles to square meters and then to percent cover.

SUBPLOT CANOPY COVER CLASS LAYER 1 (0-2 feet above ground)

Estimate the total canopy cover class of the foliage of all vascular plants in Layer 1, 0 to 2 feet above the ground. A rapid canopy cover estimate is made, ignoring overlap among species.

When collected: All subplots where SUBPLOT STATUS = 1

Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

SUBPLOT CANOPY COVER CLASS LAYER 2 (>2 - 6 feet above ground)

Estimate the total canopy cover class of the foliage of all vascular plants in Layer 2, >2 to 6 feet above the ground. A rapid canopy cover estimate is made, ignoring overlap among species.

When collected: All subplots where SUBPLOT STATUS = 1
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

SUBPLOT CANOPY COVER CLASS LAYER 3 (>6 - 16 feet above ground)

Estimate the total canopy cover class of the foliage of all vascular plants in Layer 3, >6 to 16 feet above the ground. A rapid canopy cover estimate is made, ignoring overlap among species.

When collected: All subplots where SUBPLOT STATUS = 1
Field width: 1 digit
Tolerance: +/- 1 canopy cover class
MQO: At least 90% of the time
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

SUBPLOT CANOPY COVER CLASS LAYER 4 (>16 feet above ground)

Estimate the total canopy cover class of the foliage of all vascular plants in Layer 4, >16 feet above the ground. A rapid canopy cover estimate is made, ignoring overlap among species.

When collected: All subplots where SUBPLOT STATUS = 1
Field width: 1 digit
Tolerance: +/- 1 canopy cover class
MQO: At least 90% of the time
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

Subplot Ground Variable Records

Assess the cover of ground variables found within the subplot. In areas of thick vegetation, you may opt to complete this section after you have collected the species data and have a better perspective on the ground cover. These describe things in contact with the ground surface and not occupied by vegetation cover. Multiple ground variables often occur on a subplot. It is useful to imagine the ground cover from above, with all of the vascular plant vegetation stripped off and live trees cut. Items must be visible from above. For example, a large rock completely covered with moss would not be coded, but the moss would be. Estimate the percent cover of each ground variable and place within the appropriate cover class. The sum of all ground variable covers must equal 100%.

CRYPTOBIOTIC CRUST COVER CLASS

Record the % cover class for cryptobiotic crust cover in the subplot. Cryptobiotic crust is a layer of symbiotic lichens and algae on the soil surface (common in arid regions).

When collected: All subplots where SUBPLOT STATUS = 1
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

LICHEN COVER CLASS

Record the % cover class for lichen cover in the subplot.

When collected: All subplots where SUBPLOT STATUS = 1
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

LITTER/DUFF COVER CLASS

Record the % cover class for litter and/or duff cover in the subplot. This is a continuous layer of accumulated organic matter over forest mineral soil (e.g. scattered leaves over mineral soil is coded mineral soil). This is usually more than 80% of the ground cover in the GMNF, and so it may be useful to estimate cover on all the other variables first and leave this one for last to determine if it is less than 80% cover.

When collected: All subplots where SUBPLOT STATUS = 1
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

MINERAL SOIL COVER CLASS

Record the % cover class for mineral soil cover in the subplot. This is physically weathered soil parent material that may or may not also be chemically and biologically altered. In our area (GMNF) this is usually the A and/or B horizons, usually when there is windthrow in the subplot.

When collected: All subplots where SUBPLOT STATUS = 1
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

MOSS COVER CLASS

Record the % cover class for moss cover in the subplot. This includes all bryophytes (mosses, liverworts, hornworts).

When collected: All subplots where SUBPLOT STATUS = 1
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

ROAD/TRAIL COVER CLASS

Record the % cover class for road and/or trail cover in the subplot. Include any areas compacted and unvegetated from regular use by foot travel or small motorized vehicles.

When collected: All subplots where SUBPLOT STATUS = 1
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

ROCK COVER CLASS

Record the % cover class for rock cover in the subplot. Include any rocks, boulders, or accumulations of gravel (> ¼ inch diameter) or pebbles).

When collected: All subplots where SUBPLOT STATUS = 1
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

STANDING WATER/FLOODED COVER CLASS

Record the % cover class for standing water and/or flooded cover in the subplot. Include any ponding or flowing water that is not contained within banks.

When collected: All subplots where SUBPLOT STATUS = 1

Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

STREAM/LAKE COVER CLASS

Record the % cover class for stream and/or lake cover in the subplot. Include any body of water contained within banks that is within a forested condition.

When collected: All subplots where SUBPLOT STATUS = 1

Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

TRASH/JUNK/OTHER COVER CLASS

Record the % cover class for trash, junk, or other cover in the subplot. .

When collected: All subplots where SUBPLOT STATUS = 1

Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

WOOD COVER CLASS

Record the % cover class for wood cover in the subplot. Wood pieces included should average greater than 3 inches in diameter and be in contact with the ground; smaller pieces should be included in Litter/Duff cover. Stumps and roots are included. Live trunks are included by imagining them as stumps cut flush to the ground surface.

When collected: All subplots where SUBPLOT STATUS = 1

Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

LEMP VEG QUADRAT AND SUBPLOT SPECIES FORM INSTRUCTIONS

This form is used only for subplots where SUBPLOT STATUS = 1

Quadrat Data

Place the quadrat frame to the right side of the transect line and make sure the corners are lined up at 15 and 18.3 feet from the subplot center along the azimuth line. Level the quadrat, if necessary, by propping up the quadrat corners. When a quadrat is located on a steep slope, the vegetation specialist should be positioned next to or downhill from the quadrat to prevent sliding or falling into the quadrat. In areas of thick vegetation, slide the quadrat sides through the vegetation. Using 2-meter folding rulers allows flexibility in maneuvering through the vegetation.

VEG CREW NAME, YEAR, MONTH, DAY and PLOT are the same as for the LEMP VEG Plot and Subplot Information form.

SUBPLOT NUMBER

Record the code corresponding to the number of the subplot.

When collected: All subplots where SUBPLOT STATUS = 1

Values:

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

QUADRAT NUMBER

Ensure that data entered for each quadrat corresponds with the correct quadrat number on the data sheet

When collected: Each quadrat

Values:

1	Quadrat on 30^{o}
2	Quadrat on 150^{o}
3	Quadrat on 270^{o}

QUADRAT STATUS

Record the code corresponding to how the quadrat was sampled. If QUADRAT STATUS is 1 or 3, continue to enter data for the quadrat. If the value entered is 2, 4, or 5, leave the remaining quadrat items blank.

Values:

1	Quadrat sampled
2	Quadrat not sampled because most or all of it is no longer accessible forested condition
3	Quadrat sampled, no vascular plants rooted in or overhanging within 6 feet of the ground surface
4	Quadrat not sampled, hazard present on quadrat

5 Quadrat not sampled, other reason – enter in plot notes

TRAMPLING

A trampling code is assigned to each quadrat at the start of vegetation diversity measurements. Trampling is defined as damage to plants or disturbance of the ground layer by humans, livestock, or wildlife.

When collected: QUADRAT STATUS = 1 or 3
Values:

1 Low: 0-10% of quadrat trampled; pristine to relatively undisturbed
2 Moderate: 10-50% of quadrat trampled: trampling by animals or field crew
3 High: >50% of quadrat trampled: hiking trail or heavily grazed

VEG SUBPLOT NOTES

Use these fields to record notes pertaining to the quadrats and subplot

Species Records

Species data are collected at both the subplot level and the quadrat level for each subplot. A single species list is maintained for the entire subplot. Species codes are recorded as each species is discovered for the first time on a given quadrat or subplot. Data are added to the original species' record when the species is encountered on subsequent quadrats. This section describes the data required to uniquely identify each recorded species. *Note: it is typically easier to collect quadrat species and data first, and then the remaining subplot species data.*

SPECIES CODE

Record a code for each vascular plant species found rooted in or overhanging the subplot at any height or rooted in or overhanging within 6 feet above the quadrat. Species codes must be the standardized codes in the Natural Resource Conservation Service (NRCS) PLANTS database (most recent version).

If a plant cannot be identified quickly and confidently, assign a NRCS PLANTS genus or unknown code appropriate to the species. Collect a specimen away from the quadrat unless the species is locally sparse (if 5 or fewer individuals are present in the entire plot (4 subplots) and immediate surrounding area).

When collected: First time each unique species is discovered in the subplot
Values: Accepted NRCS species when the species is known, or an accepted NRCS genus or unknown code when the species is not known

UNKNOWN NUMBER (UNK #)

When a NRCS genus or unknown code is entered for the first time on a PLOT, the UNK # is "1". If more than one unidentified species is discovered on the PLOT that is described by the same genus or unknown code, the next sequential number is assigned.

When collected: For any species coded using an NRCS genus or unknown code
Values: 1-99, assigned in sequential numbers

SPECIMEN COLLECTED (COLLECT?)

Record if a specimen was collected or not for each species, genus, or unknown code. If an unknown or genus-level species was not collected, not the reason in the PLOT SPECIES NOTES.

When collected: All species records
Values:

0	No, a specimen was not collected
1	Yes, a specimen was collected

SPECIMEN LABEL NUMBER

Record the label number for the collected specimen. The label number consists of the concatenation of the genus or unknown code, the unknown #, the plot #, and the subplot #. Write this number in sharpie on a 1-gallon plastic bag and place the specimen in the bag. Include on the bag the date, the natural community, soil drainage conditions, and the most common plants associated.

When collected: When COLLECT? = 1
Values: *genus/unk-unk#-plot#-subplot#*

PLOT SPECIES NOTES

Notes may be entered for any species encountered, but are required for each new species that is not identified. Enter text that describes the species or explains why it was not collected. This text may be used on the specimen label as well.

When collected: Required for any new unidentified species encountered on a plot and when COLLECT? = 0.
Values: English or Latin words, phrases, and numbers

Veg Quadrat Species Data Collection

SPECIES PRESENCE/ABSENCE ON QUADRAT

At each new sampled quadrat, record species presence or absence. When a new species is encountered, enter it using the fields described for **Species Records**.

When collected: For each unique species present on a quadrat with a QUADRAT STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

Blank or 0	not present
1	present

Subplot Species Data Collection

After completing the three quadrats on a sampled subplot, the vegetation specialist does a search of the entire subplot. Only species rooted in or overhanging the subplot are included. All species recorded on the current subplot's quadrats must be included in canopy cover assessments. The vegetation specialist records abundance for all species, searching for no more than an average of 45 minutes per subplot. Some vegetation specialists find they spend more time on the first subplot, but less time on other subplots because most plants have been identified and coded. Only emergent plants are recorded in wetland forest situations. Epiphytes (Spanish moss, ferns, orchids, mistletoes) are recorded as well as possible as seen from ground level.

Two types of canopy cover class estimates are made for each species: total canopy cover class and canopy cover class within each of three layers. The majority of plants will have canopy cover in only one layer, in which case the total and layer canopy cover classes will be identical. It is often easiest to estimate the species' total cover after each layer's cover has been estimated. Canopy cover is based on a vertically projected polygon described by the outline of the foliage, ignoring any normal spaces occurring between the leaves of plants. It may be useful to use a square meter quadrat as the polygon, and estimate how many square meters of a species' foliage exist in a given layer. This area estimate can then be converted to percent cover and then cover class using the LEMP VEG Plot Cheat Sheet. For tree species' canopies, it is also useful to imagine the polygons as circles of a particular radius, again using meters because that is the scale of the quadrats. The LEMP VEG Plot Cheat Sheet also provides conversions of various size circles to square meters and then to percent cover and cover class. For each species, when applying cover class, ensure that the total cover class represents no more than the sum of cover assigned for all layers, but is also at least as large as the greatest cover class assigned to any one layer. For species occurring in more than one layer, it may be useful to keep track of actual % cover estimates in crib notes to ensure the total cover class is estimated correctly.

SUBPLOT SPECIES TOTAL PERCENT CANOPY COVER CLASS

Estimate the total canopy cover class of the foliage for each plant species across all layers over the entire subplot area. A rapid canopy cover estimate is made, ignoring overlap among species. For species that occur in only one layer, the total and layer canopy cover classes are identical. For each species, when applying cover class, ensure that the total cover class represents no more than the sum of cover assigned for all layers, but is also at least as large as the greatest cover class assigned to any one layer. For species occurring in more than one layer, it may be useful to keep track of actual % cover estimates in crib notes to ensure the total cover class is estimated correctly.

When collected: Each unique species present on current subplot
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

SUBPLOT SPECIES CANOPY COVER CLASS LAYER 1 AND 2 (0-6 ft)

Estimate the total canopy cover class of the foliage for each plant species in Layers 1 and 2 combined, 0 to 6 feet above the ground, over the entire subplot area. A rapid canopy cover estimate is made, ignoring overlap among species. For plants rooted in the subplot, but with no

foliage in the combined Layer 1 and 2, enter 0 or leave blank. Cover class assigned to any one layer cannot be greater than the value assigned for the total cover class for that species.

When collected: Each unique species present on current subplot
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

SUBPLOT SPECIES CANOPY COVER CLASS LAYER 3 (>6-16 ft)

Estimate the total canopy cover class of the foliage for each plant species in Layer 3, >6 to 16 feet above the ground, over the entire subplot area. A rapid canopy cover estimate is made, ignoring overlap among species. For plants rooted in the subplot, but with no foliage in the Layer 3, enter 0 or leave blank. Cover class assigned to any one layer cannot be greater than the value assigned for the total cover class for that species.

When collected: Each unique species present on current subplot
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

SUBPLOT SPECIES CANOPY COVER CLASS LAYER 4 (> 16 ft)

Estimate the total canopy cover class of the foliage for each plant species in Layer 4, >16 feet above the ground, over the entire subplot area. A rapid canopy cover estimate is made, ignoring overlap among species. For plants rooted in the subplot, but with no foliage in the Layer 4, enter 0 or leave blank. Cover class assigned to any one layer cannot be greater than the value assigned for the total cover class for that species.

When collected: Each unique species present on current subplot
Values: Canopy Cover Classes –

t	<1%	4	21-40%
1	1-5%	5	41-60%
2	6-10%	6	61-80%
3	11-20%	7	81-100%

UNKNOWN VEG SPECIES SPECIMEN COLLECTION AND HANDLING

When you encounter a species you cannot identify quickly and confidently using field guides, follow these basic steps:

1 Assign a valid NRCS PLANTS Genus or Unknown CODE and appropriate unknown number to the specimen
2 Record if you collected the specimen, and if not explain why not in the species notes\

3 When a specimen is collected, enter the specimen label number on a 1-gallon plastic bag using a sharpie
4 In addition, record on the baggie:
   - Date
   - Collector name
   - State
   - County
   - Natural community where found
   - Substrate conditions – soil moisture, landscape position
   - Species associates – common or diagnostic plants occurring with unknown plant
   - Species notes
5 Place only one unknown specimen in each baggie.
6 Describe any newly encountered unknown species in Plot Species Notes
7 Record the quadrat occurrence or canopy cover estimate for the subplot in which the plant was encountered, as for any identified species.
8 Store the specimens in a safe place to avoid crushing during plot work, and then store in a cold cooler during transport from the field to the office
9 Once the specimens are returned to the office, they should be refrigerated until they can be pressed or delivered to a botanist for identification. Specimens must be pressed within a week of collection if they will not be identified within that timeframe.
10 When delivering to a botanist for identification, provide an email address to which final identification can be delivered.
11 When a final identification is made, revise the species codes in the appropriate data sheets.

Example of Data to be Included on Specimen Baggie

Label #: CAREX1-18-2 (unknown carex, unknown #1, plot 18, subplot 2)
Date: 8/6/2011
Collected by: DHB
State: VT
County: Bennington
Natural Community: mature Northern Hardwood forest
Substrate: well-drained loamy soil, shallow to bedrock, eastern exposure, 2200' elevation
Associates: DRIN5, HULU2, OXMO, MACA4

DOWN WOODY MATERIAL (DWM)

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).

Note: This indicator is CORE OPTIONAL on all phase 2 plots.

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.

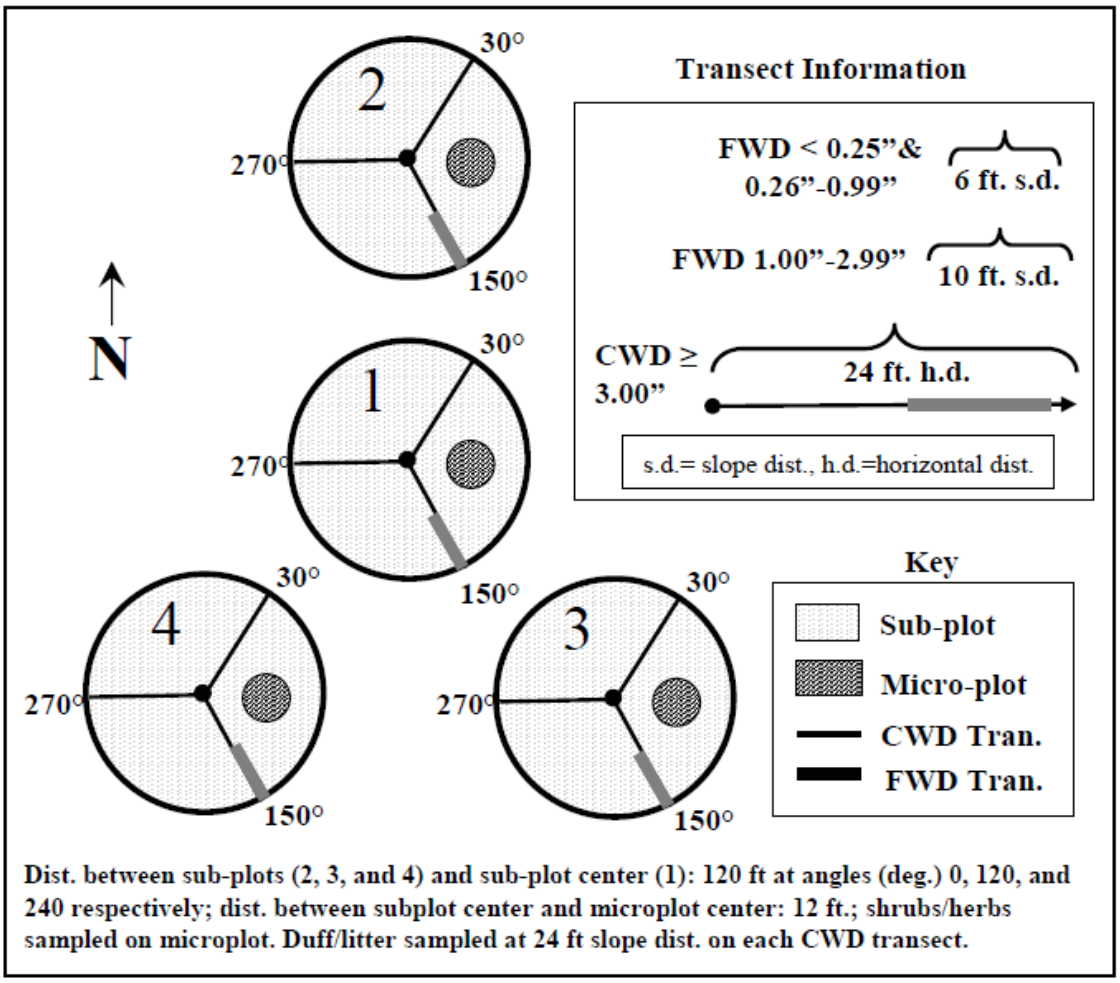


Figure 14-1. Plot layout for sampling CWD, FWD, and fuels.

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.

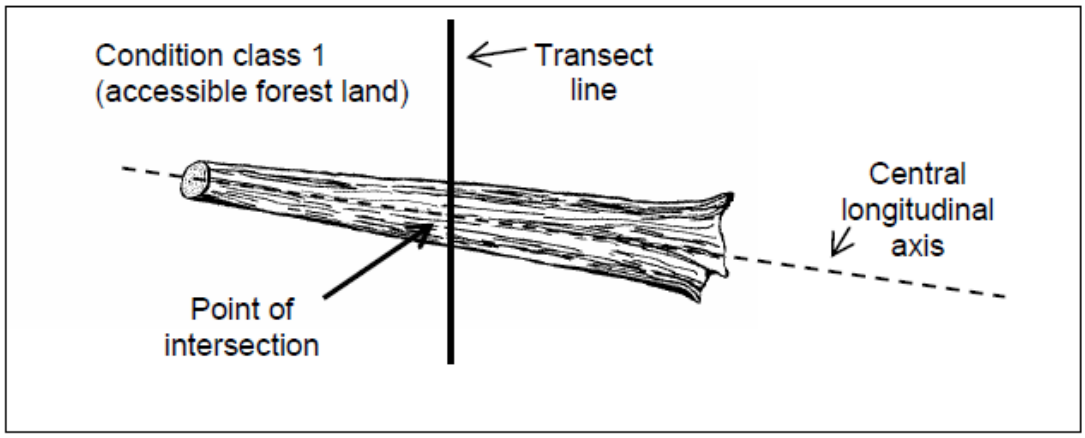


Figure 14-3. Tally rules for CWD.

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 total length measure the length to the nearest 0.1 foot to determine if it is >3.0 feet. CWD TOTAL LENGTH (14.4.3.7) 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),

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). For decay class 5: tally a piece if it is > 5.0 inches in diameter at the point of intersection and >

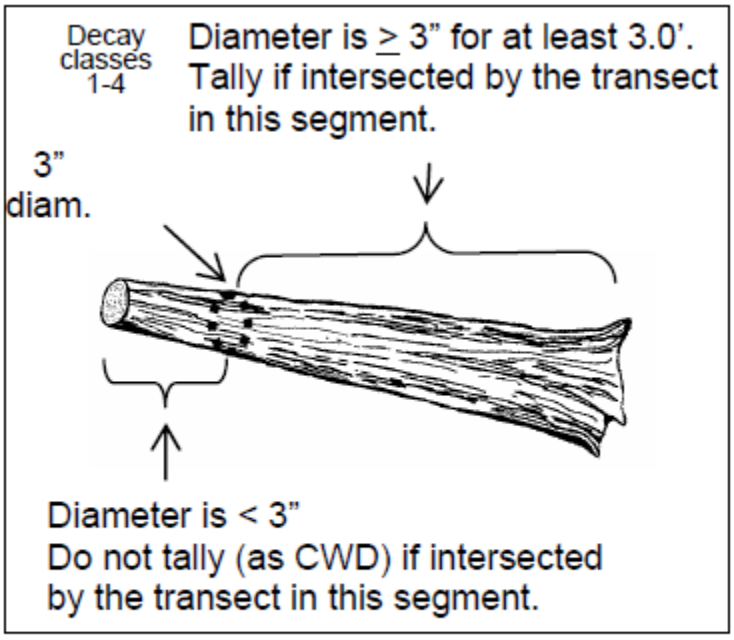


Figure 14-4. CWD tally rules for decay classes 1-4.

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.

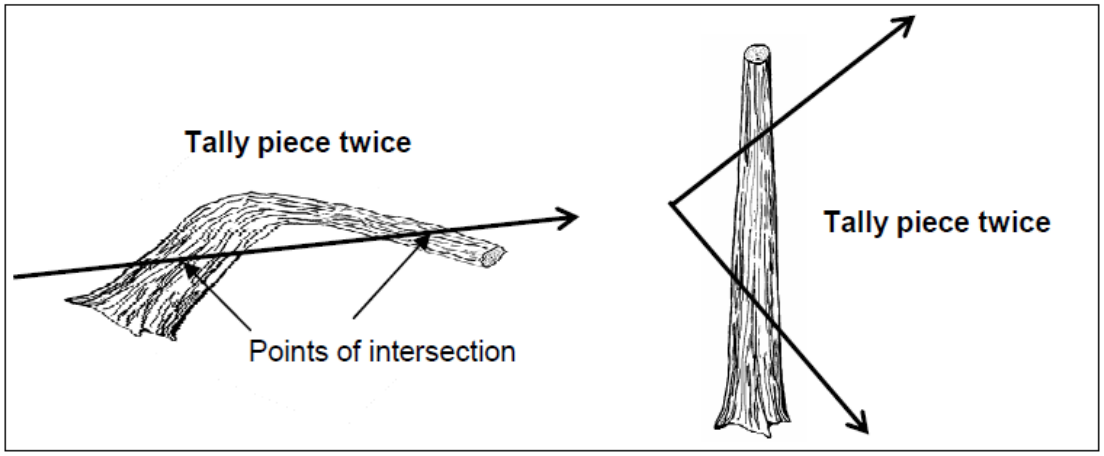


Figure 14-5. CWD tally rules: intersections.

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), CWD is not tallied in the nonforest condition.

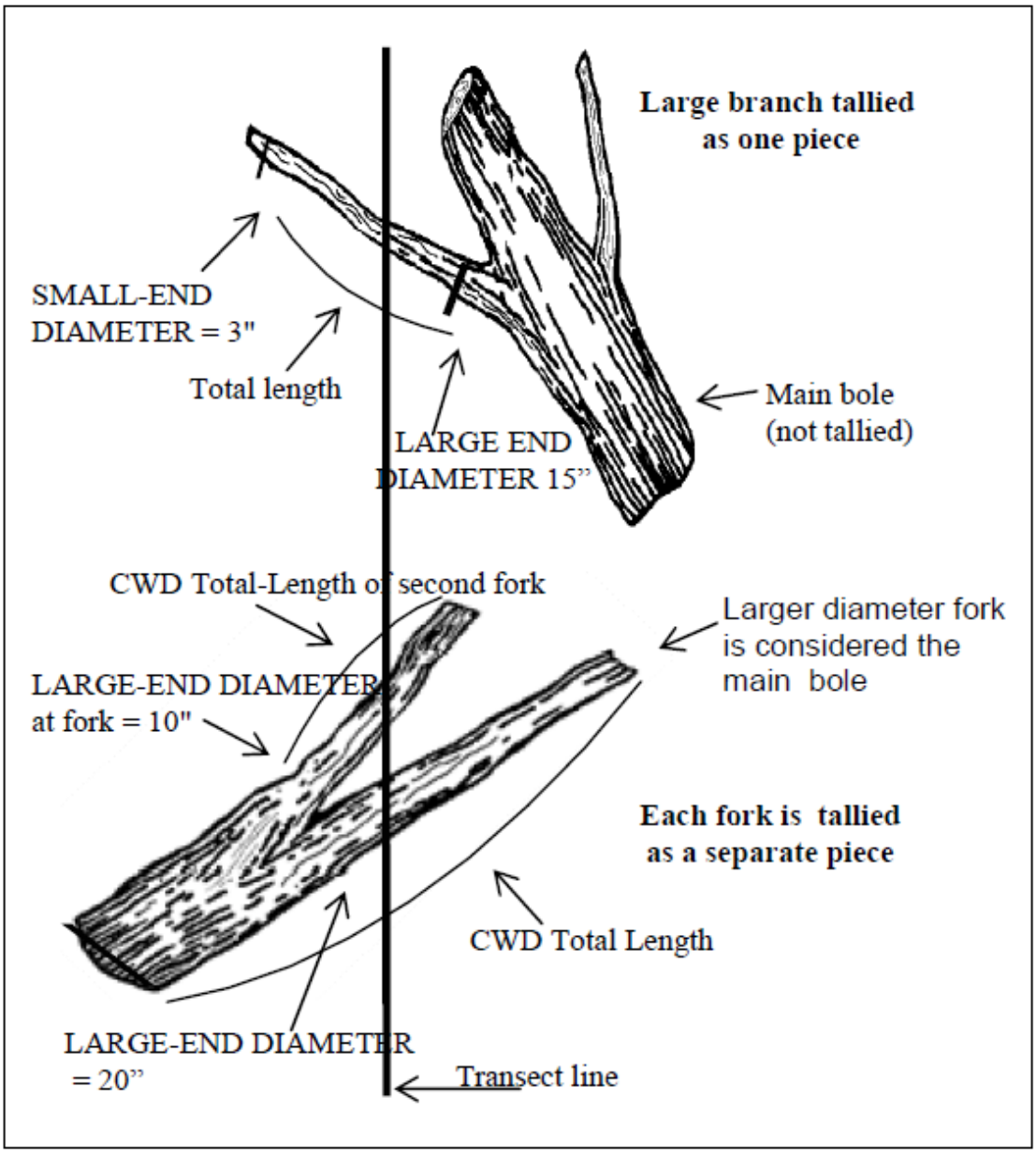


Figure 14-6. CWD tally rules for forked trees.

14.4.3 Recording Procedures for CWD

The tolerance for the total number of pieces (> 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.

14.4.3.2 TRANSECT

Record the code indicating the azimuth of the transect on which the piece is sampled.

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.

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.

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 dead conifer or 0998 for unknown dead hardwood. If all else fails, enter the unknown SPECIES code (0999).

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.

DIAMETER MEASUREMENTS

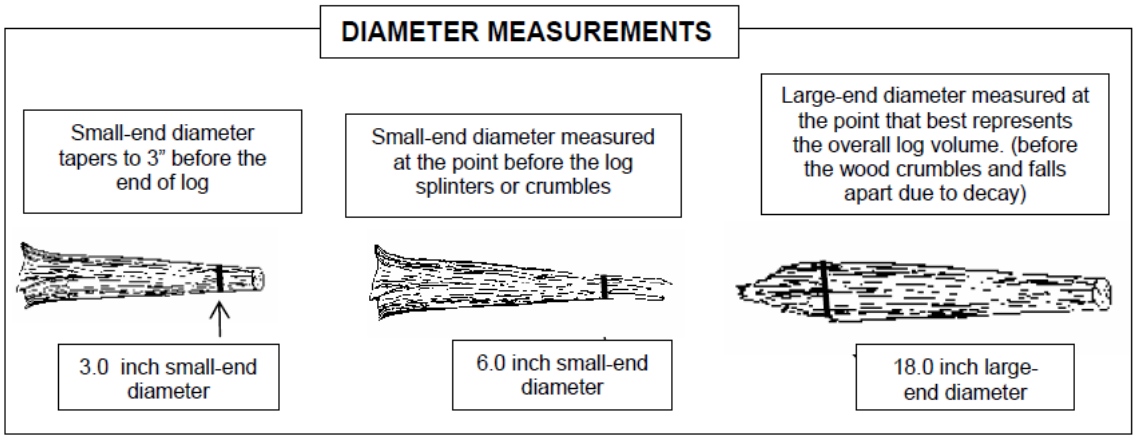


Figure 14-7. Diameter measurements

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.

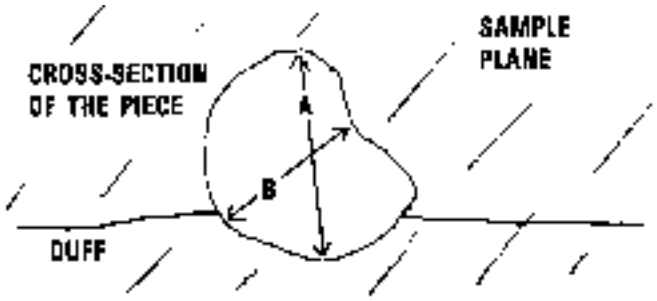


Figure 14-8. Estimating the diameter of pieces that are not round in cross-section. 13

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.

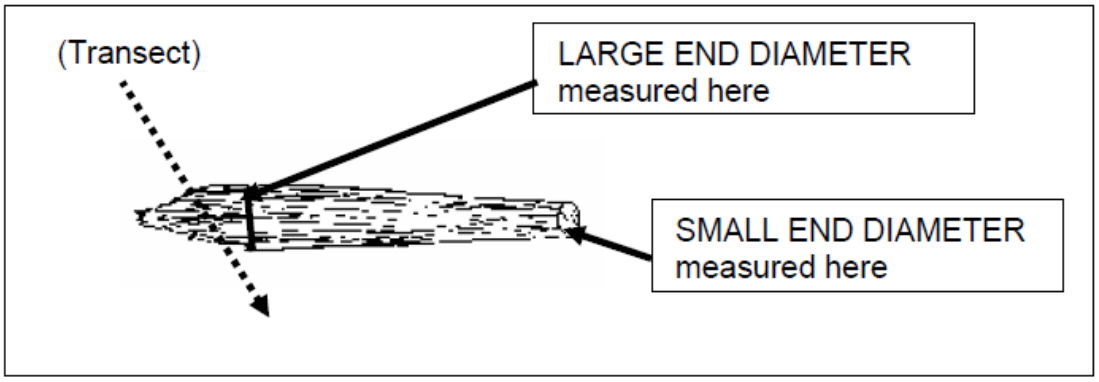


Figure 14-9. Example of decayed end intersecting the transect

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.

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).

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.

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 >3.0 feet. CWD TOTAL LENGTH is recorded to the nearest foot.

LEMP VEG Plot Cheat Sheet

Class	Cover (%)	Area (m^2)	Area (ft^2)
t	<1	<1.7	<18
1	1	1.7	18
	2	3.4	36
	3	5.1	54
	4	6.7	72
	5	8.4	90
2	6	10.1	108
	7	11.8	126
	8	13.5	144
	9	15.2	162
	10	16.8	181
3	11	18.5	199
	12	20.2	217
	13	21.9	235
	14	23.6	253
	15	25.3	271
	16	26.9	289
	17	28.6	307
	18	30.3	325
	19	32.0	343
	20	33.7	362
4	21	35.3	378
	25	42.1	452
	30	50.5	543
	35	58.9	633
	40	67.3	724
5	41	69.0	742
	45	75.8	814
	50	84.2	904
	55	92.6	994
	60	101.0	1085
6	61	102.7	1104
	65	109.4	1175
	70	117.8	1266
	75	126.2	1356
	80	134.7	1447
7	81	136.3	1465
	85	143.1	1537
	90	151.5	1628
	95	159.9	1718
	100	168.3	1809

Radius = 24 feet π= 3.14159265

Class Range		Circles		CODES	
Trace	t	Radius (m)	Area (m^2)	Variable	Code
1	1-5%	1	3	Vermont	50
2	6-10%	2	13	Addison	001
3	11-20%	3	29	Bennington	003
4	21-40%	4	51	Rutland	021
5	41-60%	5	79	Washington	023
6	61-80%	6	113	Windham	025
7	81-100%	7	154	Windsor	027

LEMP Upland Natural Communities from Thompson and Sorenson (2000)

Based on updated classification as of 1/22/2009

Code	Short Name
SF1	Subalpine Krummholz
SF2	Montane Spruce-Fir Forest
SF2a	Montane Fir Forest
SF2b	Montane Spruce Forest
SF3	Lowland Spruce-Fir Forest
SF3a	Lowland Spruce-Fir Forest, well-drained phase
SF4	Montane Yellow Birch-Red Spruce Forest
SF4a	Montane Yellow Birch-Sugar Maple-Red Spruce Forest
SF5	Red Spruce-Northern Hardwood Forest
SF6	Red Spruce-Heath Rocky Ridge Forest
SF7	Boreal Talus Woodland
SF8	Cold-Air Talus Woodland
NH1	Northern Hardwood Forest
NH1a	Beech-Red Maple-Hemlock Northern Hardwood Forest
NH1b	Sugar Maple-White Ash-Jack-in-the-pulpit Northern Hardwood Forest
NH1c	Yellow Birch-Northern Hardwood Forest
NH1d	White Pine-Northern Hardwood Forest
NH2	Rich Northern Hardwood Forest
NH2a	Northern Hardwood Limestone Forest
NH3	Mesic Red Oak-Northern Hardwood Forest
NH4	Hemlock Forest
NH4a	Hemlock-Red Spruce Forest
NH4b	Temperate Hemlock Forest
NH5	Hemlock-Northern Hardwood Forest
NH5a	Hemlock-White Pine-Northern Hardwood Forest
NH5b	Yellow Birch-Hemlock Forest
NH6	Northern Hardwood Talus Woodland
OPNH1a	Red Pine Forest
OPNH1b	Red Pine Woodland
OPNH2	Pitch Pine-Oak-Heath Rocky Summit
OPNH5	Dry Oak Woodland
OPNH6	Dry Oak Forest
OPNH7	Dry Oak-Hickory-Hophornbeam Forest
OPNH7a	Sugar Maple-Hophornbeam Forest
OPNH8	Mesic Maple-Ash-Hickory-Oak Forest
OPNH8a	Transition Hardwoods Limestone Forest
OPNH9	Mesic Clayplain Forest
OPNH10	White Pine-Red Oak-Black Oak Forest
OPNH11	Pine-Oak-Heath Sandplain Forest
OPNH12	Transition Hardwood Talus Woodland
OPNH12a	Transition Hardwood Limestone Talus Woodland
OPNH13	Sand-Over-Clay Forest

Field Protocols for Establishing and Permanently Marking Plots

This is a description of the process used to establish each LEMP plot.

1) Each new LEMP plot center was arbitrarily located in the middle of a uniform area of landform, soils and vegetation, meeting the Plot Location Parameters. Each new plot was given a unique name to reflect its location on the GMNF, and plots were sequentially numbered in the order that they were located. The LEMP plot center is also the center of subplot 1.

2) Next, the other three subplot centers were located using the Volume 1: Field Data Collection Procedures, sections 0.0 and 0.1 (pages 13-16), and the Units of Measure on page 13 of that document. Subplots 2, 3, and 4 are located 120 feet from center at azimuths of 120, 240, and 360 degrees. Distance measurements are made with a metal or cloth tape, pulled tightly. Azimuths are established using a good quality, hand-held compass, set with a declination of 14.5 degrees west. While the FIA Protocols recommend measuring in *horizontal distance*, the LEMP plot distances were measured in *slope distance.*

3) Permanent monuments were installed at each of the four subplot centers. Each monument consists of a one-inch diameter, 24 in. or 40 in. long, galvanized metal stake topped with a round, 3.5 inch diameter brass cap. Twenty-four inch stakes were used for plot centers in Wilderness Areas and in shallow soils (soils less than 20-30 in. deep to bedrock). Forty-inch stakes were used in deeper soils (soils greater than 30 inches deep to bedrock) outside of Wilderness Areas. Stakes were driven into the ground with a sledge hammer. As they were driven in, three outwardly-curving prongs were forced out of the end of the metal stake (see figure 1). These prongs minimize the potential for stake movement over the long-term. Brass caps are labeled: “Long-term Ecosystem Monitoring Plot, USDA Forest Service, Est. 200_ (insert the year), Subplot # __ .” (see Figure 3). Some plots also include the LEMP plot number. In Wilderness Areas, most monuments were installed so that the top of the brass cap is 1-2 inches below the top of the duff layer. In a few instances the stakes could not be driven in far enough to allow the caps to be in the duff layer, so rocks were loosely placed around the cap to hide it. Outside of Wilderness Areas, monument caps protrude about one foot above the soil surface (see Figure 2).

4) Three witness trees were marked at each subplot center using two diagonal bark scribes at DBH (diameter at breast height), and one scribe on the tree trunk within two feet of the ground (see Figure 2). These scribes should be maintained to ensure their visibility over the sampling intervals. The distance and azimuth from each witness tree to the plot center were recorded.

5) GPS coordinates were recorded using a Garmin GPS unit. GPS locations are estimated to be within 50 feet of the actual plot centers. During the 2010 field season, we plan to collect survey-grade GPS information on all plots using a Trimble unit. In the future, plot

monuments will be located using the GPS coordinates, scribed trees, and monuments. A metal detector will be needed to locate monuments in Wilderness areas.

Figure 1. A metal stake showing

the three outwardly-curving prongs

at the end of the stake

Figure 2. Plot monument and scribed tree outside of Wilderness. The pink flags were temporary markings.

Figure 3. A typical brass cap with the inscriptions:

- Long-term Ecosystem Monitoring Plot
- 3 – FR60, meaning LEMP plot #3 – Forest Road 60; note that the plot number and name were omitted on some monuments.
- Est. 2008, meaning Established in 2008.
- USDA-Forest Service