FOREST INVENTORY AND ANALYSIS
NATIONAL CORE FIELD GUIDE

VOLUME I SUPPLEMENT: FIELD DATA COLLECTION PROCEDURES FOR PHASE 2+ PLOTS

Version 5.0

NORTHERN RESEARCH STATION

FOREST SERVICE

U.S. DEPARTMENT OF AGRICULTURE

April 2012

U.S. Department of Agriculture, Forest Service. 2010. Forest Inventory and Analysis *National Core Field Guide*: field data collection procedures for phase 2 plots. Version 5.0. Unpublished information on file at http://www.fia.fs.fed.us/fia/data-collection/.

"Anyone who establishes a permanent plot should recognize that he or she hereby assumes responsibility for furnishing workers with a complete picture of conditions on the plot at the time of its establishment. Not only must each plot be properly marked and all measures are in near perfect order, but all notes and records must be complete. Otherwise, the plots may fail to yield the desired results and those who in later years become responsible for their care and for the analysis of the data, may be led to serious mistakes."

[U.S. Department of Agriculture, Forest Service 1935.]

NRS Note to User: Data elements and procedures from the previous regional guides may no longer be applicable. Version 5.0, Volume 1 Supplement, is based on the *National Core Field Guide, Version 5.0*, with the exception of P2 Vegetation Profile and Down Woody Materials data elements and procedures, which are based on the *National Core Field Guide, Version 6.0*. All data elements are national unless indicated as follows:

- National data elements that end in "+N" (e.g., x.x+N) have added values/codes*. Any additional regional text for a national data element is hi-lighted or shown as a "NRS Note."
- All regional data elements end in "N" (e.g., x.xN). The text for a regional data element is not hi-lighted.
- All state specific regional data elements end in "N-XX" (e.g., x.xN-ME). The text for state data element is not hi-lighted.
- National data elements or procedures with light gray text are not applicable in the North.
- [NRS Phase 2+ Supplement electronic file note: national and regional FIA data elements that are not applicable in NRS P2+ protocols are formatted as light gray hidden text.]

* It should be noted that all national data elements with added regional values/codes must be collapsed back to existing national standards by the Information Group unless supported by *NIMS*.

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VOLUME I SUPPLEMENT: FIELD DATA COLLECTION PROCEDURES FOR PHASE 2+ PLOTS

Version 5.0

Version History:

5.0 July 2009 (revised from change management process, change proposals approved by FIA Management Team, from Charleston, SC, Data Acquisition Band Meeting, Mar. 2009, and from multiple Data Acquisition Band conference calls)
October 2010 (revised from change management process and from Portland, OR, Data Acquisition Band Meeting, Feb. 2010 and subsequent conference calls)
April 2012 (NRS Volume 1 Supplement, Field Data Collection Procedures for Phase 2+ Plots, based on the *National Core Field Guide, Version 5.0*, with the exception of P2 Vegetation Profile and Down Woody Materials data elements and procedures, which are based on the *National Core Field Guide, Version 6.0*)

NRS Note: NRS will complete Phase 2+ (P2+) protocols during the window of May 1st through September 30th.

In 2012, P2+ protocols will be completed on approximately 12.5% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region, with the exception of Soil Measurements and Sampling (section 22.0). Beyond 2012, P2+ protocols may be completed on up to approximately 25% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region. Soil Measurements and Sampling protocols will be completed on approximately 6.25% of the total field plots [the historical Phase 3 (P3) plots] in the NRS Region.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.0 PLOT LEVEL DATA

NRS Note: NRS will complete Phase 2+ (P2+) protocols during the window of May 1st through September 30th.

In 2012, P2+ protocols will be completed on approximately 12.5% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region. Beyond 2012, P2+ protocols may be completed on up to approximately 25% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region.

Completion time will be recorded on P2+ field plots. Refer to NRS manual section1.0 for complete Plot Level Data protocols.

1.21.1N TOTAL HOURS TO COMPLETE EACH P2 PLUS AND P3 PLOT **[THRS]**

Record the number of hours that were required to complete each P2 Plus AND P3 plot with a PLOT STATUS of 1 or 2. Include round trip hiking time to and from your parked truck, but exclude round trip drive time to the plot.

When collected: Phase 2 Plus: When PLOT STATUS = 1
Phase 3: When PLOT STATUS = 1
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 01 – 23

5.0 TREE AND SAPLING DATA

NRS Note: NRS will complete Phase 2+ (P2+) protocols during the window of May 1st through September 30th.

In 2012, P2+ protocols will be completed on approximately 12.5% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region. Beyond 2012, P2+ protocols may be completed on up to approximately 25% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region.

Lengths will be recorded for live saplings on P2+ field plots. For convenience, the following NRS manual section 5.0 data elements are excerpted in this P2+ Supplement. Refer to NRS manual section 5.0 for complete Tree and Sapling Data protocols.

5.14 TOTAL LENGTH **[THGT]**

Record the TOTAL LENGTH of the tree, to the nearest 1.0 foot from ground level to the top of the tree. For trees growing on a slope, measure length 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.

NRS Note: TOTAL LENGTH for DRC species is recorded as the highest top of all the stems.

When Collected: NRS Phase 2+: All live tally trees ≥ 1.0 in DBH/DRC (Not Collected in ME)
Field width: 3 digits
Tolerance: +/- 10 % of true length for trees; +- 4 feet or +-10% of true length (whichever is greater) for saplings
MQO: At least 90% of the time
Values: 005 to 400

5.15 ACTUAL LENGTH **[ACTU]**

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). Examples:

Live tree with **live** broken top with **more than 50% detachment** from the tree but is minimally attached – do not record ACTUAL LENGTH. TOTAL LENGTH is taken through or past the break as are BOLE and SAWLOG LENGTHS.
Live tree with **dead** broken top with **more than 50% detachment** from the tree – record ACTUAL LENGTH in addition to TOTAL LENGTH
Dead tree with **dead** broken top with **more than 50% detachment** from the tree – Record an ACTUAL LENGTH to the break.
Dead tree with **dead** broken top with **less than or equal to 50% detachment** from the tree – record ACTUAL LENGTH through or past the break as well as BOLE and SAWLOG LENGTHS.

If the break is along the stem length, the actual length terminates where there is 50% of the stem remaining. If the top is intact including dead tops on live trees, 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.

NRS Note: If a dead tree with a broken top has a remaining branch that is1/3 the diameter at the break and extends higher, measure ACTUAL LENGTH to the top of the branch.

NRS Note: Record ACTUAL LENGTH for DRC species if what would have been the highest top is now missing.

When Collected: NRS Phase 2+: All live tally trees ≥ 1.0 in DBH/DRC (Not Collected in ME)
Field width: 3 digits
Tolerance: +/- 10 % of true length for trees; +- 4 feet or +-10% of true length (whichever is greater) for saplings
MQO: At least 90% of the time
Values: 005 to 400

5.16 LENGTH METHOD **[METH]**
Record the code that indicates the method used to determine tree lengths.

When Collected: NRS Phase 2+: All live tally trees ≥ 1.0 in DBH/DRC (Not Collected in ME)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

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

6.0 ADVANCE TREE SEEDLING REGENERATION DATA

The tree seedling sample is designed to inventory and monitor the forest's regenerative capacity. Tree seedling counts are used along with the sapling tally to estimate Advance Tree Seedling Regeneration (ATSR). Information on ATSR, specifically heights, is required for estimating regeneration success. ATSR data are used with estimates of competing vegetation derived from the P2 Vegetation Profile (manual section 8.0); and data on the abundance and character of Invasive Plants life forms (manual section 9.0). These three components form the basis for analysis of regeneration adequacy and hence, the ability of native forests to regenerate and an indication of the expected future forest composition.

NRS Note: NRS will complete ATSR protocols during the window of May 1st through September 30th.

In 2012, ATSR protocols will be completed on approximately 12.5% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region. Beyond 2012, ATSR protocols may be completed on up to approximately 25% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region.

Stocking and regeneration information are obtained by counting established 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. Hardwood and conifer seedlings must be at least 2.0 inches in length (with at least two normal-sized leaves that do not still bear cotyledons) 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 SUBPLOT, SPECIES, CONDITION CLASS, SEEDLING SOURCE, and LENGTH CLASS, up to five individuals per species. Counts beyond five may be estimated. Only count seedlings occurring in accessible forest land condition classes.

NRS Note: A seedling is measured from the base to the tip of the terminal bud. If the minimum length requirement is met for either a hardwood or softwood, the seedling is tallied.

For a summary of seedling count criteria, see Figure 1N. Advance Tree Seedling Regeneration seedling count flow chart.

6.0.1N BROWSE IMPACT **[BRWS]** (Plot-level variable)

BROWSE IMPACT refers to the consumption of tender shoots, twigs, and leaves of trees and shrubs used by animals for food. Estimate the amount of browsing pressure exerted on regeneration [typically by, but not limited to, deer, elk, feral hogs, livestock, moose, (other)].

Record the browse impact on the area within the accessible forest land portion of the four subplots.

When Collected: All plots with at least one accessible forest land condition class (PLOT STATUS=1) and with at least one subplot sampled for advance regeneration (ADVANCE REGENERATION SUBPLOT STATUS = 1).
Field width: 1 digit
Tolerance: +/- 1 class
MQO: At least 90% of the time
Values:

Code	Definition
1	**Very Low** - Plot is inside a well-maintained exclosure.
2	**Low** - No browsing observed, vigorous seedlings present (no exclosure present).

3	**Medium** - Browsing evidence observed but not common, seedlings common.
4	**High** - Browsing evidence common OR seedlings are rare.
5	**Very High** - Browsing evidence omnipresent OR forest floor bare, severe browse line.

6.0.2N ATSR (Advanced Tree Seedling Regeneration) TIME **[RTIME]**
Record the number of minutes required to complete ATSR variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 001- 120

6.0.3N NUMBER OF PERSONS COLLECTING ATSR ON EACH POINT **[RSIZE]**
Record the number of persons that specifically collected ATSR variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1- 5

6.1 SUBPLOT NUMBER
Use the same procedures described in Section 3.1.

When Collected: All counts of seedlings

6.1.1N ADVANCE REGENERATION SUBPLOT STATUS **[ARST]**
Record the code to indicate whether the subplot was sampled for advance regeneration, . If there is **any** part of an accessible portion of the subplot where other plot measurements are made but advance regeneration variables can't be assessed (e.g., because of snow, water), enter code 2.

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

1 Subplot sampled for advance regeneration
2 Subplot not sampled for advance regeneration

6.1.2N ADVANCE REGENERATION NONSAMPLED REASON
Record the reason why a subplot cannot be sampled for advance regeneration.
When collected: On all subplots where ADVANCE REGNERATION SUBPLOT STATUS = 2
Field width: 2 digits
Tolerance: No errors

MQO: At least 99% of the time
Values:

10 Other (for example, snow or water covering vegetation that is supposed to be sampled)

6.1.3N SUBPLOT SITE LIMITATION **[SLIM]**

Record site limitation code 2 or 3 if the limitation occurs on at least 30 percent of an accessible forest land condition area within the subplot, otherwise code as 1.

When Collected: Each accessible forest land condition class (CONDITION CLASS STATUS=1) on each subplot when advance regeneration is sampled on the subplot (ADVANCE REGENERATION SUBPLOT STATUS = 1).
Field width: 1 digit
Tolerance: none
MQO: At least 99% of the time
Values:

Code	Definitions
1	No site limitation
2	Rocky surface with little or no soil
3	Water-saturated soil (during the growing season)

6.1.4N MICROPLOT SITE LIMITATION **[MLIM]**

Record site limitation code 2, 3, or 4 if the limitation occurs on at least 30 percent of an accessible forest land condition area within the microplot, otherwise code as 1.

When Collected: Each accessible forest land condition class (CONDITION CLASS STATUS=1) on each microplot when advance regeneration is sampled on the subplot (ADVANCE REGENERATION SUBPLOT STATUS = 1).
Field width: 1 digit
Tolerance: none
MQO: At least 99% of the time
Values:

Code	Definition
1	No site limitation
2	Rocky surface with little or no soil
3	Water-saturated soil (during the growing season)
4	Thick duff layer (in excess of two-inches thick)

6.2 SPECIES **[SPP]**

Use the same procedures described in Section 5.8.

When Collected: All counts of seedlings
Field width: 4 digits
Tolerance: No errors for genus, no errors for species
MQO: At least 90% of the time for genus, at least 85% of the time for species
Values: See Appendix 3

6.3 CONDITION CLASS NUMBER **[CON#]**

Use the same procedures described in Section 2.0.

When Collected: All counts of seedlings

6.4 SEEDLING COUNT **[SED#]**

On each microplot, record the number of live tally tree seedlings, by species and condition class. Count up to five individuals by species: estimate the total count if there are more than five individuals of any given species in any given condition class. When seedlings are distributed evenly on a microplot, a suggested method of estimating is to count the number of seedlings on one quarter of the microplot and multiply by four (given that there is only one condition class on the microplot). Repeat for each species. Conifer seedlings must be at least 6.0 inches in length and less than 1.0 inch at DBH to qualify for counting. Hardwood seedlings must be at least 12.0 inches in length and less than 1.0 inch at DBH in order to qualify for counting.

For woodland species, each stem on a single tree must be less than 1.0 inch at DRC.
NRS (West) Note: This applies to Rocky Mountain juniper (0066) in the states of KS, NE, ND and SD.

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.
NRS Note: If snow amounts are excessive on the microplot, the seedling tally is restricted to seedlings visible above the snow. Do not excavate snow from the microplot to achieve a better measurement. This practice may compromise the integrity of the microplot by exposing seedlings and other vegetation to animal browsing; and by exposing seedlings to extreme temperatures that may lead to mortality.

When Collected: Each accessible forest land condition class on each microplot when advance regeneration is **not** sampled on the subplot (ADVANCE REGENERATION SUBPLOT STATUS = 2)
Field width: 3 digits
Tolerance: No errors for 5 or less per species; +/- 20% over a count of 5
MQO: At least 90% of the time
Values: 001 through 999

6.4.1N ADVANCE REGENERATION SEEDLING COUNT **[ARS#]**

On each microplot, record the number of established live tally tree seedlings by SPECIES, CONDITION CLASS NUMBER, SEEDLING SOURCE, and LENGTH CLASS. The first five seedlings of each SUBPLOT—SPECIES—CONDITION CLASS—SEEDLING SOURCE—LENGTH CLASS combination must be counted precisely. Counts above five seedlings may be estimates if needed to save time for 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 SUBPLOT--SPECIES--CONDITION CLASS--SEEDLING SOURCE--LENGTH CLASS combination. Established hardwood and conifer seedlings must be at least 2.0 inches in length (with at least two normal-sized leaves that do not still bear cotyledons) and less than 1.0 inch at DBH in order to qualify for counting.

Small oak, hickory, walnut, and butternut seedlings (less than 12.0 inches in length) should be at least 6.0 inches in length or have a root-collar diameter (RCD) of at least 0.25 inches.

For a summary of seedling count criteria, see Figure 1N. Advance Tree Seedling Regeneration seedling count flow chart.

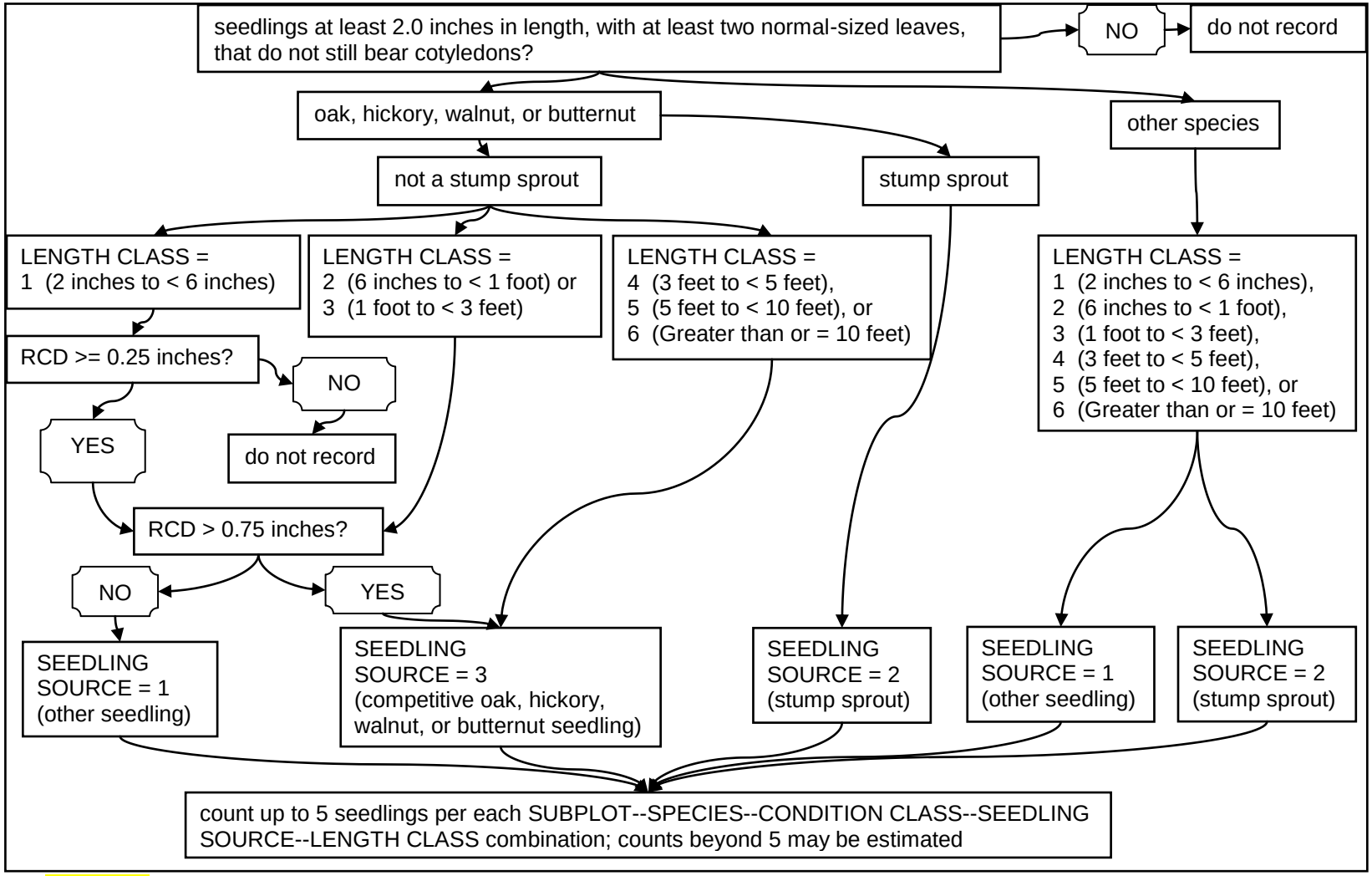

Figure 1N. Advance Tree Seedling Regeneration seedling count flow chart.

For woodland species, each stem on a single tree must be less than 1.0 inch at DRC.
NRS (West) Note: This applies to Rocky Mountain juniper (0066) in the states of KS, NE, ND and SD.

Multiple "suckers" that originate from the same location, and stump sprouts are considered one seedling. Tally only the tallest sprout for each stump. 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. Stumps must be at least 2 inches in diameter to qualify as having sprouts.

Accurate tally of all tree seedlings and saplings are required and must be completed during the leaf on window. The opening and closing of this window varies throughout the Region and from year to year, but in general begins as early as the first of May and closes as late as the end of September. The key quality assurance measure is whether the ATSR can be repeated and remeasured over a cycle length (generally 5, 7 or 10 years).

When Collected: Each accessible forest land condition class on each microplot when advance regeneration **is** sampled on the subplot (ADVANCE REGENERATION SUBPLOT STATUS = 1).
Field width: 3 digits
Tolerance: No errors for 5 or less per SUBPLOT—SPECIES—CONDITION CLASS—SEEDLING SOURCE—LENGTH CLASS combination; +/- 20% over a count of 5
MQO: At least 90% of the time
Values: 001 through 999

6.4.2N SEEDLING SOURCE **[SRCE]**

Discriminate between stump sprouts and other seedlings.

A special code (3) is used for oak, hickory, walnut, and butternut that are classified as "competitive." Research indicates that competitive seedlings are highly likely to become dominant or codominant stems in the next stand during forest succession. To be classified as competitive, stems must have a root collar diameter (RCD) > 0.75 inches or have a length of at least 3 feet. In situations with relatively high tally, it should only be necessary to check at least 10% of RCD's.

When Collected: All counts of seedlings when advance regeneration is sampled on the subplot (ADVANCE REGENERATION SUBPLOT STATUS = 1).
Field width: 1 digit
Tolerance: none
MQO: At least 99% of the time
Values:

Code	Definition
1	other seedling
2	stump sprout
3	Competitive oak, hickory, walnut, or butternut seedling

6.4.3N LENGTH CLASS **[LNGC]**

Each seedling is assigned a length class.

When Collected: All counts of seedlings when advance regeneration is sampled on the subplot (ADVANCE REGENERATION SUBPLOT STATUS = 1).

Field width: 1 digit
Tolerance: none
MQO: At least 99% of the time
Values:

Code	Definition	Code	Definition
1	2 inches to < 6 inches	**4**	3 feet to < 5 feet
2	6 inches to < 1 foot	**5**	5 feet to < 10 feet
3	1 foot to < 3 feet	**6**	Greater than or = 10 feet

8.0 PHASE 2 (P2) VEGETATION PROFILE (CORE OPTIONAL)

The Phase 2 (P2) Vegetation data are collected to describe vegetation structure and dominant species composition for vascular plants. The data collected provide a horizontal and vertical estimation of vegetation located within the sample area and provide information about the most abundant species found on the subplot. Information on the abundance, structure, and species composition of understory plant communities has many uses. It can be used to assess wildlife habitat, biomass, forage availability, grazing potential, vegetation competition with tree growth, fuel loadings from understory vegetation, and potential site productivity. The most abundant species provide information to describe plant communities and to predict associated forest stand characteristics. Accurately representing the species present on a site and monitoring their change in abundance in response to forest development, disturbance, or management is therefore important to a wide variety of users. This information is also used to augment forest ecosystem health assessments from P3 plots, in terms of vegetation structure and rates of change of community vascular plant composition.

The P2 Vegetation protocols are core-optional. Each FIA unit determines whether to collect the P2 Vegetation information, and several levels of options must be determined by each unit prior to data collection. Options declared prior to field data collection include P2 VEGETATION SAMPLING STATUS and LEVEL OF DETAIL. P2 VEGETATION SAMPLING STATUS determines if P2 Vegetation is to be collected, and, if so, what lands are included; the unit may choose to collect only on accessible forested conditions or on all accessible conditions found on the plot. The LEVEL OF DETAIL determines if data are collected on structure by growth habit only. Regardless of the LEVEL OF DETAIL, the protocols for the P2 Vegetation Profile will be implemented in such a way that basic structure and species data can be compared across the nation.

8.1 Vegetation Sampling Design

The core optional P2 Vegetation Profile includes measurements of *Vegetation Structure* (8.5) – canopy cover by layer and total aerial canopy cover of each growth habit.

P2 Vegetation is sampled on accessible condition classes within the 24.0-foot radius subplot. Inventory units implementing the P2 Vegetation Profile determine if they will include accessible forestland conditions (P2 VEGETATION SAMPLING STATUS). If the area of an accessible condition class is less than 100 percent on a subplot, P2 Vegetation measurements are recorded only on the portion that is in the accessible condition class(es). If multiple accessible condition classes are present on the subplot, separate estimates are made for each accessible condition class on the subplot. Prior to implementation, inventory units must also determine the LEVEL of DETAIL they will collect, so that regional field guides and PDR programs can be customized to ensure quality data is collected in the most efficient manner possible. All units implementing the P2 Vegetation Profile will collect LEVEL OF DETAIL = 1, *Vegetation Structure*.

The P2 Vegetation Profile is best recorded when all plant species are fully leafed out. However, crews may end up visiting plots early in the season before leaves are fully expanded or late in the season when plants are beginning to senesce. Notes can be added to subplot records indicating unusual phenological conditions. Crews should not collect P2 Vegetation data when snow covers the subplot (see 8.4.2 P2 VEG SUBPLOT SAMPLE STATUS).

NRS Note: NRS will complete P2 Vegetation protocols during the window of May 1st through September 30th.

In 2012, P2 Vegetation protocols will be completed on approximately 12.5% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region. Beyond 2012, P2 Vegetation

protocols may be completed on up to approximately 25% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region.

8.2 General Definitions

Canopy Cover – Canopy cover is defined as the area of ground surface covered by a vertical projection of the canopy of a vascular plant. The canopy is described by a polygon surrounding the outer edges of the foliage (fig. 45), without subtracting any normal spaces occurring between the leaves of plants (Daubenmire 1959[1]). Overlapping crowns are not double-counted (visualize the canopy cover collapsed into a 2-dimensional space); the maximum possible canopy cover is the percentage of the subplot area within the accessible condition.

All canopy cover estimates are focused on foliage within the sampled accessible condition class(es) within the subplot perimeter (24.0-foot radius, horizontal distance). Canopy cover is estimated for each sampled accessible condition of the subplot. If multiple sampled accessible conditions occur on a subplot, treat the condition boundary as a vertical wall on the plot: **plant foliage is included in the condition it is hanging over**, even if the plant is rooted in a different condition. However, the canopy **cover value is always estimated as a percentage of an entire subplot**. That is, if the canopy cover within the accessible condition is about equal to a circle with a radius of 5.3 feet, the canopy cover estimate will always be 5 percent, even if only 30 percent of the subplot is in the accessible condition on which the canopy cover is being measured.

Canopy cover is collected by height layer and as a total (aerial view) across all layers for each growth habit in *Vegetation Structure* (8.5). For each layer, examine the canopy cover of each Structure Growth Habit as if the other growth habits and other layers do not exist. If a Structure Growth Habit does not have foliage in a layer, enter 0 (do not count tree boles as cover). For total aerial canopy cover by Structure Growth Habit, examine each growth habit individually as if the other growth habits do not exist.

Canopy cover is estimated to the nearest 1 percent. For *Vegetation Structure* assessments, canopy cover >0 and <=1 percent is coded as 1 percent (i.e. trace amounts are coded as 1%).

Canopy cover is vertically projected from the outline of the foliage **at the time of plot visit.** All foliage that is or was alive during the current growing season is included in the cover estimates. Canopy cover from broken tops and stems is included, unless completely detached. Do not ocularly upright leaning trees.

See tabulation below for canopy cover to area relationships for a 1/24 acre subplot and figure 45 for additional visual calibrations.

Cover	Area (ft^2)	Square length on side (ft)	Circle radius (ft)
1%	18	4.3	2.4
3%	54	7.4	4.2
5%	90	9.5	5.4
10%	181	13.4	7.6
15%	271	16.5	9.3
20%	362	19.0	10.7
25%	452	21.3	12.0
50%	905	30.1	17.0

[1] Daubenmire. R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science 33(1): 43-64.

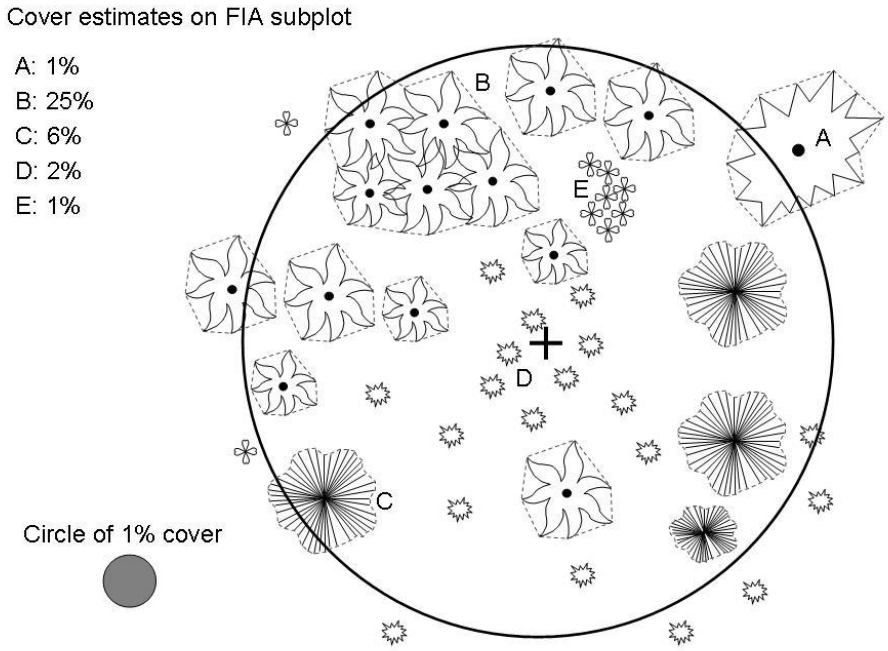

Figure 45. Assessing canopy cover.

Growth Habits – P2 Vegetation data are collected by growth habits at each LEVEL OF DETAIL. In general, growth habits for vascular plants include trees, shrubs/subshrubs/woody vines, forbs, ferns and graminoids.

However, depending on the LEVEL OF DETAIL, **trees** are grouped in different ways. *Vegetation Structure* (8.5) tree Structure Growth Habits are determined by regional core/core-optional tree species lists.

Layer Codes – Structure Growth Habits are assessed by layers in *Vegetation Structure* (8.5). Measure the layer height from ground level; see figure 46 for examples of measuring layer heights on sloping and uneven ground.

Layer 1	0 to 2.0 feet
Layer 2	2.1 to 6.0 feet
Layer 3	6.1 to 16.0 feet
Layer 4	Greater than 16 feet

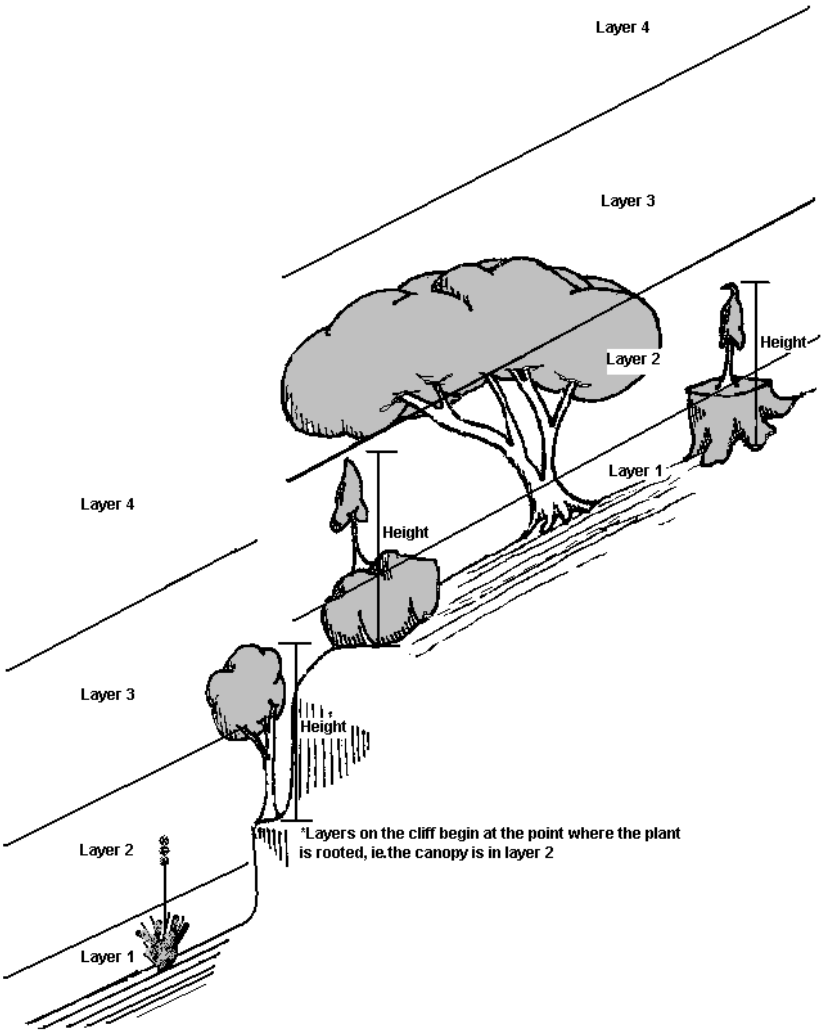

Figure 46. To determine the layer of a plant, measure the height of the layer from the ground.

NRCS PLANTS database – The Natural Resource Conservation Service (NRCS) PLANTS Database provides standardized information about the vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories. It includes names, plant symbols, checklists, distributional data, species abstracts, characteristics (including growth habits), images, crop information, automated tools, onward Web links, and references:

USDA, NRCS. 2010. The PLANTS Database (http://plants.usda.gov, 1 January 2010). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

FIA currently uses a stable code set downloaded in January of 2010.

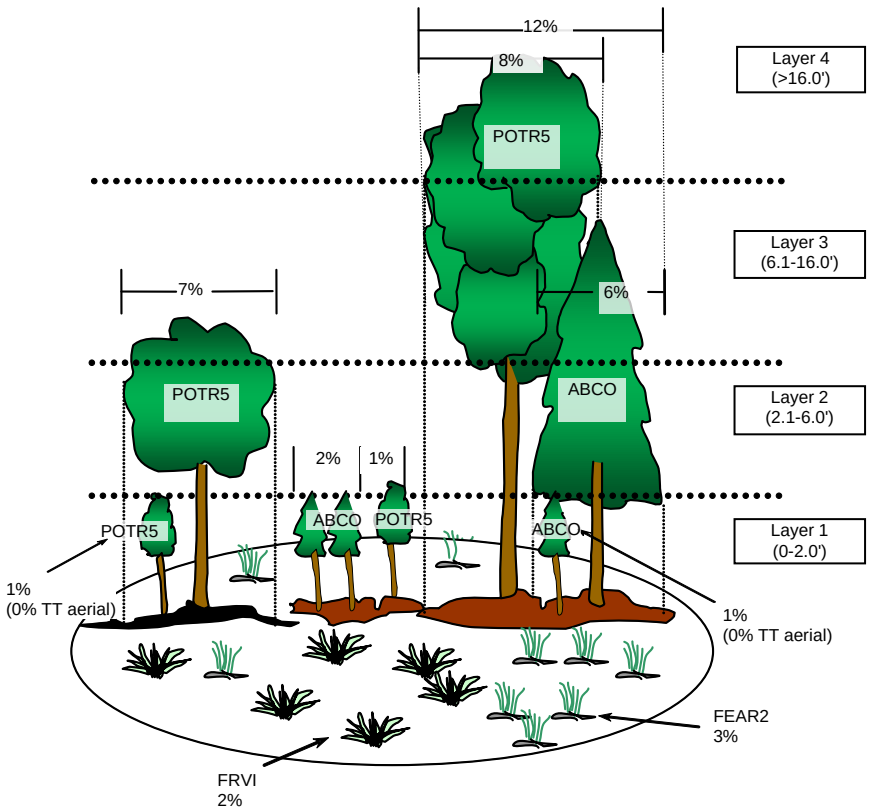

Figure 47. Example of growth habit by layer and species composition.

Table 1-Estimation of canopy cover by layer and aerial view of each Structure Growth Habit in figure 47

Vegetation Structure Growth Habit	**Layer 1 (0-2.0 ft)**	**Layer 2 (2.1-6.0 ft)**	**Layer 3 (6.1-16.0 ft)**	**Layer 4 (>16.0 ft)**	**Aerial**
		Percent canopy cover			
Tally tree sp (TT)	005	013	019	008	022
Non-tally tree sp (NT)	000	000	000	000	000
Shrub/Subshrub/Woody Vine (SH)	000	000	000	000	000
Forb (FB)	002	000	000	000	002
Fern (FN)	000	000	000	000	000
Graminoid (GR)	003	000	000	000	003

8.3 P2 Vegetation Sampling Options – Plot-Level Variables

The following options are set by the inventory unit prior to field season and are not set by field crews upon arriving at a plot. Therefore, each unit can customize the PDR program to automatically fill these variables. These variables are included to aid data management and allow various units to be compared appropriately.

8.3.1 P2 VEGETATION SAMPLING STATUS

This plot-level variable determines whether P2 Vegetation data will be recorded on the plot, and the land condition class(es) on which it will be recorded. The code used will be determined by regional needs. If P2 VEGETATION SAMPLING STATUS = 0, no further data collection is required within this field guide section.

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

0 Not sampling P2 Vegetation
1 P2 Vegetation data collected only on accessible forest land conditions (CONDITION CLASS STATUS = 1 and NONFOREST SAMPLING STATUS = 0)

8.3.2 LEVEL OF DETAIL

This plot-level variable determines whether data are collected for *Vegetation Structure* only or for *Species Composition* as well.

When collected: On all plots where P2 Vegetation is being sampled (P2 VEGETATION SAMPLING STATUS = 1)
Field width: 1 digit
MQO: No errors
Tolerances: At least 99% of the time
Values:

1 Collect data for *Vegetation Structure* only; total aerial canopy cover and canopy cover by layer for tally tree species (all sizes), non-tally tree species (all sizes), shrubs/subshrubs/woody vines, forbs, ferns, and graminoids.

8.3.2.1N VEGETATION STRUCTURE TIME **[STTIM]**

Record the number of minutes required to complete VEGETATION STRUCTURE variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 001- 120

8.3.2.2N NUMBER OF PERSONS COLLECTING VEGETATION STRUCTURE ON EACH POINT **[STSIZ]**

Record the number of persons that specifically collected VEGETATION STRUCTURE variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 1 digit

Tolerance: No errors
MQO: At least 99% of the time
Values: 1- 5

8.4 Vegetation Data Collection Location – Subplot-Level Variables

8.4.1 SUBPLOT NUMBER

Record the code corresponding to the number of the subplot.

When collected: On all subplots where P2 Vegetation is being sampled (P2 VEGETATION SAMPLING STATUS = 1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

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

8.4.2 P2 VEG SUBPLOT SAMPLE STATUS

Record the code to indicate if the subplot was sampled for P2 Vegetation. A subplot may be sampled for P2 Vegetation but not have any vascular plants present. If there is **any** part of an accessible portion of the subplot where other plot measurements are made but **all** the P2 Vegetation measurements cannot be completed on the subplot (for example, deep snow or water), enter code 2 and do not record **any** P2 Vegetation measurements.

When collected: On all subplots where P2 Vegetation is being sampled on accessible forest land (P2 VEGETATION SAMPLING STATUS=1) and at least one accessible forest land condition (CONDITION CLASS STATUS = 1) exists within the 24-foot radius subplot.
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1 Subplot sampled for P2 Vegetation
2 Subplot not sampled for P2 Vegetation

8.4.3 VEGETATION NONSAMPLED REASON

Record the reason why P2 Vegetation on a subplot cannot be sampled.

When collected: On all subplots where P2 VEG SUBPLOT SAMPLE STATUS = 2
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

10 Other (for example, snow or water covering vegetation that is

supposed to be sampled)

8.4.4 CONDITION CLASS NUMBER

Record the number for the sampled accessible condition class in which the vegetation is found. If multiple sampled accessible conditions occur on the same subplot, data will be collected for each accessible condition separately.

When collected: Any accessible measured land condition (CONDITION CLASS STATUS = 1) when P2 vegetation is being sampled on the subplot (P2 VEG SUBPLOT SAMPLE STATUS =1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

8.4.5 VEGETATION SUBPLOT NOTES

Use this field to record notes pertaining to the subplot, and any unusual conditions encountered.

When plant specimens are collected, use this field to record a community type description for each subplot sampled for P2 Vegetation. The community description is intended to fully automate the specimen collection process by providing a description of the community in which this plant was found. Some examples of community descriptions are as follows:

- 25 year aspen boundary of mature trees. very little slope. a lot of light entry
- *acer saccharum* floodplain forest. hummock-hollow microtopography.
- mature mesic hemlock-hardwood forest adjacent to pond

The community type description field is a note that is accessible via Ctrl+E from the P2 Subplot screen for P2VEG.

When collected: VEGETATION NONSAMPLED REASON = 10 or as needed
Field width: 2000 alphanumeric characters
Tolerance: N/A
MQO: N/A
Values: English language words, phrases, and numbers

8.5 Vegetation Structure

In this section, use ocular methods to estimate canopy cover by layer and aerial view cover for each Structure Growth Habit, and record to the nearest percent (canopy cover >0 and <1% is coded as 1%; i.e., trace amounts are coded as 1%.)

Canopy cover by layer:
Estimate the canopy cover in each Structure Growth Habit for each of the four layers. Include Structure Growth Habits with foliage present on the accessible condition and with foliage overhanging the accessible condition. For each layer canopy cover, examine the canopy cover of each Structure Growth Habit as if the other growth habits and other layers do not exist. Do not double-count overlapping crowns within a Structure Growth Habit; visualize the canopy cover within the layer collapsed into a 2-dimensional space. If a Structure Growth Habit does not have foliage in a layer, enter 0 (do not count tree boles as cover).

Aerial View Coverage:
Determine the total aerial canopy cover by Structure Growth Habit. .Examine each Structure Growth Habit individually as if the other growth habits do not exist. Do not double-count overlapping crowns within a Structure Growth Habit (maximum cover = the percentage of the subplot area in the accessible condition.)

The total aerial canopy cover for a Structure Growth Habit must be equal to or greater than the highest canopy cover recorded for an individual layer in that growth habit, but cannot be greater than the sum of the canopy covers recorded for all the layers in that growth habit.

Vegetation Structure Growth Habits:
Apply the definitions that follow based on the species and appearance of the plants **on the subplot-condition** (i.e., do not put the same species in multiple Structure Growth Habits on the same subplot-condition.) If a tree species has been selected as a tally tree species by the particular FIA unit, always record that species in the tally tree species growth habit (TT), even if it grows as a shrub in some environments. Woody plants **not** on the unit's tally tree species list may have a tree growth habit in some environments, and these should be recorded as non-tally tree species (NT). If the growth habit is shrub in another environment, record that species as a shrub (SH). The definitions (adapted from NRCS PLANTS) are:

TT **Tally Tree Species (TT):** All core tree species **and** any core optional tree species selected by a particular FIA unit. Any plant of that species is included, regardless of its shape and regardless of whether it was tallied on the subplot or microplot during tree tally. Seedlings (any length, no minimum), saplings, and mature plants are included.

NT **Non-tally Tree Species (NT):** Tree species not on a particular FIA unit's tree tally list that are woody plants with a single well-defined, dominant main stem, not supported by other vegetation or structures (not vines), and which are, or are expected to become, greater than 13 feet in height. Seedlings (any length, no minimum), saplings, and mature plants are included.

SH **Shrubs/Subshrubs/Woody Vines (SH):** Woody, multiple-stemmed plants of any size, subshrubs (low-growing shrubs under 1.5 feet tall at maturity), and woody vines. Most cacti are included in this category.

FB **Forbs (FB):** Herbaceous, broad-leaved plants; includes non-woody-vines, ferns (does not include mosses and cryptobiotic crusts).

FN **Fern (FN):** ferns [include ferns in Forb (FB) assessments; include only ferns (exclude other forbs) in Fern (FN) assessments]

GR **Graminoids (GR):** Grasses and grass-like plants (includes rushes and sedges).

8.5.1 TALLY TREE SPECIES COVER LAYER 1
Record canopy cover for all tally tree species in layer 1 (0-2.0 feet) to the nearest percent. Canopy cover includes all tally tree species present, regardless of DBH or DRC.

When Collected: Any accessible measured land condition (CONDITION CLASS STATUS = 1) when P2 vegetation is being sampled on the subplot (P2 VEG SUBPLOT SAMPLE STATUS = 1)
Field Width: 3 digits
Tolerance: +/- 1 class based on the following canopy cover classes: 1%, 2-5%, 6-10%, 11-25%, 26-50%, 51-75%, 76-95%, 96-100%

MQO: at least 90% of the time
Values: 000-100

8.5.2 TALLY TREE SPECIES COVER LAYER 2
Record canopy cover for all tally tree species in layer 2 (2.1- 6.0 feet) to the nearest percent. Canopy cover includes all tally tree species present, regardless of DBH or DRC. Follow the same procedures as for TALLY TREE SPECIES COVER LAYER 1.

8.5.3 TALLY TREE SPECIES COVER LAYER 3
Record canopy cover for all tally tree species in layer 3 (6.1- 16.0 feet) to the nearest percent. Canopy cover includes all tally tree species present, regardless of DBH or DRC. Follow the same procedures as for TALLY TREE SPECIES COVER LAYER 1.

8.5.4 TALLY TREE SPECIES COVER LAYER 4
Record canopy cover for all tally tree species in layer 4 (16.1 feet and above) to the nearest percent. Canopy cover includes all tally tree species present, regardless of DBH or DRC. Follow the same procedures as for TALLY TREE SPECIES COVER LAYER 1.

8.5.5 TALLY TREE SPECIES COVER – AERIAL VIEW
Record the total aerial canopy cover for all tally tree species over all layers. Canopy cover includes all tally tree species present, regardless of DBH or DRC. Follow the same procedures as for TALLY TREE SPECIES COVER LAYER 1, but include all layers.

8.5.6 NON-TALLY TREE SPECIES COVER LAYER 1
Record canopy cover for species **not** on the tally tree species list with tree growth habit in layer 1 (0-2.0 feet) to the nearest percent. Canopy cover includes all non-tally tree species present, regardless of DBH or DRC.

When Collected: Any accessible measured land condition (CONDITION CLASS STATUS = 1) when P2 vegetation is being sampled on the subplot (P2 VEG SUBPLOT SAMPLE STATUS = 1)
Field Width: 3 digits
Tolerance: +/- 1 class based on the following canopy cover classes: 1%, 2-5%, 6-10%, 11-25%, 26-50%, 51-75%, 76-95%, 96-100%
MQO: at least 90% of the time
Values: 000-100

8.5.7 NON-TALLY TREE SPECIES COVER LAYER 2
Record canopy cover for species **not** on the tally tree species list with tree growth form in layer 2 (2.1- 6.0 feet) to the nearest percent. Canopy cover includes all non-tally tree species present, regardless of DBH or DRC. Follow the same procedures as for NON-TALLY TREE SPECIES COVER LAYER 1.

8.5.8 NON-TALLY TREE SPECIES COVER LAYER 3
Record canopy cover for species **not** on the tally tree species list with tree growth form in layer 3 (6.1- 16.0 feet) to the nearest percent. Canopy cover includes all non-tally tree species present,

regardless of DBH or DRC. Follow the same procedures as for NON-TALLY TREE SPECIES COVER LAYER 1.

8.5.9 NON-TALLY TREE SPECIES COVER LAYER 4
Record canopy cover for species **not** on the tally tree species list with tree growth habit in layer 4 (16.1 feet and above) to the nearest percent. Canopy cover includes all non-tally tree species present, regardless of DBH or DRC. Follow the same procedures as for NON-TALLY TREE SPECIES COVER LAYER 1.

8.5.10 NON-TALLY TREE SPECIES COVER – AERIAL VIEW
Record the total aerial canopy cover for species **not** on the tally tree species list with tree growth habit over all layers. Canopy cover includes all non-tally tree species present, regardless of DBH or DRC. Follow the same procedures as for NON-TALLY TREE SPECIES COVER LAYER 1, but include all layers.

8.5.11 SHRUB, SUBSHRUB, AND WOODY VINE COVER LAYER 1
Record canopy cover for shrubs/subshrubs/woody vines in layer 1 (0-2.0 feet) to the nearest percent.

When collected: Any accessible measured land condition (CONDITION CLASS STATUS = 1) when P2 vegetation is being sampled on the subplot (P2 VEG SUBPLOT SAMPLE STATUS = 1)
Field width: 3 digits
Tolerance: +/- 1 class based on the following canopy cover classes: 1%, 2-5%, 6-10%, 11-25%, 26-50%, 51-75%, 76-95%, 96-100%
MQO: at least 90% of the time
Values: 000-100

8.5.12 SHRUB, SUBSHRUB, AND WOODY VINE COVER LAYER 2
Record canopy cover for shrubs/subshrubs/woody vines in layer 2 (2.1-6.0 feet) to the nearest percent. Follow the same procedures as for SHRUB, SUBSHRUB, AND WOODY VINE COVER LAYER 1.

8.5.13 SHRUB, SUBSHRUB, AND WOODY VINE COVER LAYER 3
Record canopy cover for shrubs/subshrubs/woody vines in layer 3 (6.1-16.0 feet) to the nearest percent. Follow the same procedures as for SHRUB, SUBSHRUB, AND WOODY VINE COVER LAYER 1.

8.5.14 SHRUB, SUBSHRUB, AND WOODY VINE COVER LAYER 4
Record canopy cover for shrubs/subshrubs/woody vines in layer 4 (16.1 feet and above) to the nearest percent. Follow the same procedures as for SHRUB, SUBSHRUB, AND WOODY VINE COVER LAYER 1.

8.5.15 SHRUB, SUBSHRUB, AND WOODY VINE COVER—AERIAL VIEW
Record the total aerial canopy cover for the shrub/subshrub/woody vine growth habit over all layers. Follow the same procedures as for SHRUB, SUBSHRUB, AND WOODY VINE COVER LAYER 1, but include all layers.

8.5.16 FORB COVER LAYER 1

Record canopy cover for forbs in layer 1 (0-2.0 feet) to the nearest percent.

When collected: Any accessible measured land condition (CONDITION CLASS STATUS = 1) when P2 vegetation is being sampled on the subplot (P2 VEG SUBPLOT SAMPLE STATUS = 1)
Field width: 3 digits
Tolerance: +/- 1 class based on the following canopy cover classes: 1%, 2-5%, 6-10%, 11-25%, 26-50%, 51-75%, 76-95%, 96-100%
MQO: at least 90% of the time
Values: 000-100

8.5.16.1N FERN COVER LAYER 1

Record a total canopy coverage for ferns in layer 1 (0-2.0 feet) to the nearest percent.

Include ferns in Forb (FB) assessments; include only ferns (exclude other forbs) in Fern (FN) assessments.

When collected: Any accessible measured land condition (CONDITION CLASS STATUS = 1) when P2 vegetation is being sampled on the subplot (P2 VEG SUBPLOT SAMPLE STATUS = 1)
Field width: 3 digits
Tolerance: +/- 1 class based on the following canopy cover classes: 1%, 2-5%, 6-10%, 11-25%, 26-50%, 51-75%, 76-95%, 96-100%
MQO: at least 90% of the time
Values: 000-100

8.5.17 FORB COVER LAYER 2

Record canopy cover for forbs in layer 2 (2.1-6.0 feet) to the nearest percent. Follow the same procedures as for FORB COVER LAYER 1.

8.5.17.1N FERN COVER LAYER 2

Record a total canopy coverage for ferns in layer 2 (2.1-6.0 feet) to the nearest percent. Follow the same procedures as for FERN COVER LAYER 1.

8.5.18 FORB COVER LAYER 3

Record canopy cover for forbs in layer 3 (6.1-16.0 feet) to the nearest percent. Follow the same procedures as for FORB COVER LAYER 1.

8.5.18.1N FERN COVER LAYER 3

Record a total canopy coverage for ferns in layer 3 (6.1-16.0 feet) to the nearest percent. Follow the same procedures as for FERN COVER LAYER 1.

8.5.19 FORB COVER LAYER 4

Record canopy cover for forbs in layer 4 (16.1 feet and above) to the nearest percent. Follow the same procedures as for FORB COVER LAYER 1.

8.5.19.1N FERN COVER LAYER 4

Record a total canopy coverage for ferns in layer 4 (16.1 feet and above) to the nearest percent. Follow the same procedures as for FERN COVER LAYER 1.

8.5.20 FORB COVER—AERIAL VIEW

Record the total aerial canopy cover for the forb growth habit over all layers. Follow the same procedures as for FORB COVER LAYER 1, but include all layers.

8.5.20.1N FERN COVER—AERIAL VIEW

Record the total canopy cover for the fern growth habit over all layers. Follow the same procedures as for FERN COVER LAYER 1, but include all layers.

8.5.21 GRAMINOID COVER LAYER 1

Record canopy cover for graminoids in layer 1 (0-2.0 feet) to the nearest percent.

When collected: Any accessible measured land condition (CONDITION CLASS STATUS = 1) when P2 vegetation is being sampled on the subplot (P2 VEG SUBPLOT SAMPLE STATUS = 1)
Field width: 3 digits
Tolerance: +/- 1 class based on the following canopy cover classes: 1%, 2-5%, 6-10%, 11-25%, 26-50%, 51-75%, 76-95%, 96-100%
MQO: at least 90% of the time
Values: 000-100

8.5.22 GRAMINOID COVER LAYER 2

Record canopy cover for graminoids in layer 2 (2.1-6.0 feet) to the nearest percent. Follow the same procedures as for GRAMINOID COVER LAYER 1.

8.5.23 GRAMINOID COVER LAYER 3

Record canopy cover for graminoids in layer 3 (6.1-16.0 feet) to the nearest percent. Follow the same procedures as for GRAMINOID COVER LAYER 1.

8.5.24 GRAMINOID COVER LAYER 4

Record canopy cover for graminoids in layer 4 (16.1 feet and above) to the nearest percent. Follow the same procedures as for GRAMINOID COVER LAYER 1.

8.5.25 GRAMINOID COVER—AERIAL VIEW

Record the total aerial canopy cover for the graminoid growth habit over all layers. Follow the same procedures as for GRAMINOID COVER LAYER 1, but include all layers.

9.0 INVASIVE PLANTS

The objectives of the Phase 2 (P2) invasive plants protocol are to document abundance and monitor changes in abundance of selected species over time. Combined with other plot data and other datasets, this data can be used to predict the future spread of selected species. Invasive plant species are having tremendous economic and ecological impacts on our nation's forests, and the impacts are increasing over time. Providing accurate, statistically valid estimates of the distribution and abundance of some of the most damaging species will give managers and policy-makers a better understanding of the problem than they would otherwise have.

Each FIA unit, in collaboration with vegetation experts, has developed lists of the most important invasive species to monitor on forested lands. Depending on local needs or forest conditions, there may be different lists of species for individual states or portions of states. Changes to the species on these lists are managed by the individual FIA units using local change procedures. However, when an FIA unit samples invasive species, they will use the field protocols contained in this chapter.

Data will be collected by crew members who have been trained and certified in the Invasive plants protocol methods. These crew members are expected to have field guides that allow for unambiguous identification of the plant species on the list they are to use, and training in field identification and cover estimation of those species under different conditions.

Note: Avoid becoming part of the problem! There is a risk that field crews walking into plot locations could pick up seeds along roadsides or other patches of invasive plants and spread them through the forest and on to the plot. Be aware of the vegetation you are traveling through and consider stopping and removing seeds from boots and clothing before entering uninvaded lands, particularly remote areas that are rarely visited.

9.1 Invasive Species Sample Design

Phase 2 sampling of invasive species is most often focused on accessible forest condition classes within the 24.0-foot radius subplot. If the total area of all accessible forest land condition classes is less than 100 percent on a subplot, **invasive species measurements are done only on the portion that is in accessible forest land condition classes.** If multiple accessible forested condition classes are present on the subplot, separate estimates are made for each condition class on the subplot. Canopy cover estimates are only made for the area within accessible forest condition(s)—for example, vegetation cover over-hanging a nonforest road condition is not included in the estimate.

NRS Note: Nonforest inventories are not conducted in our region, i.e. NONFOREST SAMPLING STATUS = 1.

Canopy cover is estimated for any listed invasive species present on the measured condition(s) of a subplot, regardless of abundance (i.e., there is no minimum cover threshold for sampling) (appendix 9). When crews are not sure about the identification of a plant that might be a listed invasive, they are encouraged to collect specimens for later identification (appendix 10). Rules and expectations for plant collection and identification are specified by individual FIA units.

NRS Note: NRS will complete P2 Invasive Plants (NRS manual section 9.0) protocols during the window of May 1st through September 30th.

In 2012, P2 Invasive Plants protocols will be completed on approximately 12.5% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region. Beyond 2012, P2 Invasive

Plants protocols may be completed on up to approximately 25% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region.

9.2 Species Records

The invasive plant recorder does a search of each measured condition on the subplot. **Only** listed species rooted in or overhanging (and rooted out of) this condition are included. For tree species, there are no minimum (or maximum) height limits as are required for seedling counts. All vegetation and plant parts that are or were alive during the current growing season are included in the cover estimates (e.g., brown Canada thistle in late summer is counted, live buds on Russian olive in late fall are used to estimate crown cover).

Total cover is estimated on measured conditions on each 24.0-foot radius subplot for every species on the invasive plant list found. If multiple conditions are being sampled on the same subplot, separate cover estimates for every species must be made.

9.3 INVASIVE PLANT SAMPLING STATUS (Plot-level variable)

Determines whether invasive plant data will be recorded on the plot and the land class(es) on which it will be recorded.

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

0 Not collecting invasive plant data
1 Invasive plant data collected only on accessible forest land conditions (CONDITION CLASS STATUS = 1) (Downloaded “hidden” value)

NRS Note: Nonforest inventories are not conducted in our region, i.e. NONFOREST CONDITION STATUS = 2

9.3.1N INVASIVE TIME **[ITIME]**

Record the number of minutes required to complete INVASIVE variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 01- 99

9.3.2N NUMBER OF PERSONS COLLECTING INVASIVE ON EACH POINT **[ISIZE]**

Record the number of persons that specifically collected INVASIVE variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 1 digit
Tolerance: No errors

MQO: At least 99% of the time
Values: 1- 5

9.4 SUBPLOT NUMBER
Record the code corresponding to the number of the subplot.

When collected: On all subplots where INVASIVE PLANT SAMPLING STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

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

9.5 INVASIVE PLANT SUBPLOT STATUS **[INST]** (Subplot-level variable)
Record the code to indicate whether the subplot was sampled for invasive plants. A subplot may be sampled but not have any invasive plants present. If there is **any** part of an accessible portion of the subplot where other plot measurements are made but invasive plants can't be assessed (e.g., because of snow, water), enter code 3 and do not record **any** invasive plant measurements.

When collected: On all subplots where (INVASIVE PLANT SAMPLING STATUS=1 and SUBPLOT STATUS=1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1 Subplot sampled, invasive plants present
2 Subplot sampled, no invasive plants present
3 Subplot not sampled for invasive plants

9.6 INVASIVE PLANT NONSAMPLED REASON (Subplot-level variable)
Record the reason why a subplot cannot be sampled for invasive plants.

When collected: On all subplots where INVASIVE PLANT SUBPLOT STATUS = 3
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

10 Other (for example, snow or water covering vegetation that is supposed to be sampled)

9.7 INVASIVE PLANT DATA NOTES
Use this field to record any notes about the CONDITION(s) on the subplot, particularly any unusual conditions encountered.

When plant specimens are collected, use this field to record a community type description for each subplot sampled for P2 Invasive Plants. The community description is intended to fully automate the specimen collection process by providing a description of the community in which this plant was found. Some examples of community descriptions are as follows:

- 25 year aspen boundary of mature trees. very little slope. a lot of light entry
- *acer saccharum* floodplain forest. hummock-hollow microtopography.
- mature mesic hemlock-hardwood forest adjacent to pond

The community type description field is a note that is accessible via Ctrl+E from the P2 Subplot screen.

When collected: INVASIVE PLANT NONSAMPLED REASON=10 or as needed
Field width: Unlimited alphanumeric character field
Tolerance: N/A
MQO: N/A
Values: English language words, phrases, and numbers

9.8 CONDITION CLASS NUMBER **[CON#]**

Record the number for the measured condition class in which the invasive plant(s) is found. If multiple measured conditions occur on the same subplot, data will be collected for each condition separately.

When collected: Any condition class where (INVASIVE PLANT SAMPLING STATUS=1 and CONDITION CLASS STATUS=1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1-9

9.9 SPECIES CODE **[ISPP]**

Record the code for any species listed in appendix 9 that is found rooted in or overhanging (and rooted out of) the measured condition within the subplot. Species codes must be the standardized codes in the Natural Resource Conservation Service (NRCS) PLANTS database January 2000 version maintained by the FIA IM group (USDA, NRCS. 2000. The PLANTS database [http://plants.usda.gov/plants]. National Plant Data Center, Baton Rouge, LA 70874-4490). NRS Note: Species codes must be the standardized codes in the Natural Resource Conservation Service (NRCS) PLANTS database January 2010 version maintained by the FIA IM group (USDA, NRCS. 2010. The PLANTS database [http://plants.usda.gov/plants]. National Plant Data Center, Baton Rouge, LA 70874-4490).

NRS Note: For the four invasive *Lonicera* shrub species record in NRS, use the LONIC code if you cannot key out to species. All others key to species.

If a species is suspected of being a listed invasive but cannot be identified quickly and confidently, and the FIA unit's protocols require specimen collection, assign a NRCS PLANTS unknown code. A subset of acceptable unknown codes that can be used is listed below. Collect a specimen unless the species is locally sparse. A species is "locally sparse" if five or fewer plants are present in the entire plot (4 subplots) and immediate surrounding area.

Unknown Code	Common Name

2FERN	Fern or Fern Ally
2FORB	Forb (herbaceous, not grass nor grasslike)
2GRAM	Graminoid (grass or grasslike)
2PLANT	Plant
2SHRUB	Shrub (>.5m)
2SUBS	Subshrub (<.5m)
2TREE	Tree
2VH	Vine, herbaceous
2VW	Vine, woody

When collected: On all conditions within subplots where INVASIVE PLANT SUBPLOT STATUS=1 and ((INVASIVE PLANT SAMPLING STATUS=1 and CONDITION CLASS STATUS=1)
Field width: 8 alpha-numeric characters
Tolerance: No errors
MQO: At least 99% of the time
Values: Accepted NRCS species code from the appropriate list for the unit when the species is known, or a NRCS unknown code when the species is not known.

9.9.1N Unknown Plants and Voucher Specimen Collection

Collection of a plant specimen is required if:

1) You cannot quickly and confidently ID a plant that you think is on our invasive plants list.

2) You find one of the invasive plants on our list, but it has not been found in the State in which the plot is located. Use the field ID guide, A Guide to Nonnative Invasive Plants Inventoried in the North by Forest Inventory and Analysis, by Cassandra Olson and Anita F. Cholewa, to determine which states the invasive has not been recorded. The distribution maps in these guides are from the NRCS Plants Database.

Follow these Basic Steps:

1. Assign a valid NRCS PLANTS Genus (listed in appendix 9) or Unknown CODE (listed in 9.9) and assign a unique species number (see 9.10)
2. Record if a specimen was collected or not in INVASIVE SPECIMEN COLLECTED (see 9.13).
3. When a specimen is collected, enter a SPECIMEN LABEL NUMBER (see 9.14). Place the pre-printed label with the corresponding label number in the bag with the specimen.
4. If no specimen is collected, record in INVASIVE PLANT NOTES why (see 9.15).
5. Describe the unknown species in INVASIVE PLANT NOTES (see 9.15).
6. Record the canopy cover estimates for the sample units where the plant was encountered, as for any identified species.

SPECIAL SAFETY NOTE FOR NRS: Please do not collect known hazardous plants, such as *Ailanthus altissima* or *Heracleum mantegazzianum* (Giant hogweed). These plants are known to cause blisters and/or rashes. For more information, go to the following website and see section on Special P2/P3 alerts: http://nrs.fs.fed.us/fia/safety/pdfs/hazardous-plants/toxic-plants.pdf

9.10 UNIQUE SPECIES NUMBER **[UNQ#]**

When any species code is entered for the first time on a plot, the UNIQUE SPECIES NUMBER assigned is "1". If more than one unidentified species is recorded that is described by the same unknown code, the next sequential number is assigned. If a previously-recorded unidentified species is encountered again elsewhere on the plot, the UNIQUE SPECIES NUMBER that corresponds to the earlier encountered specimen must be entered. For example, an unknown thistle and unknown hawkweed would both be given a species code of "2FORB" but would need to be given different UNIQUE SPECIES NUMBERs when measured.

When collected: All species records
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 1-99, assigned in sequential numbers

9.11 SPECIES CANOPY COVER **[PCOV]**

A rapid canopy cover estimate, to the nearest percent cover, is made for each species for all foliage across all layer heights. **Canopy cover is based on a vertically-projected polygon described by the outline of the foliage**, ignoring (i.e. without subtracting) any normal spaces occurring between the leaves of plants (Daubenmire 1959), and ignoring overlap among multiple layers of a species [i.e. overlapping crowns are not double-counted (visualize the canopy cover collapsed into a 2-dimensional space)]. For each species, cover can never exceed 100 percent; the maximum possible canopy cover is the percentage of the subplot area within the accessible forested condition. Cover is estimated for each measured condition on the subplot separately. However, the foliage **cover is always estimated as a percent of an entire subplot**. For example, on a subplot with two sampled conditions, a species occurs with a cover equal to a circle with a radius of 7.6 feet on the full subplot, or 10 percent cover. On condition class #1 it covers an area equal to a circle of 2.4 feet radius and is recorded as 1 percent cover. The remainder, 9 percent cover, is recorded for condition #2. If the species is only present on condition class #1 with an area equal to a circle of 2.4-feet radius it is recorded as 1 percent. The proportion of the subplot in each condition does not matter.

NRS Note: The SPECIES CANOPY COVER percent cannot exceed the percent area represented for the forested condition

If cover is greater than 0 but less than 1.5 percent, record as 1 percent cover. For species of moderate cover, it may be easiest to divide the subplots into quarters, estimate canopy cover of each quarter separately, and then add them together. The following area-cover sizes may be useful in developing estimates :

Subplot radius = 24.0 feet, Subplot area = 1809 ft^2			
Cover	Area (ft^2)	Length of a side of a square(ft)	Radius of circular area(ft)
1%	18	4.3	2.4
3%	54	7.4	4.1
5%	90	9.5	5.3
10%	181	13.4	7.6
20%	362	19	10.7

When collected: All species records
Field width: 3 digits

Tolerance: +/- 1 class based on the following canopy cover classes: 1%, 2-5%, 6-10%, 11-25%, 26-50%, 51-75%, 76-95%, 96-100%
MQO: At least 90% of the time
Values: 001 to 100

9.12 INVASIVE PLANT SPECIMEN COLLECTION RULE (Plot-level variable)
Downloaded code to indicate if collection of specimens of unknown invasive species is required.

When collected: Downloaded on all plots where INVASIVE PLANT SAMPLING STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1 FIA unit requires specimen collection for invasive plants

NRS NOTE: This is a hidden variable and will be recorded as code 1, so you will not see this on the PDR screen.

9.13 INVASIVE SPECIMEN COLLECTED **[VOUC]**
Record if a specimen was collected for each species or unknown code. If the record is an unknown code, your unit requires specimen collection, and a plant specimen is not collected, describe the reason it was not collected in 9.15, INVASIVE PLANT NOTES.

When collected: Each record where INVASIVES PLANT SUBPLOT STATUS=1, INVASIVE PLANT SPECIMEN COLLECTION RULE = 1, and an unknown SPECIES CODE was used.
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time

Values:

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

9.14 SPECIMEN LABEL NUMBER **[LABL]**
Record the label number for the collected specimen.

When collected: Where INVASIVE SPECIMEN COLLECTED=1
Field width: 5 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 99999, as pre-printed and assigned by FIA unit.

NRS PDR Note: MIDAS will auto populate the SPECIMEN LABEL NUMBER with a unique code, when INVASIVE SPECIMEN COLLECTED = 1.

9.14.1N Field Specimen Label

Revised data collection software auto-generates a label number when a specimen is collected. Write out the generated LABEL NUMBER on a small piece of paper and include it in the bag with the specimen.

Label Number:1 Date: 8/06/03 Unknown Code: ACANT2 Unique Species Nbr: 1 Veg Spec. crew number: John Doe

Figure 24-2N. Example of field label for unknown specimen.

9.14.2N Official Specimen Label

Official specimen labels are printed from plot data and accompany the unknown (or voucher) specimen as it is pressed, dried, and submitted for further identification. Labels will not include sensitive plot identification data – the unique specimen label number is sufficient identification for each specimen.

Specimen Voucher

Label Number: 21 **Resolved Species Code:**

Resolved scientific name:

Resolved by (name):

Date Collected: 6/22/2005

Unknown Code: 2GRAM **Unique Species Nbr:** 7

Field collected scientific name:

Collected by: John Doe

State: State name **County:** County name

Community type(s) where found: ridgetop with atv trl, stripped yrs ago bottomland, old stripmine moist bottom

Species Notes: delicate, hairy joints

9.15 INVASIVE PLANT NOTES

Notes are **required** for each species record with an unknown code. Enter text that describes the species or that explains why it was not collected if collection was required but not done. This text may be used on the specimen label and any spreadsheet used to track specimens.

When collected: Required for each record with an unknown code and SPECIMEN LABEL NUMBER.
Field width: Unlimited alphanumeric character field
Tolerance: N/A
MQO: N/A

Values: English language words, phrases, and numbers

NRS NOTE: Record this note while in the invasive species record. Press the “Ctrl”+“N”.

Listed are reasons why a specimen was not collected from 4.0:

Species is locally sparse
Species has less than 1% canopy cover on the subplot and no mature foliage or reproductive parts are present
Hazardous situation
Time limitation
Already collected with previous entry of genus or unknown code with the same unique species number
Specimen collected for immediate/local identification only
Other (explain in notes)

9.16 References

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science 33(1): 43-64.

10.0 DOWN WOODY MATERIALS (PHASE 2 – CORE OPTIONAL)

Down woody materials (DWM) are important components 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 wood components and fuels estimated by the FIA program are coarse wood, slash, fine wood, and litter and duff depth. The DWM protocol includes the following three suites of measurement options:

OPTION I. BASE:
The BASE option provides a minimum set of variables necessary to produce estimates for volume, biomass, carbon, and fuel load per acre on a broad scale. Base variables are required any time DWM is measured, and are labeled "BASE" in this chapter. Measurements include:

OPTION I: BASE Variables

BASE Layout: DWM SAMPLING STATUS, DWM NUMBER OF SUBPLOTS, DWM NUMBER OF TRANSECTS ON SUBPLOT, DWM TRANSECT LENGTH, DWM NOTES

BASE Transect Line Segmenting: SUBPLOT NUMBER, TRANSECT, SEGMENT CONDITION CLASS NUMBER, SEGMENT BEGINNING DISTANCE (HD), SEGMENT ENDING DISTANCE (HD), DWM TRANSECT SEGMENT SAMPLE STATUS, DWM TRANSECT NONSAMPLED REASON

BASE CWD: SUBPLOT NUMBER, TRANSECT, CWD CONDITION CLASS, PIECE ON SUBPLOT OR ANNULAR PLOT?, CWD DECAY CLASS, SPECIES, DIAMETER AT POINT OF INTERSECTION, DIAMETER OF HOLLOW AT POINT OF INTERSECTION, CWD LENGTH >=3 FEET

BASE Pile: PILE SUBPLOT NUMBER, PILE TRANSECT, PILE CONDITION CLASS NUMBER, PILE BEGINNING DISTANCE, PILE ENDING DISTANCE, COMPACTED HEIGHT OF CWD IN PILE, PILE DECAY CLASS, PILE SPECIES

BASE FWD: FWD SUBPLOT NUMBER, FWD TRANSECT, FWD CONDITION CLASS NUMBER, FWD TRANSECT SEGMENT SAMPLE STATUS, FWD TRANSECT NONSAMPLED REASON, SMALL FWD COUNT, MEDIUM FWD COUNT, LARGE FWD COUNT, HIGH COUNT REASON

BASE Duff/Litter Depth: DUFF/LITTER SUBPLOT NUMBER, DUFF/LITTER TRANSECT, DUFF/LITTER CONDITION CLASS NUMBER, DUFF/LITTER SAMPLE STATUS, DUFF/LITTER NONSAMPLED REASON, DUFF DEPTH, LITTER DEPTH, DUFF AND LITTER METHOD

DWM is sampled on accessible forest conditions intersected by a transect. If a transect crosses a condition boundary, the boundary locations on the transect are recorded. All 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 Coarse Woody Debris (CWD, ≥3 inches diameter and ≥0.5 foot long) or Fine Woody Debris (FWD, <3 inches diameter) are tallied if the central axis of the piece is intersected by the plane of the transect.

Note: DWM is a CORE OPTIONAL indicator on all Phase 2 plots. When measured on Phase 2 plots, all the BASE data items must be measured and other data items can be added as desired (designated as P2 OPTIONAL on data items.) However, DWM is a CORE indicator on all Phase

3 plots, and both BASE and WILDLIFE/ECOLOGICAL data items must be measured (see table 3).

Table 3. DWM Protocol Options Variables

OPTION I: BASE		
REQUIRED: BASE Layout Variables		
REQUIRED: BASE Transect Line Segmenting Variables		
REQUIRED: BASE CWD Variables **P2 OPTIONAL:** CWD HORIZONTAL DISTANCE, DIAMETER AT SMALL END, DIAMETER AT LARGE END, CWD TOTAL LENGTH		
REQUIRED: BASE Pile Variables		
REQUIRED: BASE FWD Variables		
REQUIRED: BASE Duff/Litter Depth Variables		

NRS Note: NRS will complete P2 DWM protocols during the window of May 1st through September 30th.

In 2012, P2 DWM protocols will be completed on approximately 12.5% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region. Beyond 2012, P2 DWM protocols may be completed on up to approximately 25% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region.

10.1 Definition of Down Woody Materials

Coarse Woody Debris – In this inventory, CWD includes downed, dead tree and shrub boles, large limbs, and other woody pieces that are ≥3 inches in diameter, ≥0.5 foot long, severed from their original source of growth, and leaning > 45 degrees from vertical. CWD **also** includes dead tally species trees or single-stemmed woodland species trees (either self-supported by roots, severed from roots, or uprooted and supported by other objects) that are leaning >45 degrees from vertical and not considered part of the standing tree inventory. Portions of dead trees that are separated greater than 50 percent (either above or below 4.5 feet), are considered severed and are included in the CWD inventory (see discussion and diagrams in section 5.7.2 - Standing Dead). For multi-stemmed non-tally tree woody species (Appendix 3) ,, only tally stems that are dead and detached**.** Include as CWD all dead multi-stemmed woodland tree stems that do not qualify as standing dead if they meet the size and lean angle requirements for CWD pieces. Also included are non-machine processed round wood such as fence posts and cabin logs.

CWD is measured primarily using intersect diameter. In rare instances when pieces are in a pile and it is impossible to estimate the size of individual pieces, use the pile protocol described in Section 10.7.

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 (see discussion and diagrams in section 5.7.2 - Standing Dead).
3. Dead shrubs, self-supported by their roots.
4. Trees still attached and showing signs 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.

Fine Woody Debris – In this inventory, FWD includes downed, dead branches, twigs, and small tree or shrub boles <3 inches in diameter 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)

10.2 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 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, starting at the subplot center and working towards the fixed radius plot boundary. 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 QA purposes.

Note: If any portion of the transect in the measured condition is not measurable, a non-sample code can be separately used for each component (CWD, FWD, duff/litter). However, if CWD is not measureable due to an obstruction such as snow or water, do not measure DWM (CWD, FWD, or duff/litter) on any part of the transect and set DWM TRANSECT SAMPLE STATUS = 0 (see section 10.5.6). In addition, all transect information will be accounted for individually for CWD, FWD, and duff/litter for all plots with a DWM Sampling Status code >0.

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, horizontal distance).

10.2.1 CWD Transects

Two transects are established that originate at the subplot center and extend out 24.0 feet horizontal distance (the radius of the subplot) (fig. 50). 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.

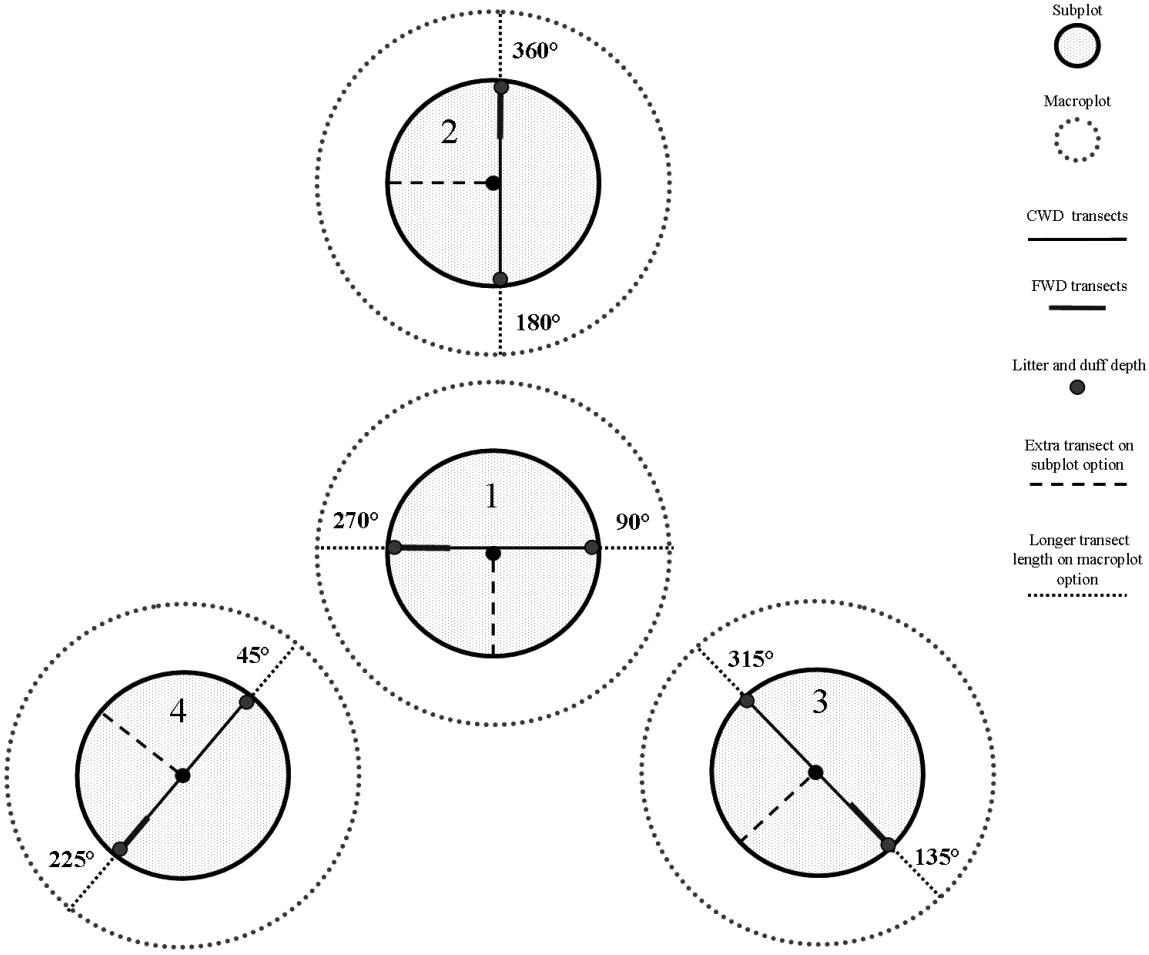

Figure 50. Plot layout for sampling CWD, FWD, and litter and duff depth. CWD transects include two 24-foot transects per subplot (starting at subplot center designated by its azimuth as labeled).

10.2.2 FWD Transects

On a portion of one CWD transect on each subplot, FWD is tallied within 3 size classes. Because FWD is generally present in high densities, a shorter transect will pick up an acceptable amount

of tally. The transect begins at 14 feet (horizontal distance) from the subplot center and extends out either 6 or 10 feet (horizontal distance) depending on the FWD size class, as follows:

Category of FWD	Size Class	Diameter range	Transect length (horizontal distance)	Transect location (horizontal distance)
Small FWD	1	0 in to 0.24 in	6 feet	14 to 20 feet
Medium FWD	2	0.25 in to 0.9 in	6 feet	14 to 20 feet
Large FWD	3	1.0 in to 2.9 in	10 feet	14 to 24 feet

It is helpful to have a size gauge available until your eye is 'trained' to recognize the 3 FWD size classes. Examples include a plastic or cardboard card with 3 notches cut for each size class, or a set of 3 dowels representing each size class.

10.3 Plot-Level Variables for DWM Protocol

The codes in this section define the type of variables and transect configuration used for measuring DWM. The variables will help define the design of previously-collected data and directly feed into compilation of expansion factors for measured DWM. These variables are predefined for an inventory and generally will be downloaded to the PDR.

10.3.1 DWM SAMPLING STATUS (BASE)

Record the code that describes whether DWM data will be recorded and which variables will be recorded. If code = 0, no further data collection is required within this manual section.

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

0 Not sampling DWM
1 BASE biomass DWM variables collected on measured land conditions (CONDITION CLASS STATUS = 1).

10.3.2 DWM NUMBER OF SUBPLOTS (BASE)

Identify the number of subplots on which DWM is measured. When DWM SAMPLING STATUS = 1, number of subplots = 4.

When collected: All plots where DWM SAMPLING STATUS >0
Field width: 1 digit
MQO: No errors
Tolerances: At least 99% of the time
Values: 1 to 4

10.3.3 DWM NUMBER OF TRANSECTS ON SUBPLOT (BASE)

Identify the number of transects per subplot on which DWM is measured. A "transect" is defined as a line starting from subplot center and ending at or beyond the subplot boundary. When DWM SAMPLING STATUS = 1, number of transects per subplot = 2.

When collected: All plots where DWM SAMPLING STATUS >0

Field width: 1 digit
MQO: No errors
Tolerances: At least 99% of the time
Values: 1 to 3

10.3.4 DWM TRANSECT LENGTH (BASE)

Identifies the length of each transect on which DWM is measured. The minimum transect length when DWM SAMPLING STATUS >0 is 24.0 feet, measured to the nearest 0.1 foot. When DWM SAMPLING STATUS = 1, transect length equals 24 feet .

When collected: All plots where DWM SAMPLING STATUS>0
Field width: 3 digits (xx.y)
Tolerance: +/- 1 ft
MQO: At least 95% of the time
Values: 24.0

10.3.5 DWM NOTES (BASE)

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

When collected: All plots where DWM SAMPLING STATUS >0, as needed
Field width: Unlimited alphanumeric character field
Tolerance: N/A
MQO: N/A
Values: English language words, phrases and numbers

10.3.5.1N DOWN WOODY MATERIAL TIME **[DTIME]**

Record the number of minutes required to complete DWM variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 001- 120

10.3.5.2N NUMBER OF PERSONS COLLECTING DWM ON EACH SUBPLOT **[DSIZE]**

Record the number of persons that specifically collected DWM variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1- 5

10.5 Transect Line Segmenting

Transect lines are segmented to determine the length of transect that occurs within each mapped condition class intersecting the line. These lengths determine the expansion factors for the measured DWM. It is important that any changes or corrections to condition identity, location and size mapped on the subplot spatially match the segmentation done on the transects. A segment is a length of transect that is in one condition. Segments are identified by recording the BEGINNING DISTANCE and ENDING DISTANCE from subplot center towards the end of the transect.

If any part of the transect segment is in a measured condition but the CWD is not measurable (e.g., snow or water), do not measure any DWM (CWD, FWD, or duff/litter depth) on that transect segment and set DWM TRANSECT SEGMENT SAMPLE STATUS = 0.

Starting at the subplot center and working towards the fixed radius plot boundary, each segment of transect line in a different condition class is delineated and recorded as a separate record. The horizontal BEGINNING DISTANCE and ENDING DISTANCE are recorded for each condition class encountered (fig. 51). The first record for each transect will have a BEGINNING DISTANCE of 0 feet. If only one condition class occurs on the transect line, only one segment is recorded. The last segment on all transects must have an ENDING DISTANCE of 24.0 feet horizontal distance if sampling the subplot. All condition segments on the transect must be defined and all transect length recorded and accounted for, either by condition, or by DWM TRANSECT SEGMENT SAMPLE STATUS.

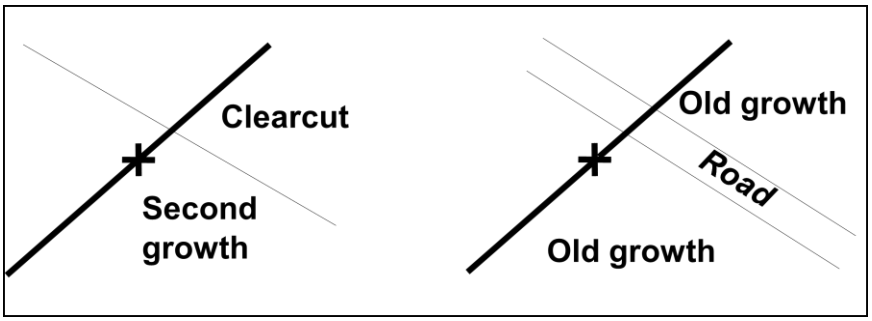

Figure 51. Transects are installed across condition class boundaries.

10.5.1 SUBPLOT NUMBER (BASE)

Record the code indicating the subplot center from which the transect originates.

When collected: All transect segments on plots where DWM SAMPLING STATUS >0
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

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

10.5.2 TRANSECT (BASE)

Record the transect azimuth (degrees) on which a condition class is being delineated. These transects, when being installed, have a tolerance of +/- 2 degrees.

When Collected: All transect segments where DWM SAMPLING STATUS > 0

Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

Subplot	Transect direction (degrees) from center of subplot
1	090
	270
2	360
	180
3	135
	315
4	045
	225

10.5.3 SEGMENT CONDITION CLASS NUMBER (BASE)
Record the code indicating the number of the condition class for the transect segment. Use the same code assigned to the condition class on the subplot or elsewhere on the plot. The first segment recorded for each transect will have the same CONDITION CLASS NUMBER as assigned to the subplot center.

When collected: All transect segments where DWM SAMPLING STATUS >0
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

10.5.4 SEGMENT BEGINNING DISTANCE (BASE)
Record the location (using horizontal distance to nearest 0.1 foot) on the transect line where the transect intersects the boundary with the adjacent condition class nearer to the subplot center. The first record for each transect will have a BEGINNING DISTANCE of 0 ft. Each subsequent record will have a BEGINNING DISTANCE equal to the ENDING DISTANCE of the previous record.

When collected: All transect segments where DWM SAMPLING STATUS >0
Field width: 3 digits (xx.y)
Tolerance: +/- 1 ft
MQO: At least 95% of the time
Values: 00.0 to 24.0 horizontal feet

10.5.5 SEGMENT ENDING DISTANCE (BASE)
Record the location (using horizontal distance to nearest 0.1 foot) on the transect line where the transect exits the condition class being delineated and intersects the boundary with a different condition class further away from the subplot center. If no other condition classes are encountered, record the location (using horizontal distance) of the end of the transect line.

When collected: All transect segments where DWM SAMPLING STATUS >0
Field width: 3 digits (xx.y)
Tolerance: +/- 1 ft
MQO: At least 95% of the time
Values: 00.1 to 24.0 horizontal feet

10.5.6 DWM TRANSECT SEGMENT SAMPLE STATUS (BASE)

Record the sample status for the transect segment. If any part of the segment is in an accessible condition that would be measured (CONDITION CLASS STATUS = 1), but the CWD is not measurable due to an obstruction such as snow or water, do not measure DWM on any part of the transect segment, and set code to 0 for that segment. In all other situations, set the code to 1. For conditions on which DWM would not be measured regardless (CONDITION CLASS STATUS = 3), will automatically be coded 1; those conditions should be identified in the transect segmenting.

When Collected: All transect segments on plots where DWM SAMPLING STATUS >0
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0	Transect segment not sampled
1	Transect segment sampled

10.5.7 DWM TRANSECT SEGMENT NONSAMPLED REASON (BASE)

Record the reason that DWM cannot be measured on the transect.

When Collected: All transects where DWM TRANSECT SEGMENT SAMPLE STATUS = 0
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

10	Other (for example, snow or water covering CWD that is supposed to be sampled). “Note required” when using this code.

10.6 Sampling Methods for COARSE WOODY DEBRIS (CWD)

10.6.1 Tally Rules for Coarse Woody Debris (CWD)

1. Coarse woody debris (CWD) is sampled on accessible forest conditions. Tally CWD by starting at the subplot center and working towards the fixed radius plot boundary. Measurements should **not** be taken along transects moving inward toward subplot center. Tally a piece if its central longitudinal axis intersects the transect, and the condition class is measured at the point of intersection (fig. 52). The entire piece is assigned to this condition.

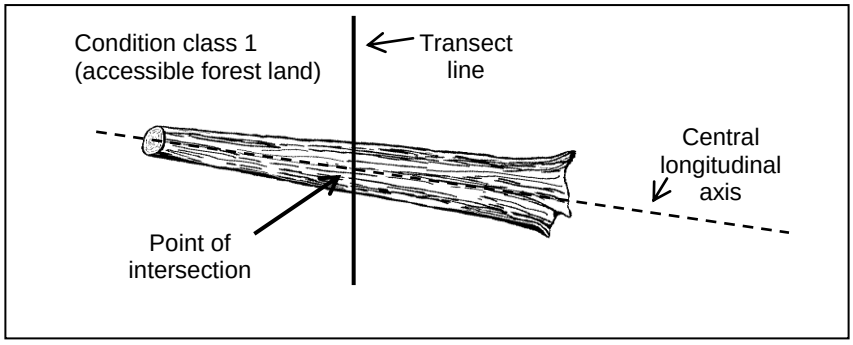

Figure 52. Tally rules for CWD.

2. Tally dead trees and tall stumps that are leaning > 45 degrees from vertical. Do not tally live trees or standing dead trees and tall 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' for determining what qualifies as standing and down dead trees and portions/tops of trees. Most CWD will be lying on the ground.

   Note: In order to avoid double counting or totally missing trees or portions in either protocol, once a decision is made on whether a tree or portion/top of a tree is considered standing or down it is important to include it in either one or the other protocol (standing tree or CWD), but not both. See additional diagrams in section 5.7.2 – Standing Dead.

In Figure 52.1N, the bole of a live or dead tree contains a break of > 50% resulting in a dead tree top that is still attached to the main bole. Since the break is > 50% the lean angle is measured between the large end (by the break) and the small end of the piece, if this angle is > 45 degrees from vertical the dead broken top would be considered a piece of CWD.

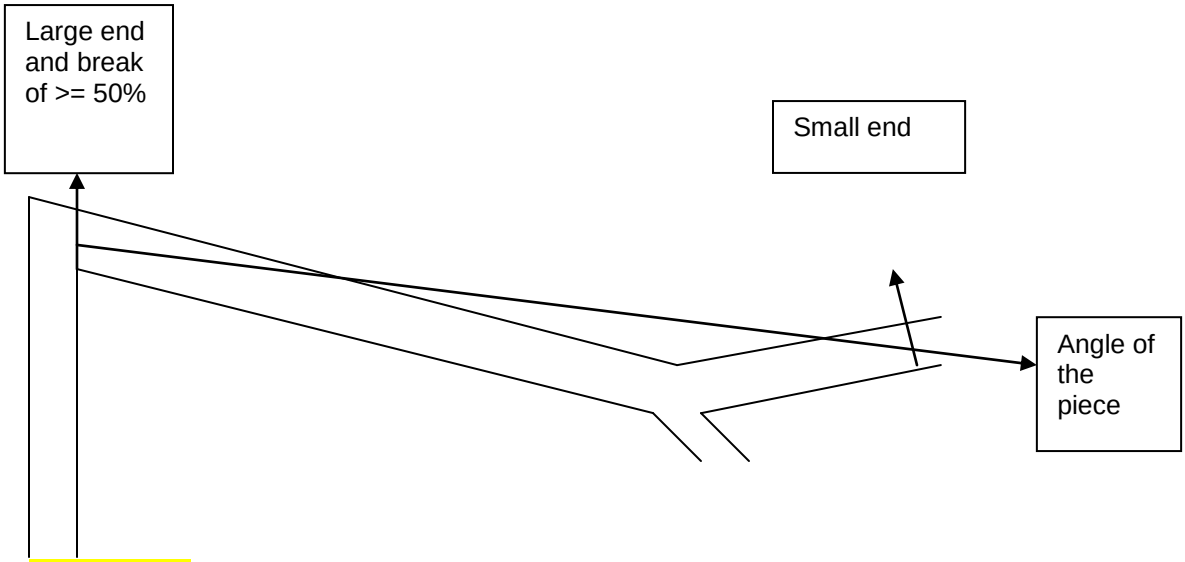

Figure 52.1N. Determining the lean angle when > 50% of the bole is broken.

In Figure 52.2N, Piece 1 is lying horizontally on the ground and qualifies as a piece of CWD. Piece 2 would not be measured because it has an angle of less than 45 degrees from vertical.

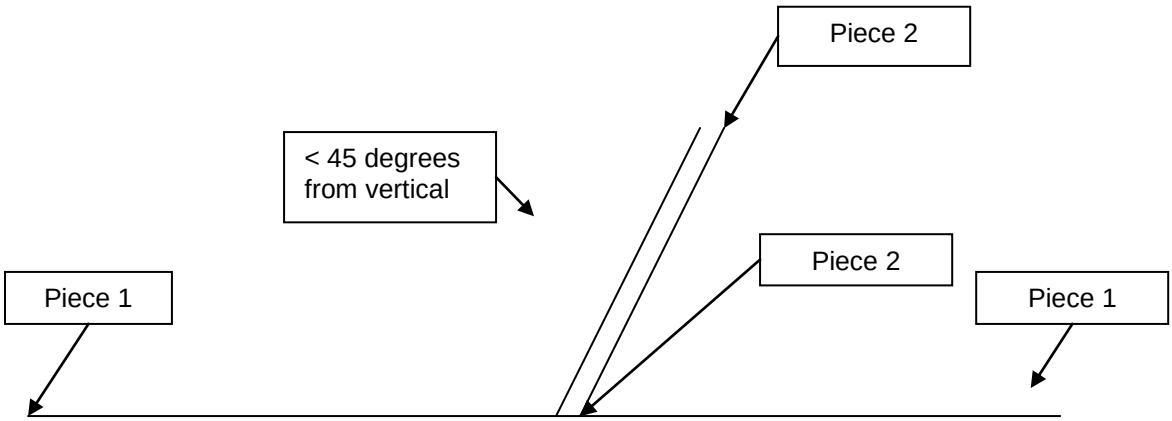

Figure 52.2N. Determining the lean angle of branches connected to a qualifying piece of CWD.

3. The minimum length for any tally piece is 0.5 feet and it needs to meet the minimum transect diameter guidelines.

4. Decay class of the piece determines whether or not the piece is tallied (see section 10.6.3.6).

   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 (fig. 53).

   For decay class 5: tally a piece if it is >5.0 inches in diameter at the point of intersection and >5.0 inches high from the uphill side of the ground. 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.

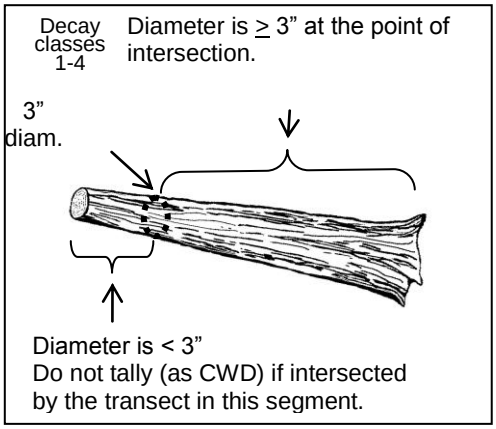

Figure 53. Tally rules for CWD decay classes 1-4.

5. Tally pieces created by natural causes (examples: natural breakage or uprooting) or by human activities such as cutting. In some cases it may be impossible to measure or estimate individual pieces—for example when CWD pieces are in machine-piled slash piles or windrows, or are part of jumble from flooding, landslide or avalanche. In these situations, piles are

described using the instructions in section 10.6 'Sampling Residue Piles'. Because biomass estimates from piles have great uncertainty associated with them, pieces should be measured individually if at all possible.

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.

   NRS Note: as moss and sphagnum can often cover the majority of CWD surfaces in some ecosystems, it is when a portion or entirety of a CWD piece becomes incorporated/buried within the forest floor/soil horizons that that CWD piece/portion is not measured. The presence of moss/sphagnum on CWD is not a condition that excludes CWD measurement, rather the CWD piece needs to be buried within the forest floor or submerged in peatland situations.

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 (see fig. 54).

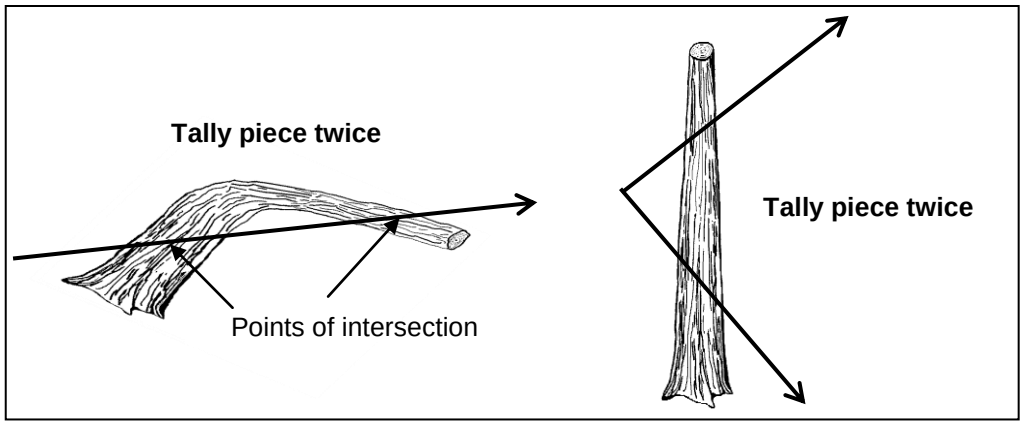

Figure 54. CWD tally rules: intersections.

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 smallest azimuth degree transect.

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 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 55).

13. If a transect intersects a non-measured condition (e.g. an inaccessible condition class, or a non-sampled code for CWD), CWD is not tallied on that portion of the transect.

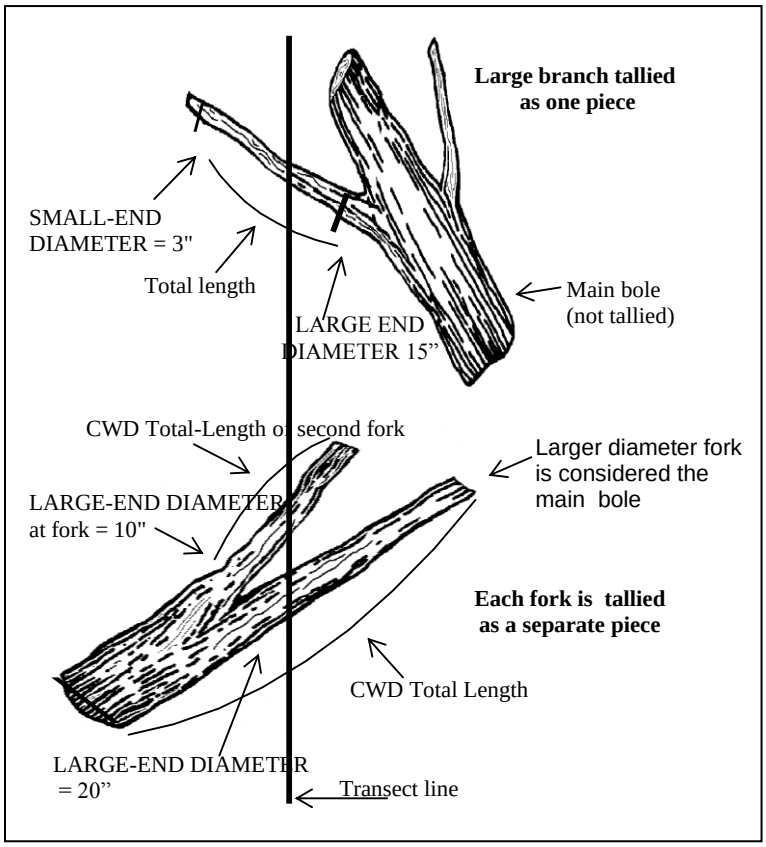

Figure 55. CWD tally rules for forked trees.

10.6.3 Recording Procedures for CWD

10.6.3.1 SUBPLOT NUMBER (BASE)

Record the code indicating the number of the subplot center from which the transect originates.

When collected: All tally pieces in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

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

10.6.3.2 TRANSECT (BASE)

Record the azimuth of the transect on which the CWD piece is sampled.

When Collected: All tally pieces where DWM TRANSECT SAMPLE STATUS = 1
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

Subplot	Transect direction (degrees) from center of subplot
1	090
	270
2	360
	180
3	135
	315
4	045
	225

10.6.3.3 CWD CONDITION CLASS (BASE)

Record the condition class number for each CWD piece at the point where the central longitudinal axis of the piece intersects the transect. If there is only one condition on the plot all CWD pieces will be assigned to CWD condition class = 1. If more than one condition has been identified and/or mapped on the plot/subplot, record the appropriate condition based on the location of the transect diameter measurement. All CWD pieces require a condition class and only classes that have been identified and/or mapped are valid.

When Collected: All tally pieces in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values: 1 to 9

10.6.3.4 PIECE ON SUBPLOT OR ANNULAR PLOT? (BASE)

Identify whether point of transect intersection with piece is on the subplot . If not extending transects onto annular plots all pieces will be assigned code = 1.

When Collected: All tally pieces in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

1	Central longitudinal axis of piece intersects the transect on the subplot (<= 24.0 horizontal feet)

10.6.3.5 CWD HORIZONTAL DISTANCE (WILDLIFE OPTION, NRS P2+)

Record the horizontal 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 horizontal distances, record the top piece first. CWD HORIZONTAL DISTANCE may be useful for verifying condition class, for QA checks, or for studies of different transect lengths.

When Collected: WILDLIFE: All tally pieces in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1 and DWM SAMPLING STATUS =2
OPTIONAL: All tally pieces in CONDITION CLASS STATUS =1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1 and DWM SAMPLING STATUS = 1 or 3
Field width: 3 digits (xx.y)
Tolerance: +/- 1.0 ft
MQO: At least 90% of the time
Values: 00.0 to 24.0

10.6.3.6 CWD DECAY CLASS (BASE)

Record a 1-digit code indicating the decay class of the piece. Code the decay class that predominates along the observed length of the piece. Use the guide below to determine CWD DECAY CLASS.

When Collected: All tally pieces in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: +/- 1 class
MQO: At least 90% of the time
Values:

Decay Class	Structural Integrity	Texture of Rotten Portions	Color of Wood	Invading Roots	Branches and Twigs
1	Sound, freshly fallen, intact logs	Intact, no rot; conks of stem decay absent	Original color	Absent	If branches are present, fine twigs are still attached and have tight bark
2	Sound	Mostly intact; sapwood partly soft (starting to decay) but can't be pulled apart by hand	Original color	Absent	If branches are present, many fine twigs are gone and remaining fine twigs have peeling bark
3	Heartwood sound; piece supports its own weight	Hard, large pieces; sapwood can be pulled apart by hand or sapwood absent	Reddish-brown or original color	Sapwood only	Branch stubs will not pull out
4	Heartwood rotten; piece does not support its own weight, but maintains its shape	Soft, small blocky pieces; a metal pin can be pushed into heartwood	Reddish or light brown	Through-out	Branch stubs pull out
5	None, piece no longer maintains its shape, it spreads out on ground	Soft; powdery when dry	Red-brown to dark brown	Through-out	Branch stubs and pitch pockets have usually rotted down

Note: CWD DECAY CLASS 5 pieces can be difficult to identify because they often blend into the duff and litter layers. They must still resemble a log; therefore, the first tally rule is that they must

be >5.0 inches in diameter and > 5.0 inches from the surface of the ground. 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. CWD DECAY CLASS 1 should be reserved for 'freshly fallen' logs that are completely intact (i.e., recent windfalls, or harvest).

10.6.3.7 SPECIES (BASE)

Record the code indicating the species of the piece. Since CWD pieces are not necessarily always tally species, record the most detailed available species code (see appendix 3). Some species codes are only genus specific (e.g., Prunus), or hardwood-softwood specific. Search for the species code that has the most detail for the identified piece. For shrubs or vines enter unknown softwood (0299) or hardwood (0998).

Species identification may be uncertain for some pieces. The piece's bark (either attached or sloughed and lying 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).

When Collected: All tally pieces in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1 and CWD DECAY CLASS = 1 to 4
Field width: 4 digits
Tolerance: No errors
MQO: At least 80% of the time
Values: See species codes in appendix 3

10.6.3.8 Diameters

If possible, the best way to measure diameter is to wrap the tape perpendicular to the longitudinal axis at the point of transect intersection (fig. 56). If that is not possible it is useful to carry a steel carpenters retracting tape to measure diameters. Other methods include wrapping a tape around the bole if possible, holding a straight-edge ruler above the piece, or using calipers.

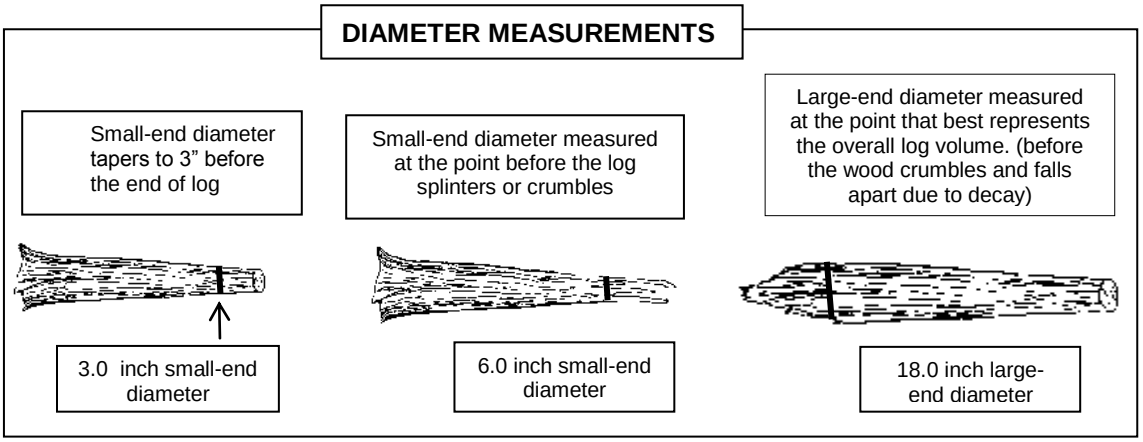

Figure 56. Diameter measurements

For pieces that cannot be taped and 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 57), and enter the average in the diameter field. This technique applies to intersect, small-end, and large-end diameters.

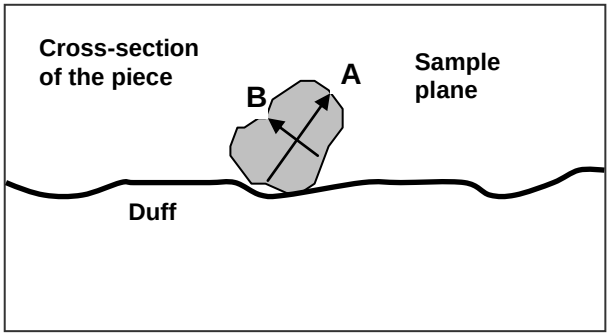

Figure 57. Estimating the diameter of pieces that are not round in cross-section.

If the transect intersects the log at the decayed or splintered end (fig. 58), record the diameter at this location as the intersect diameter. Record the large end and small end diameters on the same side of the transect diameter as illustrated. Record the small end diameter as 3 inches if it tapers below 3 inches. 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.

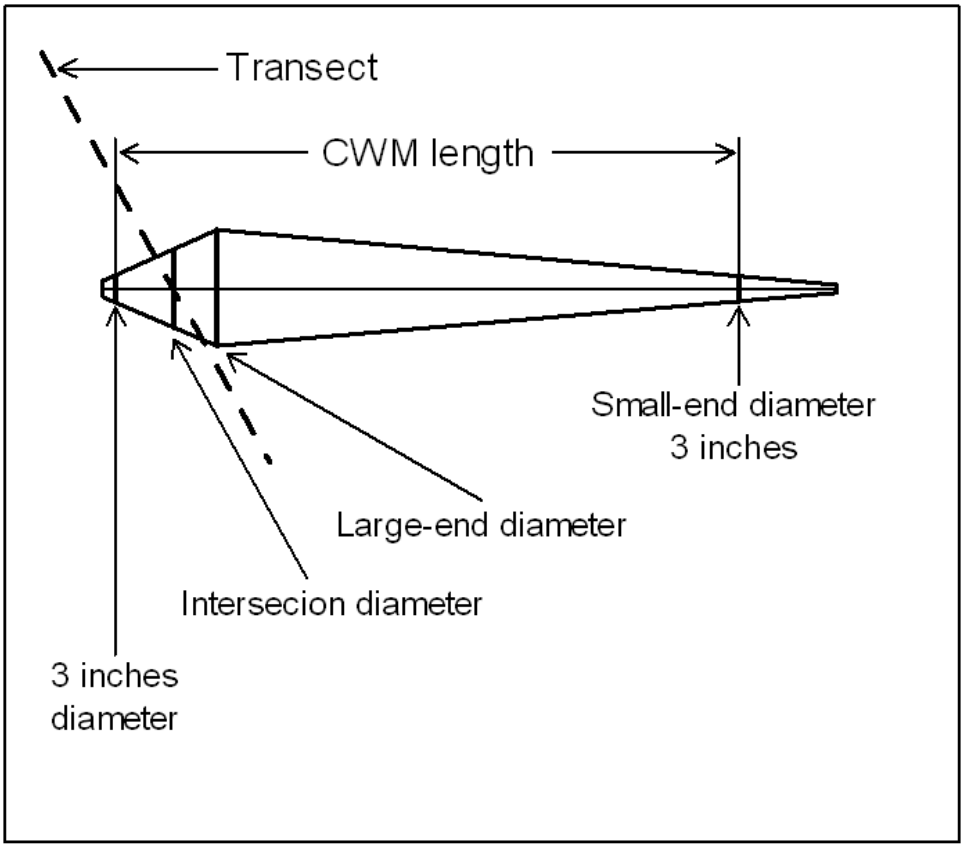

Figure 58. Example of decayed end intersecting the transect

10.6.3.8.1 DIAMETER AT POINT OF INTERSECTION (BASE)

Record the piece's diameter at the point where the transect intersects the longitudinal center of the piece. Record the diameter to the nearest inch. 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.

When Collected: All tally pieces in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 3 digits
Tolerance: Pieces <20.0 inches diameter: +/- 1 inch for decay class 1-4, +/- 2 inches for decay class 5
Pieces >20.0 inches diameter (decay classes 1-4): +/- 2 inches for each 20-inch increment >20.0 inches
Pieces >20.0 inches diameter (decay class 5): +/- 3 inches for each 20-inch increment above 20.0 inches
MQO: At least 90% of the time
Values: 003 to 200 inches

10.6.3.8.2 DIAMETER OF HOLLOW AT POINT OF INTERSECTION (BASE)

Record the diameter of hollow at the point of intersection. This variable contributes to reducing bias in biomass estimate and only applies to the point of intersection. If it can be ascertained that the piece is hollow at the transect diameter location, measure or estimate the diameter of hollow to the nearest inch, otherwise record as 0. Diameter of hollow must be less than the transect

diameter. Note: Record a hollow diameter only when it is obvious that a piece is hollow at the point of intersection (a hole or crack in the piece, evidence of hollow as observed from the end, etc.). Unlike 10.6.3.10, there is no hollow size requirement for this variable.

When Collected: All tally pieces in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1 and CWD DECAY CLASS = 1 to 4
Field width: 3 digits
Tolerance: Pieces <20.0 inches diameter: +/- 1 inch
Pieces >20.0 inches diameter: +/- 2 inches for each 20-inch increment above 20.0 inches
MQO: At least 80% of the time
Values: 000, 001 to 200 inches

10.6.3.9 Length Measurements

Measure the length of the piece (to the nearest foot) along its centerline, either to the end of the piece or to the point where the diameter reaches 3 inches. If the piece tapers at both sides, due to decay or breakage, the length is measured for the 3-inch diameter cutoff at both ends, regardless of where the large end-diameter may be (see fig. 58). No length is recorded for pieces <3 feet long.

10.6.3.9.1 CWD LENGTH >= 3 FEET (BASE)

Record the code that indicates whether the CWD TOTAL LENGTH is less than 3 feet long (and at least 0.5 foot long). Distinguish length orientation by direction of the pith. Note: the diameter of a small piece may be larger than its length. Total length of the log is measured between the physical ends of the log.

When Collected: All tally pieces >0.5 foot long, where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: +/- 20%
MQO: At least 90% of the time
Values: 1 to 2

1	CWD TOTAL LENGTH ≥3 feet
2	CWD TOTAL LENGTH ≥0.5 foot and < 3 feet

10.7 SAMPLING RESIDUE PILES

A pile is an accumulation of large woody material in which individual pieces are impossible to tally separately. Piles may be created by human activity or natural causes. However, loose piles created by windthrow, landslides, fires or other natural causes, or by thinning or logging operations, should be tallied using the regular CWD protocols unless it is physically impossible to separate individual pieces. The pile protocol should only be used as a last resort, when the regular CWD protocols cannot be used.

Piles are tallied only if intersected by a transect and located in an accessible forest condition class (CONDITION CLASS STATUS = 1) . An estimate of the length and depth of the pile, species composition and decay class are recorded:

1. Tally individual pieces along the transect until it is not possible to measure them separately and record the horizontal transect distance to this point. Then, record the horizontal transect distance to the point where individual pieces can again be tallied separately (see figure 60).

2. If the pile straddles two condition classes, assign it to the condition class that is closest to subplot center along the transect.

3. Estimate the average height of the pile along the transect. Visually compact the pile to estimate the height of wood, excluding air, rocks, debris and pieces of wood less than 3 inches in diameter at the plane of intersection with the transect. There is a tendency to overestimate the proportion of the cross-section of the pile made of wood. Note that when packing perfect circles of equal diameter, the maximum attainable packing ratio is less than 90% (see figure 61).

4. Record the predominant species in the pile. If it is not possible to identify the species, or if there is an even mixture of several species, record the genus, or hardwood / softwood code.

5. Record the predominant decay class of the pieces in the pile.

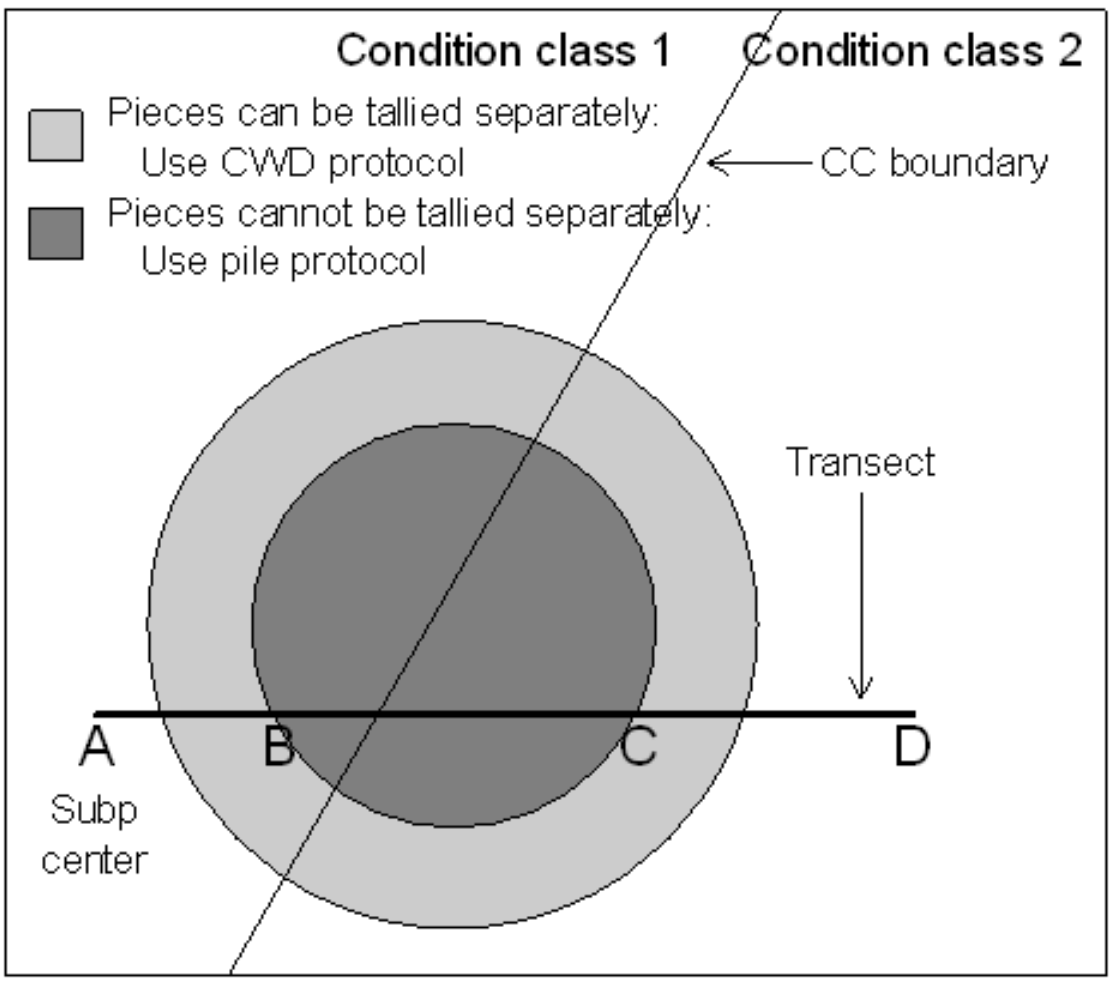

Figure 60. Example for measuring a pile. Pieces can be identified and tallied separately between points A-B and C-D, so the CWD protocols are used, even though part of the transect may be within the pile. Between points B and C, pieces cannot be tallied separately and the pile protocol is used. Enter the horizontal distance at B as the pile beginning distance, the horizontal distance at C as the predominant decay class between B and C. Assign the entire pile to condition class 1.

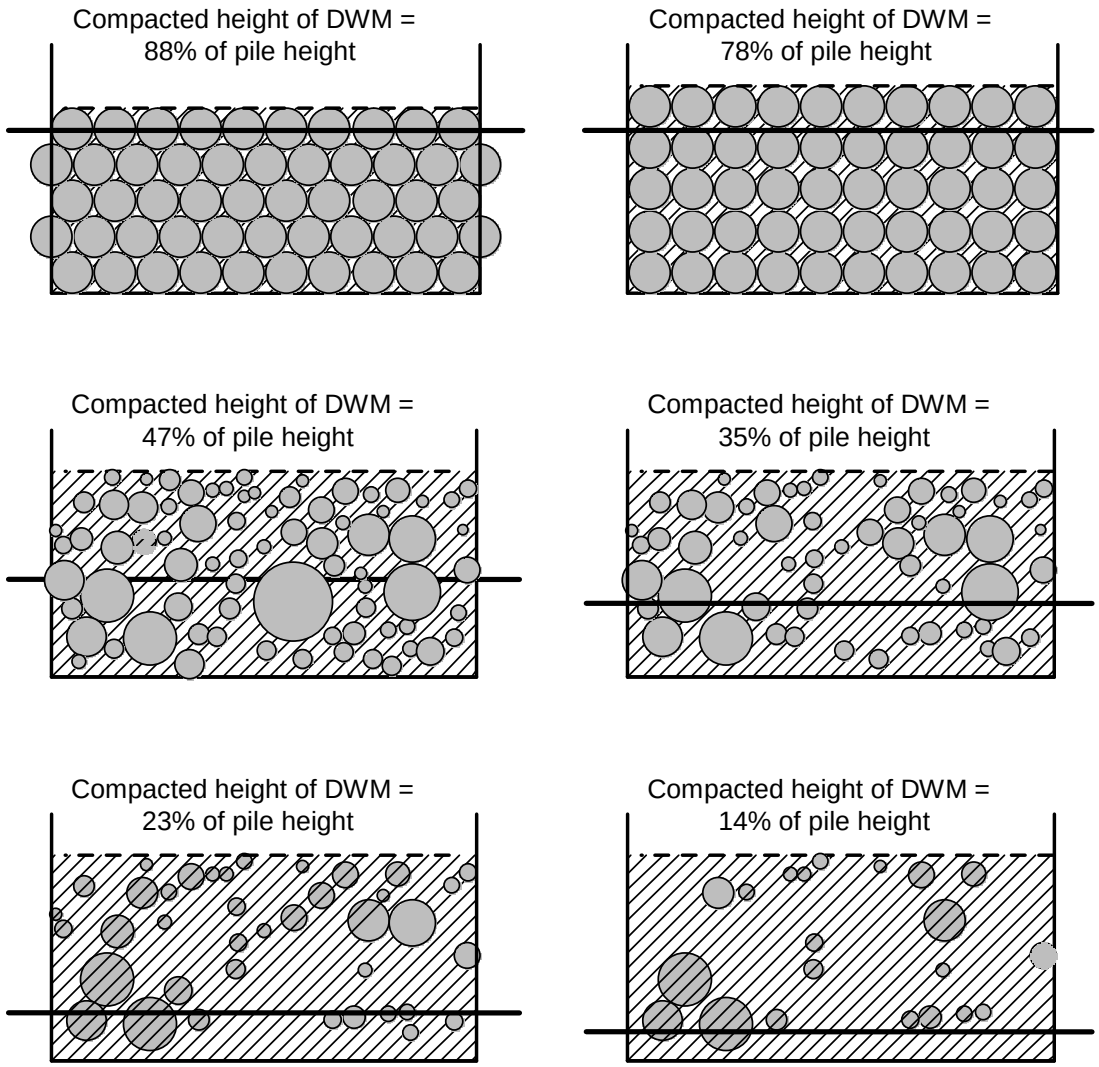

Figure 61. Calculating compacted height of CWD. The dashed line represents the height of the pile, the solid, thick line the compacted height of wood. Grey circles are cross sections of woody pieces greater than 3 inches of diameter and the fill represents debris, air and smaller pieces of wood.

10.7.1 PILE SUBPLOT NUMBER (BASE)

Record the code indicating the number of the subplot center from which the transect originates.

When collected: All sampled residue piles on transects in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values

1 Center subplot

2 North subplot
3 Southeast subplot
4 Southwest subplot

10.7.2 PILE TRANSECT (BASE)
Record the azimuth of the transect on which the pile is sampled.

When Collected: All sampled residue piles on transects in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

Subplot	Transect direction (degrees) from center of subplot
1	090
	270
2	360
	180
3	135
	315
4	045
	225

10.7.3 PILE CONDITION CLASS NUMBER (BASE)
Record the code indicating the number of the condition class. If the pile straddles two condition classes, assign it to the one closest to subplot center along the transect.

When collected: All sampled residue piles on transects in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field Width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

10.7.4 PILE BEGINNING DISTANCE (BASE)
Record the horizontal length of the transect to the beginning of the pile (to the nearest 0.1 foot), defined as the point when pieces cannot be tallied individually. If the pile occupies subplot center, record 00.0 for the beginning distance.

When collected: All sampled residue piles on transects in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 3 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 00.0 to 24.0 feet

10.7.5 PILE ENDING DISTANCE (BASE)

Record the horizontal length of the transect to the end of the pile, defined as the point when pieces can be tallied individually again. If the transect ends within the pile, record DWM TRANSECT LENGTH.

When collected: All sampled residue piles on transects in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 3 digits (xx.y)
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 00.1 to 24.0 feet

10.7.6 COMPACTED HEIGHT OF CWD IN PILE (BASE)

Record average height of wood pieces greater than 3 inches in diameter at the intersection of the transect with the pile. Record value to the nearest foot. Visually compact the pile to estimate the height of wood, excluding air, debris and pieces of wood less than 3 inches in diameter at the point of intersection with the transect. If the transect starts or ends within a pile, only consider the portion of cross-section of the pile above the measured transect.

When collected: All sampled residue piles on transects in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 1 to 99 feet

10.7.7 PILE DECAY CLASS (BASE)

Record a 1-digit code indicating the predominant decay class in the pile. Use the guide below to determine CWD DECAY CLASS.

When Collected: All sampled residue piles on transects in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: +/- 1 decay class
MQO: At least 90% of the time
Values:

Decay Class	Structural Integrity	Texture of Rotten Portions	Color of Wood	Invading Roots	Branches and Twigs
1	Sound, freshly fallen, intact logs	Intact, no rot; conks of stem decay absent	Original color	Absent	If branches are present, fine twigs are still attached and have tight bark
2	Sound	Mostly intact; sapwood partly soft (starting to decay) but can't be pulled apart by hand	Original color	Absent	If branches are present, many fine twigs are gone and remaining fine twigs have peeling bark

3	Heartwood sound; piece supports its own weight	Hard, large pieces; sapwood can be pulled apart by hand or sapwood absent	Reddish - brown or original color	Sapwo od 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	Throug h-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	Throug h-out	Branch stubs and pitch pockets have usually rotted down

10.7.8 PILE SPECIES (BASE)

Record the code indicating the predominant species / species group in the pile. If it is not possible to identify the species, or if there is an even mixture of several species, record the genus, or hardwood / softwood code.

When Collected: All sampled residue piles on transects in CONDITION CLASS STATUS = 1 where DWM TRANSECT SEGMENT SAMPLE STATUS = 1 and PILE DECAY CLASS = 1 to 4
Field width: 4 digits
Tolerance: No errors
MQO: At least 90% of the time
Values: See species codes in appendix 3

10.8 Sampling Methods for Fine Woody Debris (FWD)

1. Fine Woody Debris (FWD) is only sampled on accessible forest land conditions(CONDITION CLASS STATUS = 1). FWD is tallied on the outer portion of the following transects: 270°on subplot 1, 360°on subplot 2, 135°on subplot 3, and 225°on subplot 4. The length of FWD transects is measured in horizontal distance, starting at 14.0 feet and extending for 6.0 or 10.0 feet depending on FWD size class.

2. If the start of the FWD transect segment is in a measured condition (see item 1 above) but a portion of the transect segment is not visible due to the presence of snow or standing water, consider the entire transect segment not measurable. In this situation, do not sample anything on the transect segment--set FWD TRANSECT SEGMENTSAMPLE STATUS code = 0 and record the reason in FWD TRANSECT SEGMENT NONSAMPLED REASON.

3. Only sample FWD that intersects the transect in a plane from the ground to a height of 6 feet.

4. FWD is sampled in three size classes, along transect azimuths described in item 1 above (see section 10.2 for details on transects). Pieces in two FWD size classes (0.01 to 0.24

inches and 0.25 to 0.9 inches) are counted on a 6-foot transect, from 14 to 20 feet horizontal distance. Pieces in the largest size class (1.0 to 2.9 inches) are counted on a 10-foot transect, from 14 to 24 feet. These transects overlap. Note: individual diameters are not recorded for FWD.

5. Count a piece of FWD if it intersects the transect. Be sure to count only woody material such as a twig, branch, wood fragment, or small shrub or tree bole Do not count material that is actually litter, such as pine or fir needles, non-woody parts (e.g., petiole and rachis) of a shrub or tree, etc.

6. Accumulate the number of pieces counted within each size class and enter the total count on one record for the subplot. If there is no tally on a transect, enter zeros for the count. If the transect is not measured (FWD TRANSECT SAMPLE STATUS = 0) the count is null.

7. Accurate counts of FWD can be conducted efficiently up to about 50 pieces for small and medium size classes, and up to 20 pieces for the large size class. After that, crews can begin estimating counts in a systematic fashion. Transects that fall on very dense FWD where counting is nearly impossible, can be sub-sampled and calculated. For example, an accurate count can be conducted on a 2.0-foot section of the transect and then multiplied by 3 to provide an estimate for the 6 foot transect, as long as the crew feels that the remaining transect has a similar density of FWD pieces.

8. If a transect intersects a large pile of material such as a wood rat's nest, recently fallen tree (with many attached fine branches), or a residue pile, crews should estimate a count based on # 7 above, but also enter a code indicating that this is an unusual situation (see section 10.5.7). In the case of a residue pile on the transect, estimate a count by looking at the transect just before and after the pile along with assessing what's inside the pile, and enter a count for the whole transect.

9. If rocks or logs are present along the transect (14- to 24-foot section) include any FWD that is present on top of these things in the respective FWD counts. If the obstructions are so large (huge boulder) that the top surface cannot be seen, assume the count is zero in this area, and continue counting if there is transect line beyond the boulder.

10. If a transect crosses a condition class boundary, record the condition class number and enter a count for each condition on separate records. Transect lengths within each condition class will be obtained from the transect segmenting data entered for the plot.

NRS Note: Only tally FWD that falls on top of the litter layer, do not dig through the litter layer looking for FWD.

10.8.1 FWD SUBPLOT NUMBER (BASE)

Record the code indicating the subplot center from which the transect originates.

When collected: All FWD transect segments where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1	Center subplot
2	North subplot
3	Southeast subplot

4 Southwest subplot

10.8.2 FWD TRANSECT (BASE)
Record the azimuth (degrees) of the transect on which FWD is sampled.

When collected: All FWD transect segments where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: degrees

Subplot	Transect direction (degrees) from center of subplot
1	270
2	360
3	135
4	225

10.8.3 FWD CONDITION CLASS NUMBER (BASE)
Record the code indicating the number of the condition class at the start of the transect (14.0 feet horizontal distance from subplot center).

When collected: All FWD transect segments where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

10.8.4 FWD TRANSECT SEGMENT SAMPLE STATUS (BASE)
Record the sample status for FWD on the transect. There may be situations where the CWD is measurable, but the FWD is hidden from view by snow or water and not measurable. If any part of the FWD transect segment is on a measured condition but the FWD is not measurable, do not count any FWD and set the STATUS code to 0 and the FWD TRANSECT NONSAMPLED REASON code to 10.

In all other situations, set the code to 1. Conditions on which FWD would not be measured regardless (CONDITION CLASS STATUS = 3 or CONDITION CLASS STATUS = 2) should always be coded 1.

When collected: All FWD transect segments where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0 FWD transect segment not sampled
1 FWD transect segment sampled

10.8.5 FWD TRANSECT SEGMENT NONSAMPLED REASON (BASE)
Record the reason that FWD cannot be measured on the transect.

When Collected: All FWD transect segments where FWD TRANSECT SEGMENT SAMPLE STATUS = 0
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

10	Other (for example, snow or water covering CWD that is supposed to be sampled). “Note required” when using this code.

10.8.6 SMALL FWD COUNT (BASE)
Record the number of pieces counted in this size class (0.01 to 0.24-inch diameter) along the transect segment. An accurate count should be conducted up to 50 pieces. If the count exceeds 50, the transect can be sub-sampled to estimate a total count for the transect length (see 10.8, #8).

When collected: All FWD transect segments in CONDITION CLASS STATUS = 1 where FWD TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 3 digits
Tolerance: 0 to 50 = +/- 20% of the total count for the transect
51 to 100 = +/- 25% of the total count for the transect
100 + = +/- 50% of the total count for the transect
MQO: At least 90% of the time
Values: 000 to 999 pieces

10.8.7 MEDIUM FWD COUNT (BASE)
Record the number of pieces counted in this size class (0.25 to 0.99-inch diameter) along the transect segment. An accurate count should be conducted up to 50 pieces. If the count exceeds 50, the transect can be sub-sampled to estimate a total count for the transect segment (see 10.8, # 8).

When collected: All FWD transect segments in CONDITION CLASS STATUS = 1 where FWD TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 3 digits
Tolerance: +/- 20% of the total count for the transect
MQO: At least 90% of the time
Values: 000 to 999 pieces

10.8.8 LARGE FWD COUNT (BASE)
Record the number of pieces counted in this size class (1.0 to 2.9 inch diameter) along the transect segment. An accurate count should be conducted up to 20 pieces. If the count exceeds 20, the transect can be sub-sampled to estimate a total count for the transect segment (see 10.8, # 8).

When collected: All FWD transect segments in CONDITION CLASS STATUS = 1 where FWD TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 3 digits

Tolerance: +/- 20% of the total count for the transect
MQO: At least 90% of the time
Values: 000 to 500 pieces

10.8.9 HIGH COUNT REASON (BASE)

Enter a code that applies to the situation encountered on the transect. Enter a code if any of the counts on the transect are greater than 100 pieces.

When collected: All FWD transect segments in CONDITION CLASS STATUS = 1 where FWD TRANSECT SEGMENT SAMPLE STATUS = 1 and (SMALL FWD COUNT ≥ 100 or MEDIUM FWD COUNT ≥100 or LARGE FWD COUNT ≥100
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

1	High count is due to an overall high density of FWD across the transect
2	Wood Rat's nest located on transect
3	Tree or shrub laying across transect
4	Other reason
5	Residue pile

10.9 DUFF AND LITTER DEPTH MEASUREMENTS

Depth measurements are sampled in accessible forest land conditions. The depth of the duff layer and litter layer are important components of carbon tracking and fire models that estimate fire behavior, fire spread, fire effects, and smoke production. These measurements are taken at the 24-foot location on each transect. If an object such as a rock, log, or residue pile is present at the sample point, depths will be estimated by examining the surface of the object or the area surrounding the object. In the office, an average depth will be calculated and stored with other information about the condition class on the plot.

10.9.1 Definitions

1. Litter is the layer of freshly fallen leaves, needles, twigs (<0.25 inch in diameter), cones, detached bark chunks, dead moss, dead lichens, detached small chunks of rotted wood, dead herbaceous stems, and flower parts (detached and not upright). Litter is the loose plant material found on the top surface of the forest floor which is undecomposed or only partially decomposed organic material. The components of the litter layer can still be readily identified (e.g., plant leaves, twigs, and peat, etc.).

   Litter is flash fuel – so think about it as the loose material that is exposed to the air, capable of igniting quickly and carrying a fire across the surface of the forest floor.

   Litter does not include bark that is still attached to a down log, or rotten chunks of wood that are still inside a decaying log or log end (i.e., if a decayed log end has a lot of rotten cubes or pieces laying on a log surface and exposed to air, they are considered part of the log and not litter – fire would burn differently if it hit a pile of rotten punky wood chips cradled by the unrotted sapwood shell). If these rotten chunks have spilled out to the ground and are actually on the ground surface, then they would be included in the litter layer.

Litter does not include animal manure.

2. Duff is the layer just below litter located just above the A-horizon (or uppermost soil mineral horizon). Duff is a dark soil layer dominated by organic material derived from the decomposition of plant and animal litter (pine straw, leaves, twigs, etc) and deposited on top of an organic or mineral surface. This layer is distinguished from the litter layer in that the original organic material has undergone sufficient decomposition that the source of this material (e.g., individual plant parts) can no longer be identified. You should see no recognizable plant parts. When moss is present, the top of the duff layer is just below the green portion of the moss.

   If peat is present in your part of the country, record it with the duff layer. Peat is an accumulation of partially decayed vegetation matter that forms under conditions of poor drainage such as those found in wetlands or bogs. A layer of peat develops when dead plant material is inhibited from decaying fully because of acidic or anaerobic conditions. In some areas of the U.S. the depth of this layer can be extensive.

10.9.2 Overview of Measurements

Depth measurements will be taken at the 24-foot (horizontal distance) location on each transect. If a log, rock, or residue pile occurs at the sample location, record the depth of the litter on top and below these objects and estimate the duff depth as close to the object as possible. Examine the area around the object to develop an average depth for these layers.

DUFF/LITTER SAMPLE STATUS identifies whether or not the duff and litter depth could be measured or reasonably estimated. Examples of situations where measurement is not possible include the presence of snow or standing water at the sample location. In this case, the STATUS code is set to 1 with the DUFF/LITTER NONSAMPLED REASON code set to 10.

The DUFF AND LITTER METHOD variable has three options for indicating if duff and litter were measured or estimated at each sample location. The default value for this variable is 1, indicating that both depths were measured and recorded. A code of 2 means that litter depth was measured, but duff depth was estimated and a code of 3 indicates that both duff and litter depths were estimated.

Carefully expose a shallow profile of the forest floor by digging out an area at the sample point using a knife, hatchet, or other tool. Estimate the depth of each layer with a ruler to the nearest 0.1 inch. As you dig the hole for this measurement, if you encounter a subsurface rock, root, or buried log – stop the depth measurement at this point. If there is a log, rock, or residue pile on the surface at the sample point, and there appears to be duff and litter under it (or litter on top of it), record a reasonable estimate for each depth. Most likely, the area immediately adjacent to the obstruction will have to be examined to determine an average depth. Depths of zero are perfectly valid: for example if the point falls on bedrock or on top of a log that is resting on mineral soil.

As a general rule, duff depth should rarely exceed a few inches (except when a peat layer is present). Crews should be absolutely sure they are measuring deep duff depths, instead of mineral soil layers or parts of the litter layer. Duff can easily weigh more than 6 times that of litter. If unsure of the bottom of the duff layer, crews should feel the texture of the suspect material in their hand. Rub the soil between your fingers. Does it crumble (duff) or feel more like modeling clay (mineral). If the layer includes a substantial amount of peat, stop the measurement at 2 feet.

The height of the litter should be measured at the top of the loose material located at the sample point on the transect (or nearby if an obstruction exists). Try to preserve the conditions of this

location by walking around this point, so the QA staff will measure the same height as the original crew.

10.9.3 DUFF/LITTER SUBPLOT NUMBER (BASE)
Record the code indicating the number of the subplot center from which the transect originates.

When collected: All duff/litter transects where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

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

10.9.4 DUFF/LITTER TRANSECT (BASE)
Record the azimuth (degrees) of the transect on which duff/litter is sampled.

When collected: All duff/litter transects where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

Subplot	Transect direction (degrees) from center of subplot
1	090
	270
2	360
	180
3	135
	315
4	045
	225

10.9.5 DUFF/LITTER CONDITION CLASS NUMBER (BASE)
Record the code indicating the number of the condition class at the sample point (24.0 feet horizontal distance from subplot center)

When Collected: All duff/litter transects where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

10.9.6 DUFF/LITTER SAMPLE STATUS (BASE)

Record the sample status for duff and litter depth on the transect. There may be situations where the CWD is measurable (e.g., shallow depth of snow or water), but the duff and litter are not measurable. If the measurement point is on a measured condition but the duff/litter is not measurable, do not measure duff/litter and set code to 0 with the DUFF/LITTER NONSAMPLED REASON code set to 10.

In all other situations (including where duff and litter depth = 0), set the code to 1. For example, conditions on which duff/litter would not be measured regardless (CONDITION CLASS STATUS = 3 or) should always be coded 1.

When collected: All duff/litter transects where DWM TRANSECT SEGMENT SAMPLE STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0	Duff and litter point not sampled
1	Duff and litter point sampled

10.9.7 DUFF/LITTER NONSAMPLED REASON (BASE)

Record the reason that duff/litter cannot be measured on the transect.

When Collected: All duff/litter transects where DUFF/LITTER SAMPLE STATUS = 0
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

10	Other (snow or water covering measurement point that is supposed to be sampled). “Note required” when using this code

10.9.8 DUFF DEPTH (BASE)

Record the code indicating the depth of the duff layer to the nearest 0.1 inch. Record 24.0 inches when DUFF DEPTH is >24.0 inches and enter Code #4 (Litter depth was measured, duff (peat) depth exceeds 24.0 inches) for 10.9.8 DUFF AND LITTER METHOD.

When Collected: All duff/litter transects in measureable conditions (CONDITION CLASS STATUS = 1 where DUFF/LITTER SAMPLE STATUS = 1
Field width: 3 digits (xx.y)
Tolerance: +/- 0.5 inch
MQO: At least 90% of the time
Values: 00.0 to 24.0 inches

10.9.9 LITTER DEPTH (BASE)

Record the code indicating the depth of the litter layer to the nearest 0.1 inch.

NRS Note: When sphagnum moss is encountered on a plot only consider litter that rests on top of the moss – do not count the moss itself as litter.

When Collected: All duff/litter transects in measureable conditions (CONDITION CLASS STATUS = 1 where DUFF/LITTER SAMPLE STATUS = 1
Field width: 3 digits (xx.y)
Tolerance: +/- 0.5 inch
MQO: At least 90% of the time
Values: 00.0 to 99.9 inches

10.9.10 DUFF AND LITTER METHOD (BASE)

Record the code indicating whether duff and litter depths were measured or estimated.

When Collected: All duff/litter transects where DUFF/LITTER SAMPLE STATUS = 1 and duff/litter transect is in a measureable condition (CONDITION CLASS STATUS = 1)
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:

1 Both duff and litter depth were measured
2 Litter depth was measured, duff depth (≤ 24.0 inches) was estimated
3 Both duff and litter depth were estimated
4 Litter depth was measured, duff (peat) depth exceeds 24.0 inches (note required)

10.10 References

Scott, J.E.; Burgan, R.H. 2005. Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model. General Technical Report RMRS-GTR-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p.

10.11 Contact Information

Contact information for the National Advisor for this indicator is: Chris Woodall, USDA Forest Service, Northern Research Station, 1992 Folwell Ave, St. Paul, MN 55108, cwoodall@fs.fed.us, (Note: this web address may be revised in the future. Please visit the Northern Research Station web site for an updated link www.nrs.fs.fed.us .)

22.0 SOIL MEASUREMENTS AND SAMPLING

The objective of the Phase 3 (P3) Soils Indicator is to assess forest ecosystem health in terms of the physical and chemical properties of the soils. The soil resource is a primary component of all terrestrial ecosystems, and any environmental stressor that alters the natural function of the soil has the potential to influence the vitality, species composition, and hydrology of forest ecosystems.

Specifically, soils data are collected on P3 plots to assess (Santiago Declaration 1995):

- the potential for erosion of nutrient-rich top soils and forest floors.
- factors relating to the storage and cycling of nutrients and water.
- the availability of nutrients and water to plants (dependent upon soil structure and texture).
- carbon sequestration (the amount of carbon tied up in soil organic matter).
- deposition of toxic metals from pollution.
- acidification of the soil from deposition of pollutants.

Chemical properties of the soil are analyzed in order to develop indices for plant nutrient status, soil organic matter, and acidification. Together, these three factors largely determine the fertility and potential productivity of forest stands. Soil nutrient status refers to the concentration of plant nutrients (e.g., potassium, calcium, magnesium, and sodium) and is a key indicator of site fertility and species composition. The amount of organic matter in the soil largely determines water retention, carbon storage, and the composition of soil biota. Loss of soil organic matter as a result of management practices can alter the vitality of forest ecosystems through diminished regeneration capacity of trees, lower growth rates, and changes in species composition. Finally, increased soil acidity resulting from deposition of atmospheric pollutants has the capacity to reduce nutrient availability, decrease rates of decomposition, promote the release of toxic elements into the soil solution (e.g., aluminum), and alter patterns and rates of microbial transformations.

Nutrient and water availability to forest vegetation is also dependent on the physical capacity of roots to grow and access nutrients, water, and oxygen from the soil. In addition to playing an important role in plant nutrition, the physical properties of the soil largely determine forest hydrology, particularly with regards to surface and ground water flow. Human activities that result in the destruction of soil aggregates, loss of pore space (compaction), and erosion may increase rates of surface runoff and alter historic patterns of stream flow. In some areas, these changes may result in flooding and/or dewatered streams and can reflect on both the health of aquatic ecosystems and the management and conservation of associated forest and agricultural areas.

22.1 Summary Of Method

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

NRS Note: NRS will complete Soil Measurements and Sampling protocols during the window of May 1st through September 30th.

Beginning in 2012, Soil Measurements and Sampling protocols will be completed on approximately 6.25% of the total field plots in the NRS Region [i.e. on the historical Phase 3 (P3) plots].

The soil measurement and sampling procedures are divided into three parts: soil erosion, soil compaction, and soil chemistry. Data collection for soil erosion assessment consists of

estimating the percent of bare soil in each subplot. These measurements are combined with data from other sources and used to parameterize established models for erosion potential (RUSLE – Revised Universal Soil Loss Equation, WEPP – Water Erosion Prediction Project). Soil compaction measurements consist of an estimate of the percentage of soil compaction on each subplot along with a description of the type of compaction. Data are recorded using a handheld computer (PDR) with a preloaded data input program.

The chemical and physical properties of the soil are assessed through the collection of soil samples, which are then submitted to a regional laboratory for analysis. Soil samples are collected from the forest floor (subplots 2, 3, and 4) and underlying mineral soil layers (subplot 2). The entire forest floor layer is sampled from a known area after measuring the thickness of the duff (humus) and litter layers at four locations in a sampling frame of known area. Once the forest floor has been removed, mineral or organic soils are sampled volumetrically by collecting cores from two depths: 0 to 4 inches and 4 to 8 inches. The texture of each layer is estimated in the field and characterized as organic, loamy, clayey, sandy, or coarse sandy. Following soil sampling, the depth to any restrictive horizon within the top 20 inches is estimated using a soil probe. In the case of organic soils (e.g., wetland soils), samples are collected from the litter layer and the 0-4 inch and 4-8 inch organic layers.

Physical and chemical properties of the soil are determined in the laboratory. Analyses of forest floor samples include bulk density, water content, total carbon, and total nitrogen. Analyses of mineral soil samples include bulk density, water content, coarse fragment content, total organic and inorganic carbon, total nitrogen, plant available (extractable) phosphorus and sulfur, exchangeable cations (calcium, magnesium, sodium, potassium, and aluminum), pH, and trace metals such as manganese. These data are used to provide indexes of nutrient status, acidification, and carbon sequestration.

22.2 Definitions

Cryptobiotic crusts	A layer of symbiotic lichens and algae on the soil surface (common in arid regions)
Duff (Humus)	A soil layer dominated by organic material derived from the decomposition of plant and animal litter and deposited on either an organic or a mineral surface. This layer is distinguished from the litter layer in that the original organic material has undergone sufficient decomposition that the source of this material (e.g., individual plant parts) can no longer be identified.
Forest floor	The entire thickness of organic material overlying the mineral soil consisting of the litter and the duff (humus).
Litter	Undecomposed or only partially decomposed organic material that can be readily identified (e.g., plant leaves, twigs, etc.)
Loam	The textural class name for a soil having a moderate amount of sand, silt, and clay.
Mineral soil	A soil consisting predominantly of products derived from the weathering of rocks (e.g., sands, silts, and clays).
Organic soil	For the purposes of FIA, an organic soil is defined as any soil in which the organic horizon is greater than 8 inches in thickness. These soils are prevalent in wetland areas such as bogs and marshes and may be

	frequently encountered in certain regions of the country (e.g., Maine, northern Minnesota, coastal regions)
Restrictive layer	Any soil condition which increases soil density to the extent that it may limit root growth. This limitation may be physical (hard rock) or chemical (acid layer) or both.
Sampling frame	A frame used to collect forest floor samples from a known area. A bicycle tire 12 inches in diameter has been selected as the national standard.
Soil erosion	The wearing away of the land surface by running water, wind, ice or other geological agents.
Texture	The relative proportion of sand, silt, and clay in a soil.

22.3 Equipment And Supplies

Minimum required equipment is listed below. Field personnel may add equipment as needed to improve efficiency in some areas.

22.3.1 Field Gear Unique to the Soil Indicator

- Retractable measuring tape or ruler graduated in tenths of an inch for measuring soil layer depths.
- Frame for sampling known area of surface litter material. A small bicycle tire (16 x 2.125 in tire size with an internal diameter of 12 in) has been chosen as the standard size.
- Impact-driven soil core (2-in diameter x 8-in depth) sampler with two 2-in diameter by 4-in long stainless steel core liners for obtaining mineral soil samples.
- Additional bulk density sampling equipment: crescent wrench and universal slip wrench for disassembling bulk density sampler if stuck.
- Tile probe (42 in) for measuring depth to a restrictive layer.
- Garden trowel or hand shovel for sampling forest floor and excavating soil sample hole where soil core sampler cannot be used.
- Small knife with sharp blade for sampling the forest floor layers.
- Pruning shears (very useful in cutting through roots and litter).
- Plastic water bottle for use in hand-texturing soil.
- Small plastic tarp (1 yd x 1 yd) to use as a working surface.
- Indelible ink markers (black thin-line) for marking sample bags.
- Cleaning cloths or tissues.
- Soil sample bags (9 x 12 in or quart size) for mineral soil samples.
- Soil sample bags (10 x 18 in or gallon size) for forest floor samples.
- Soil sample labels.

22.3.2 Optional Soils Equipment

- Supplemental soil sampling equipment for organic soils: Dutch auger.
- Supplemental soil sampling equipment for saturated or wetland soils: mud auger or piston-type core sampler.
- Garden gloves.

- 1-in diameter soil tube probe to take soil samples for hand-texturing or where soil core sampler cannot be used.

22.3.3 Required Equipment not Unique to the Soil Indicator:

- Compass for locating sampling points.
- Measuring tape -100 ft loggers tape for measuring distance to sampling locations.
- Flagging for marking soil sample points.
- Back pack for carrying sampling equipment to the field.
- Clear plastic shipping tape to cover labels after they have been filled out.

22.4 Laboratory Analyses

Phase 3 forest floor samples are analyzed in the laboratory for:

- Bulk density.
- Water content.
- Total carbon.
- Total nitrogen.

Phase 3 mineral soil samples are analyzed for:

- Bulk density, water content, and coarse fragment [>0.08-in (>2-mm)] content.
- pH in water and in 0.01 M CaCl2.
- Total carbon.
- Total organic carbon.
- Total inorganic carbon (carbonates) (pH>7.5 soils only).
- Total nitrogen.
- Exchangeable cations (Na, K, Mg, Ca, Al, Mn).
- Extractable sulfur and trace metals.
- Extractable phosphorus (Bray 1 method for pH < 6 soils, Olsen method for pH > 6 soils).

Methods for preparing and analyzing the collected soil samples are available in a separate document.

22.5 Quality Assurance (QA)

The QA program for the soils indicator addresses both field and laboratory measurements. For field measurements, QA protocols are the same as those used for all other Phase 3 indicators. Tolerances have been established for each of the measurements. The tolerances are used during training, certification and auditing to assist with the control of data quality. Periodic re-measurements are undertaken to establish data quality attributes such as precision, bias and comparability.

This field guide only addresses aspects of QA related to the field portion of the program. Soil laboratories have another set of guidelines for ensuring data quality and are required to enroll in a national proficiency testing program. Details of the lab QA protocol may be obtained by contacting the regional lab directors.

22.5.1 Training And Certification

Field crews are trained to make field measurements as well as take soil samples. After training, all field crew members are tested and certified for soil indicator measurements. Each trained crew member must demonstrate the ability to conduct soil measurements within established MQOs.

22.5.2 Hot Checks, Cold Checks, and Blind Checks

QA/QC for the field portion of the soil indicator consists of three parts:

Hot Check – an inspection normally done as part of the training process. The inspector is present on the plot with the trainee and provides immediate feedback regarding data quality. Data errors are corrected. Hot checks can be done on training plots or production plots.

Cold Check – an inspection done either as part of the training process, or as part of the ongoing QC program. Normally the installation crew is not present at the time of inspection. The inspector has the completed data in-hand at the time of inspection. The inspection can include the whole plot or a subset of the plot. Data errors are corrected. Discrepancies between the two sets of data may be reconciled. Cold checks are done on production plots only.

Blind Check – a re-installation done by a qualified inspection crew without production crew data on hand; a full re-installation of the plot for the purpose of obtaining a measure of data quality. The two data sets are maintained separately. Discrepancies between the two sets of data are not reconciled. Blind checks are done on production plots only.

22.5.3 Reference Plots

Remeasurements of field observations by regional trainer crews occur on routine plots recently visited by a standard field crew (cold checks or hot checks) or on reference plots. All erosion and soil compaction remeasurements can be taken on the subplots as described in the soil measurement methods. Reference plots should be selected with areas of bare and compacted soil to allow for an evaluation of a crew's ability to make these measurements.

22.5.4 Debriefing

Feedback from the field crews is critical to identifying problems with the soil indicator measurements and improving the program for subsequent field seasons. Crew members conducting soil measurements should fill out a debriefing form and submit it to the regional field coordinator prior to the end of the field season. Crew members should consider it part of their responsibility to report any problems, inconsistencies, or errors in the field guide or the method.

22.6 Plot Information

22.6.1 CURRENT DATE

Record the year, month, and day that the current plot visit was completed as described in 22.6.1.1 – 22.6.1.3.

22.6.1.1 YEAR

Record the year that the plot was completed.

When collected: All soils plots
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: > 2003

22.6.1.2 MONTH

Record the month that the plot was completed.

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

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

22.6.1.3 DAY

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

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

22.6.2 CREW NUMBER

Record the code to indicate the number assigned to the crew member who collected soils on this plot. The first 2 digits are for the responsible unit's station number (NRS – 24xxxx, SRS – 33xxxx, RMRS – 22xxxx, and PNW – 26xxxx)

When collected: All soils plots
Field width: 6 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

NRS	240001 – 249999
SRS	330001 – 339999
RMRS	220001 – 229999
PNW	260001 - 269999

22.6.3 QA STATUS

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

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

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

22.6.4 NOTES

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

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

22.6.4.1N SOILS TIME **[STIME]**

Record the number of minutes required to complete SOILS variables on each SUBPLOT.

When collected: Phase 3: When SUBPLOT STATUS = 1 or 2
A soil sample could be taken when the subplot is status 2, if the location of the sample falls in accessible forest land. Soil samples are located in the macroplot.
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 000- 120

22.6.4.2N NUMBER OF PERSONS COLLECTING SOILS ON EACH POINT **[SSIZE]**

Record the number of persons that specifically collected SOILS variables on each SUBPLOT.

When collected: Phase 3: When SUBPLOT STATUS = 1 or 2
A soil sample could be taken when the subplot is status 2, if the location of the sample falls in accessible forest land. Soil samples are located in the macroplot.
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1- 5

22.7 Soil Erosion And Compaction

Erosion is defined as the wearing away of the land surface by running water, wind, or ice. Erosion is a natural process that occurs on all non-flat areas of the landscape. However, human activity (such as timber removal or road-building) can result in accelerated rates of erosion that degrade the soil and reduce the productivity of land. Extensive areas of soil erosion can have a major effect on the aquatic ecosystems associated with forests, recreational opportunities, potable water supplies and the life span of river infrastructure (e.g., dams, levees).

On average, the U. S. loses about 5 billion tons of soil annually to water and wind erosion. As this soil is removed from the landscape, it carries with it all of the nutrients and organic matter that took decades to centuries (or longer) to build up. On human time scales, fertile topsoil is not a renewable resource.

On FIA plots, soil erosion potential is estimated using published models, such as the Revised Universal Soil Loss Equation (RUSLE) and the Water Erosion Prediction Project (WEPP). These models are based on factors that represent how climate, soil, topography, and land use affect soil erosion and surface runoff. Generally, these models require the following factors for analysis: percent slope, slope length, precipitation factor, vegetation cover, and litter cover. Some of these factors are collected as part of the P2 mensuration data and other P3 indicators (percent slope and vegetation cover), one factor is obtained from outside sources (precipitation factor), and the remaining factors (% cover, which is given by 100 minus % BARE SOIL, and SOIL TEXTURE) are measured on each subplot as part of the soil indicator.

Estimates of bare soil are made on all four subplots. Soil texture is measured at the soil sampling site adjacent to subplot 2 during the collection of mineral and organic soil samples.

Compaction refers to a reduction in soil pore space and can be caused by heavy equipment or by repeated passes of light equipment that compress the soil and break down soil aggregates. This compression increases the bulk density and reduces the ability of air and water to move through the soil. These conditions also make it more difficult for plant roots to penetrate the soil and obtain necessary nutrients, oxygen, and water.

In general, compaction tends to be a greater problem on moist soils and on fine-textured soils (clays). These effects can persist for long periods of time and may result in stunted tree growth.

Information about compaction is collected on all subplots that are in a forested condition. Compaction data collected as part of the soil indicator include an estimate of the percent of each subplot affected by compaction and the type(s) of compaction present.

22.7.1 PERCENT COVER OF BARE SOIL

Record a two-digit code indicating the percentage of the subplot that is covered by bare soil (mineral or organic). Fine gravel [0.08-0.20 inch (2-5 mm)] should be considered part of the bare soil. However, do not include large rocks protruding through the soil (e.g., bedrock outcrops) in this category because these are not erodible surfaces. For the purposes of the soil indicator, cryptobiotic crusts are not considered bare soil.

If the subplot includes non-forested areas, multiply the % COVER OF BARE SOIL in the forested part of the subplot by the % of the subplot that is in forested area. For example, if 50% of the subplot is forested and the % COVER OF BARE SOIL of the forested part is 30%, then the % COVER OF BARE SOIL for the entire subplot is 15 %.

When Collected: When any portion of the subplot contains at least one accessible forested condition class
Field Width: 2 digits

Tolerance: +/- 10%
MQO: 75% of the time
Values:

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

22.7.2 PERCENT COMPACTED AREA ON THE SUBPLOT

Record a two-digit code indicating the percentage of the subplot that exhibits evidence of compaction. Soil compaction is assessed relative to the conditions of adjacent undisturbed soil. Do not include improved roads in your evaluation.

When Collected: When any portion of the subplot contains at least one accessible forested condition class
Field Width: 2 digits
Tolerance: +/- 15%
MQO: 75% of the time
Values:

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

22.7.3 TYPE OF COMPACTION - RUTTED TRAIL

Type of compaction is a rutted trail. Ruts must be at least 2 inches deep into mineral soil or 6 inches deep from the undisturbed forest litter surface. Record a “1” if this type of compaction is present; record a “0” if it is not present.

When Collected: When PERCENT COMPACTED AREA ON THE SUBPLOT > 00
Field Width: 1 digit
Tolerance: No errors
MQO: 75% of the time
Values:

1	Present
0	Not present

22.7.4 TYPE OF COMPACTION – COMPACTED TRAIL

Type of compaction is a compacted trail (usually the result of many passes of heavy machinery, vehicles, or large animals). Record a “1” if this type of compaction is present; record a “0” if it is not present.

When Collected: When PERCENT COMPACTED AREA ON THE SUBPLOT > 00
Field Width: 1 digit
Tolerance: No errors
MQO: 75% of the time
Values:

1	Present
0	Not present

22.7.5 TYPE OF COMPACTION – COMPACTED AREA

Type of compaction is a compacted area. Examples include the junction areas of skid trails, landing areas, work areas, animal bedding areas, heavily grazed areas, etc. Record a “1” if this type of compaction is present; record a “0” if it is not present.

When Collected: When PERCENT COMPACTED AREA ON THE SUBPLOT > 00
Field Width: 1 digit
Tolerance: No errors
MQO: 75% of the time
Values:

1	Present
0	Not present

22.7.6 TYPE OF COMPACTION – OTHER

Type of compaction is some other form. Record a “1” if this type of compaction is present; record a “0” if it is not present. (An explanation must be entered in the plot notes).

When Collected: When PERCENT COMPACTED AREA ON THE SUBPLOT > 00
Field Width: 1 digit
Tolerance: No errors
MQO: 75% of the time
Values:

1	Present
0	Not present

22.8 Soil Sample Collection

The chemical and physical properties of the soil are assessed through the collection of soil samples, which are then submitted to a regional laboratory for analysis. Soil samples are collected from the forest floor (subplots 2, 3, and 4) and underlying mineral soil layers (subplot 2). The entire forest floor layer is sampled from a known area after measuring the thickness at the north, south, east, and west edges of a sampling frame of known area. Once the forest floor has been removed, mineral and organic soils are sampled volumetrically by collecting cores from two depths: 0 to 4 inches and 4 to 8 inches. The texture of each layer is estimated in the field and

characterized as organic, loamy, clayey, sandy, or coarse sandy. Following soil sampling, the depth to any restrictive horizon within the top 20 inches is estimated using a soil probe. In the case of organic soils, samples are collected from the litter layer and the 0 to 4 inch and 4 to 8 inch organic layers.

Soil samples are collected within the annular plot along soil sampling lines adjacent to subplots 2, 3, and 4 (fig. 22-1). During the first visit to a plot for soil sampling, soil samples will be collected at the point denoted as Soil Visit #1. On subsequent visits to a plot, soil sampling sites visit #2 or larger will be sampled. The soil sampling sites are spaced at 10-foot intervals alternating on opposite sides of soil sampling site number 1.

The initial sampling points (Soil Visit #1) are located:

- Subplot 2 soil measurement site: 30 feet due south (180o) from the center of subplot 2.
- Subplot 3 soil measurement site: 30 feet northwest (300o) from the center of subplot 3.
- Subplot 4 soil measurement site: 30 feet northeast (60o) from the center of subplot 4.

If the soil cannot be sampled at the designated sampling point due to trampling or an obstruction (e.g., boulder, tree, standing water), the sampling point may be relocated to any location within a radius of 5 feet.

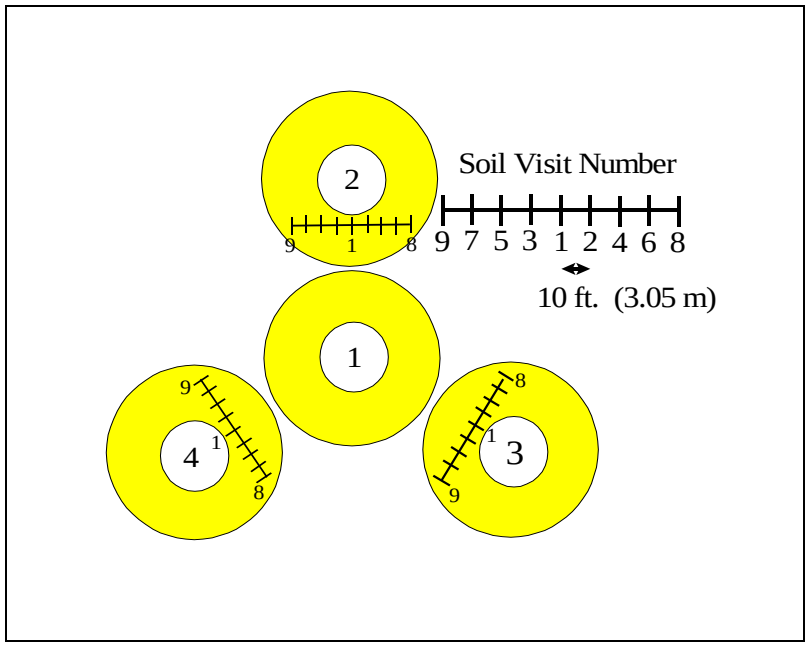

Figure 22-1. Location of soil sampling sites

22.8.1 Forest Floor

Forest floor samples are collected from soil sampling sites adjacent to subplots 2, 3, and 4. Samples are collected if, and only if, the soil sampling sites are forested. The forest floor is sampled as a complete unit using a sampling frame (fig. 22-2).

1. Place the sampling frame over the sampling point taking care not to compact the litter layer. Locate the points due north, due east, due south and due west on the inside of the soil sampling frame and mark these with small vinyl stake flags. Carefully remove the sampling frame.

2. Measure the thickness of the entire forest floor to the nearest 0.1 inch at the four flagged locations. At each sampling point, also measure the thickness of the litter layer.

   In some soils, telling the difference between the bottom of the forest floor and the top of an organic-rich mineral horizon can be difficult. If uncertain:

   - Look for evidence of plant parts (e.g., leaves, needles). If you can see them decomposing in place, you're still in the forest floor.

   - Rub the soil between your finger. Does it crumble (organic forest floor) or feel more like modeling clay (try pinching into a ribbon).

   - Look for shiny flecks of mica or quartz (won't help in all soils).

   - Look for a subtle change in color. Organic horizons tend to be black; a mineral horizon will tend to be more brownish.

   - Wet a sample of the material and press it between your fingers. Note the color of the liquid that runs out. The blacker the color, the higher the organic content.

   - Check for a change in density (mineral soils are denser).

3. Replace the soil sampling frame. Using a pair of clippers, carefully remove all live vegetation from the sample area. Living mosses should be clipped at the base of the green, photosynthetic material.

4. Using a sharp knife or a pair of clippers, carefully cut through the forest floor along the inner surface of the frame to separate it from the surrounding soil.

5. Using inward scooping motions, carefully remove the entire volume of the forest floor from within the confines of the sampling frame. Discard all woody debris (including pine cones, large pieces of bark, and decomposed wood) above 0.25 inches in diameter (approximately the diameter of a pencil). Discard any rocks or pebbles collected with the forest floor material.

6. Working over the tarp, place the entire forest floor layer sample into a pre-labeled gallon sample bag. In some areas more than one bag might be required to hold the sample. If so, label the bags with identical information, then add "1 of 2" and "2 of 2" respectively.

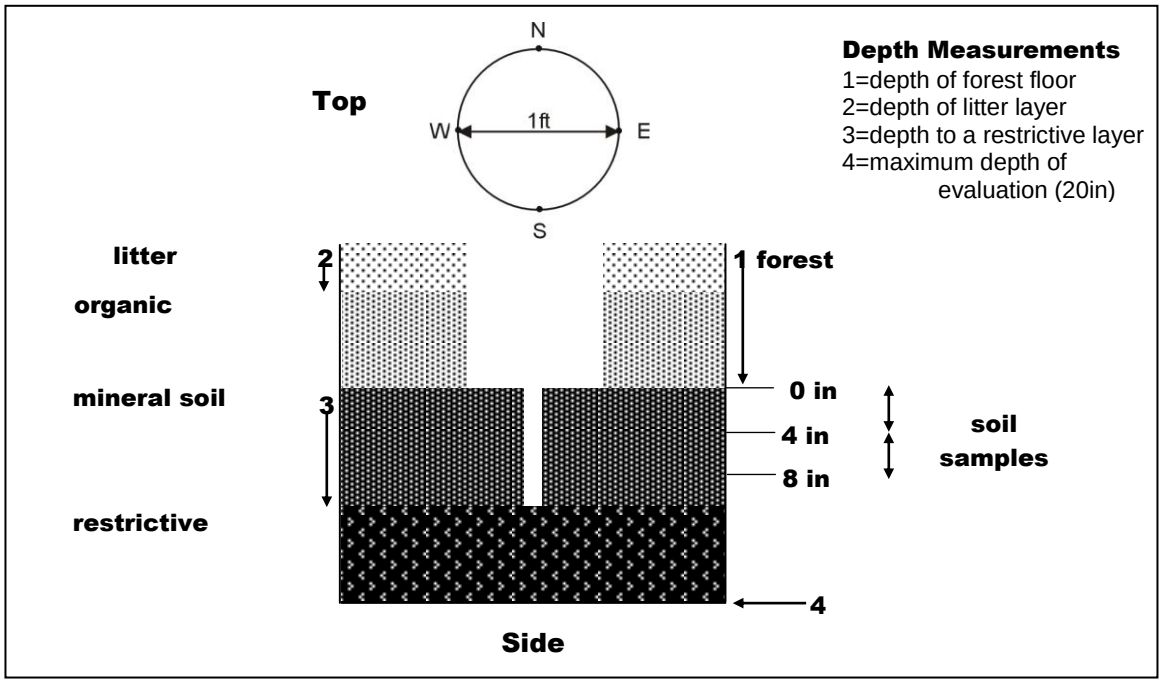

Figure 22-2. Cross-sectional views of sampling sites (top view and side view).

22.8.2 Assembly and Operation of Impact Driven Soil Corer (Bulk Density Sampler)

The impact driven core sampler (fig. 22-3) is used to collect a known volume of soil with a minimum of compaction and disturbance. The weight of this core is then used to determine bulk density (the mass of soil per unit volume), an important physical property of the soil. Although we usually think about the soil in terms of the mineral fraction, soils are actually a matrix of solids (mineral and organic), water, and air. The ratio between these fractions (pore space) determines the capacity of the soil to provide nutrients, air, and water to plant roots.

In addition, bulk density is used to convert the chemical concentrations obtained in the lab to a volumetric basis, which is more meaningful in terms of plant nutrition.

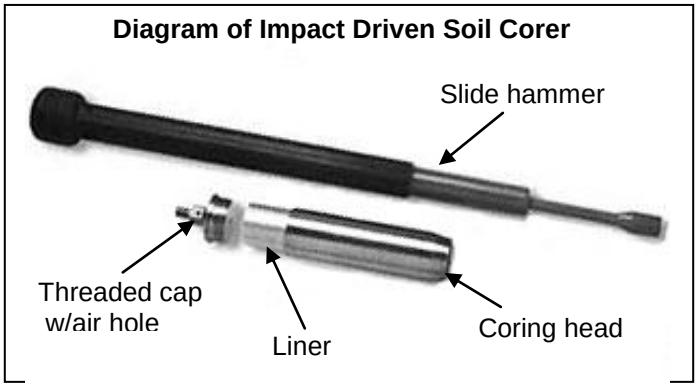

Figure 22-3. Diagram of Impact Driven Soil Corer

Assembly

- Thread the top cap of the soil coring head onto the slide hammer attachment and tighten. This connection must be tight; if not, this connection may be sheared off during use.

- Insert two 2-in diameter x 4-in long stainless steel soil core liners into the soil coring head. It may be helpful to number the core liners with an indelible marker in order to tell them apart after the sample has been collected.

- Thread the soil coring head onto the top cap and slide hammer attachment until the top rim of the coring head just contacts the top cap. Make sure that the vent hole in the top cap is kept open, so that air displaced while the coring head is driven into the soil can escape from inside the coring head.

Maintenance

- Take care to clean and dry the inside and outside of the soil coring head after each sample. Moisture can cause rust build-up on the inside of the core head and make it difficult to insert and remove the liners.

- Use a brush and rag to clean both the inside and outside of the core liners as well. Grit on the outside of the liner can cause damage to the inside of the coring head and make it difficult to collect samples.

- Never twist, pull, or put pressure on the core sampler while the hammer attachment is extended. This can cause the attachment to break or bend.

22.8.3 Mineral Soil

Two mineral soil samples 0-4 inch and 4-8 inch are collected from the soil sampling site adjacent to subplot 2 only, and are collected if, and only if, the soil sampling site is forested (fig. 22-2).

1. Mineral soil samples are collected from within the area of the sampling frame after the forest floor has been removed.

2. Place the core sampler in a vertical position and drive the sampler into the soil until the top of the coring head is about 1 inch above the mineral soil surface. At this point, the soil should be even with the top of the liner.

3. With the handle of the slide hammer down, rotate the sampler in a circular motion. This motion breaks the soil loose at the bottom of the sampler and makes it easier to remove the core. Do not extend the sliding part of the slide hammer upwards to gain additional leverage as this may bend the attachment. Remove the core sampler from the ground by pulling the slide hammer upwards in a smooth vertical motion.

4. If a complete and intact core has been collected, unscrew the coring head from the top cap and carefully slide the core liners onto the tarp (see sections 22.8.5 and 22.8.6 for techniques used in handling problem soils). If necessary, use the crescent and slip wrenches to separate the parts. Trim the top and bottom of the

core even with the liner rims. Take care to avoid any loss of soil from the cores; if any material spills, you must resample.

5. Using a knife, slice through the soil core at the interface between the two liners (the 4-inch depth). Remove the soil from the 0-4 inch stainless steel liner and place it into a pre-labeled soil sample bag. Repeat for the 4-8 inch core. Be sure to place all of the material in the liner (including coarse fragments, roots, soil, etc.) into the sample bags.

6. For each plot, you should have a maximum of five samples:

   - Three labeled gallon bags containing the forest floor samples from the sampling sites adjacent to subplots 2, 3, and 4. Additional bags may be needed for deep soils.
   - One labeled quart bag containing the 0 - 4 inch mineral soil sample from the soil sampling site adjacent to subplot 2.
   - One labeled quart bag containing the 4 - 8 inch mineral soil sample from the soil sampling site adjacent to subplot 2.

7. Clean all soil sampling equipment thoroughly before sampling soil at the next plot.

22.8.4 Regulations Governing Sample Collection (National Historic Preservation Act)

The National Historic Preservation Act of 1966 (as amended) provides for the protection of historical and cultural artifacts. Due to the random placement of the Phase 3 monitoring design, a possibility exists that a Phase 3 plot may be located on a site of prehistoric or historical significance.

If cultural artifacts are encountered on a Phase 3 plot, do not take soil samples. Code the site as not sampled on the PDR and record a plot note explaining why soil samples were not taken.

If needed, archeologists or cultural resource specialists in these land management agencies will assist in obtaining permission to sample. Assistance is also available from State Historic Preservation Programs for state and private lands.

22.8.5 Alternate Sampling Methods for “Problem” Soils

In some cases, the soil coring procedure outlined above will not work. For example, in saturated organic soils, use of the core sampler may cause significant compaction of the sample. Very sandy soils or dry soils may tend to fall out of the liners, while in soils with a high rock content or a shallow depth to bedrock, it may not be possible to drive the core sampler into the ground. Approaches to handling these specific problems are addressed in section 22.8.6.

In general, make at least three attempts to collect a sample using the core sampler. If these attempts are unsuccessful, then use one of the following techniques to collect a sample.

1. Excavation method (hand shovel) – Dig a shallow hole whose width is at least 1.5 times the length of your knife. Starting at the top of the mineral soil, measure down 8 inches. Make a mark on the side of the hole at 4 and 8 inches. Use your hand shovel to collect material from the 0-4 and 4-8 inch depth increments. Collect a sufficient volume of soil from the sides of the hole at each depth increment to approximately equal the volume of a soil core liner and place each depth increment sample in separate soil sample

bags. Be sure to collect material from throughout the entire depth increment to avoid biasing the sample.

2. Tube probe – Remove the forest floor from an area and use the tube probe to collect samples from the 0-4 inch depth at a number of locations. Composite these samples until you have a sample volume approximately equal to that of the soil core liner. Repeat the sub-sampling and compositing for the 4-8 inch layer by returning to the points sampled previously and pushing the tube probe into the soil an additional 4 inches.

3. Dutch auger – Dutch augers can be very useful in wetland or saturated soils. In an area where the forest floor has been removed, drill into the soil with the auger and use a tape measure to help you collect material from the 0-4 and 4-8 inch depth increments.

For all of these methods, make sure to collect approximately the same amount of soil material [< 0.08 inch (< 2 mm)] that would have been needed to fill the core liner. Completion of the laboratory analyses requires at least 5 ounces (150 g) of mineral soil.

In soils with a large number of small rocks and pebbles, this means that you will need to collect a larger amount of sample so that the lab will have enough material to analyze once the rocks have been removed. In these soils, collect enough material to fill two core liners.

Be certain to circle “Other” on the label under sampler type.

22.8.6 Commonly Encountered Problems

It may not always be possible to obtain soil core samples using the soil core sampler. The following section provides some suggestions on how to overcome these problems.

1. Rocky soils

In soils containing a high percentage of rocks, it may not be possible to drive the core sampler in to the required depth of 8 inches. If this occurs, remove any soil within the sampler, test for the presence of an obstruction using a plot stake pin or the tile probe, and make a second attempt either within the area where the forest floor has been removed or within the available soil sampling area (within a 5-foot radius of the original soil sampling location). Make a maximum of five attempts. If a complete sample from the 0-4 inch depth can be obtained, collect that sample. Otherwise, use the excavation or soil tube probe approaches outlined above (section 22.8.5).

2. Very sandy soils (or very dry soils) – sample falls out of the core

If the soil will not stay in the core liner, use the shovel to dig around the soil coring head while it is still in place. Tilt the soil corer to one side and insert the blade of the shovel underneath the base *of the core. Use the base of the shovel to hold the sample in place as you remove the corer from* the soil. Depending on the soil type, this technique may require some practice and/or the use of a partner.

3. Saturated or wetland soils.

Attempt to collect a sample using the soil corer. If this is not possible, or if compaction occurs, use one of the three alternate methods outlined in section 22.8.5.

4. Buried Soils

In areas located adjacent to rivers or other bodies of water, sediment transport and periodic flooding may result in the formation of buried soils. Buried soils may be identified by alternating layers of mineral soil and forest floor material. To confirm the presence of a buried soil, excavate a small hole near the soil sampling site with a shovel and look for the presence of forest floor and litter materials buried between layers of mineral soil.

Collect only the litter and organic matter currently on the soil surface as a forest floor sample following the standard protocol. Attempt to collect 0-4 and 4-8 inch samples using the bulk density corer. If this is not possible, or if the cores do not fill completely, collect a sample using a shovel following the excavation method outlined in 22.8.5. Place a star on the upper right corner of the sampling label, circle "Other" for sampler type, and make a clear note on the shipping form to indicate that this sample represents a buried soil.

5. Other situations in which a complete 8 inch core cannot be collected

If a complete core cannot be obtained in one sample, but is cohesive enough to collect a second sample from the same hole, try the following. Collect a partial sample and measure the length of the collected core. Reinsert the sampler and drive it into the soil to an additional depth close to the length of the collected core. Remove the new core from the sampler. When placed together, the two cores should exceed 8 inches in length. With a knife, cut the cores at the 4-inch and 8-inch lengths. Replace the additional soil into the soil hole.

In some soil types, the 0-4 inch core may not fill completely, although the 4-8 inch core appears to be full. In this instance, attempt to collect a second core by driving the core deeper into the soil. In terms of the soil chemistry, it is better to slightly overcompact the sample than to under fill the core. Make three attempts to completely fill the core, driving the corer deeper each time. If you are still unable to obtain a complete 0-4 inch core, collect the 0-4 inch sample and mark "Other" under sampler type. An under filled core cannot be used a bulk density sample. If the 4-8 inch sample is full, it should be collected as a bulk density sample (mark "Bulk Density" under sampler type)

22.8.7 Organic soils

These soils are prevalent in certain regions of the country (e.g., Maine, northern Minnesota, coastal regions) and proper sampling requires modification of the above procedures.

- Due to the large thickness of the underlying organic soil, sampling is restricted to the litter layer. Measure the entire thickness of the forest floor to a maximum depth of 20 inches. However, only collect a sample of the litter layer (see section 22.8.1).

- Attempt to collect a soil sample using the impact driven corer. In many cases, this will not be possible without severe compaction of the sample. If compaction occurs, or if you have difficulty in obtaining a complete core, samples may be collected at the 0 - 4 inch and 4 - 8 inch depth increments using a Dutch auger or shovel (see section 22.8.5).

22.8.8 SUBPLOT NUMBER

Record the number of the subplot adjacent to the soil sampling site.

When Collected: All soil sample locations
Field Width: 1 digit
Tolerance: No errors

MQO: At least 99% of the time
Values: 2 to 4

22.8.9 VISIT NUMBER

Record the number of the location where the soil sample is being attempted (fig. 22-1)

When Collected: All soil sample locations
Field Width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1 to 9

22.8.10 SOIL SAMPLE STATUS

Record whether or not a forest floor or mineral soil sample is being collected at the soil sampling location. For both forest floor and mineral samples, it is the condition of the soil sampling sites in the annular plot that determines whether soil samples are collected. Samples are collected if, and only if, the soil sampling site is in a forested condition. In rare instances, the soil sampling site may occur in a forested condition that has not been sampled on any of the 4 subplots. If this is the case, then use SOIL SAMPLE STATUS code 11 to indicate that a sample has been collected for a forest condition that is not otherwise represented on the plot.

When Collected: All soil sample locations (mineral soil on subplot 2 and forest floor on subplots 2, 3, and 4
Field Width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:

01 Sampled: forest that has been identified as a condition on the plot
02 Not sampled: non-forest

The following are for forest conditions:

03 Not sampled: too rocky to sample
04 Not sampled: water or boggy
05 Not sampled: access denied
06 Not sampled: too dangerous to sample
07 Not sampled: obstruction in sampling area
08 Not sampled: broken or lost equipment
09 Not sampled: other - enter reason in plot notes
11 Sampled: forest that has NOT been identified as a condition on the plot

22.8.11 CONDITION CLASS NUMBER

Record the forested CONDITION CLASS NUMBER that best represents the condition from which the soil sample is being taken. If the condition class for the soil sample is different from any recorded on the 4 subplots, enter the CONDITION CLASS NUMBER for the most similar forest condition sampled on the plot.

When Collected: Soil sample locations that are being sampled (SOIL SAMPLE STATUS = 1 or 11)
Field Width: 1 digit
Tolerance: No errors

MQO: At least 95% of the time
Values: 1 to 9

22.8.12 FOREST FLOOR THICKNESS – NORTH

Record the thickness (to the nearest 0.1inch) of the forest floor measured from the top of the litter layer to the boundary between the forest floor and mineral soil.

In some soils, telling the difference between the bottom of the forest floor and the top of an organic-rich mineral horizon can be difficult. If uncertain:

- Look for evidence of plant parts (e.g., leaves, needles). If you can see them decomposing in place, you're still in the forest floor.
- Rub the soil between your finger. Does it crumble (organic forest floor) or feel more like modeling clay (try pinching into a ribbon).
- Look for shiny flecks of mica or quartz (won't help in all soils).
- Look for a subtle change in color. Organic horizons tend to be black; a mineral horizon will tend to be more brownish.
- Wet a sample of the material and press it between your fingers. Note the color of the liquid that runs out. The blacker the color, the higher the organic content.
- Check for a change in density (mineral soils are denser).

Measure to a maximum depth of 20.0 inches. If the thickness of the forest floor is greater than 20.0 inches, then code "20.0". For locations where bare soil or bedrock material is exposed, enter "00.0" inches depth. On organic soils, measure the entire thickness of the forest floor (to 20.0 inches) even though you will only sample the litter layer.

When Collected: When SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

22.8.13 FOREST FLOOR THICKNESS – EAST

Record the thickness (to the nearest 0.1 inch) of the forest floor measured from the top of the litter layer to the boundary between the forest floor and mineral soil.

Measure to a maximum depth of 20.0 inches. If the thickness of the forest floor is greater than 20.0 inches, then code "20.0". For locations where bare soil or bedrock material is exposed, enter "00.0" inches depth. On organic soils, measure the entire thickness of the forest floor (to 20 inches) even though you will only sample the litter layer.

When Collected: When SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 inches
MQO: 90% of the time
Values: 00.0 to 20.0

22.8.14 FOREST FLOOR THICKNESS – SOUTH

Record the thickness (to the nearest 0.1 inch) of the forest floor measured from the top of the litter layer to the boundary between the forest floor and mineral soil.

Measure to a maximum depth of 20.0 inches. If the thickness of the forest floor is greater than 20.0 inches, then code “20.0”. For locations where bare soil or bedrock material is exposed, enter “00.0" inches depth. On organic soils, measure the entire thickness of the forest floor (to 20.0 inches) even though you will only sample the litter layer.

When Collected: When SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

22.8.15 FOREST FLOOR THICKNESS – WEST

Record the thickness (to the nearest 0.1 inch) of the forest floor measured from the top of the litter layer to the boundary between the forest floor and mineral soil.

Measure to a maximum depth of 20.0 inches. If the thickness of the forest floor is greater than 20.0 inches, then code “20.0”. For locations where bare soil or bedrock material is exposed, enter “00.0" inches depth. On organic soils, measure the entire thickness of the forest floor (to 20.0 inches) even though you will only sample the litter layer.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

22.8.16 THICKNESS OF THE LITTER LAYER - NORTH

Record the thickness of the litter layer (to the nearest 0.1 inch) at the north location within the sampling frame. The bottom of the litter layer can be distinguished as the boundary where plant parts (such as leaves or needles) are no longer recognizable as such because of decomposition. Another criterion is that the organic layer may contain plant roots, but the litter layer will probably not. At some locations, the depth of the forest floor and the litter layer may be the same. For locations where bare soil or bedrock material is exposed, enter “00.0" inches depth.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

22.8.17 THICKNESS OF THE LITTER LAYER - EAST

Record the thickness of the litter layer (to the nearest 0.1 inch) at the east location within the sampling frame. The bottom of the litter layer can be distinguished as the boundary where plant parts (such as leaves or needles) are no longer recognizable as such because of decomposition. Another criterion is that the organic layer may contain plant roots, but the litter layer will probably not. At some locations, the depth of the forest floor and the litter layer may be the same. For locations where bare soil or bedrock material is exposed, enter “00.0" inches depth.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in

MQO: 90% of the time
Values: 00.0 to 20.0

22.8.18 THICKNESS OF THE LITTER LAYER - SOUTH

Record the thickness of the litter layer (to the nearest 0.1 inch) at the south location within the sampling frame. The bottom of the litter layer can be distinguished as the boundary where plant parts (such as leaves or needles) are no longer recognizable as such because of decomposition. Another criterion is that the organic layer may contain plant roots, but the litter layer will probably not. At some locations, the depth of the forest floor and the litter layer may be the same. For locations where bare soil or bedrock material is exposed, enter “00.0" inches depth.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

22.8.19 THICKNESS OF THE LITTER LAYER - WEST

Record the thickness of the litter layer (to the nearest 0.1 inch) at the west location within the sampling frame. The bottom of the litter layer can be distinguished as the boundary where plant parts (such as leaves or needles) are no longer recognizable as such because of decomposition. Another criterion is that the organic layer may contain plant roots, but the litter layer will probably not. At some locations, the depth of the forest floor and the litter layer may be the same. For locations where bare soil or bedrock material is exposed, enter “00.0" inches depth.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 2 in
MQO: 90% of the time
Values: 00.0 to 20.0

22.8.20 DEPTH TO RESTRICTIVE HORIZON

Insert the tile probe into five locations within the soil sampling area (center, north, east, south and west edges) to identify if a restrictive horizon exists. Record the median depth to a restrictive layer (to the nearest 0.1 inch). The maximum depth for testing for a restrictive horizon is 20.0 inches. If a restrictive layer is encountered within the 20.0 inches, record the median depth (to the nearest 0.1 inch) to the restrictive horizon of the five locations probed. Record:

20.0 if a restrictive horizon is not encountered.
00.0 if superficial bedrock is present.
99.9 if too many rock fragments or cobbles prevent inserting soil probe.

When Collected: SOIL SAMPLE STATUS = 1
Field Width: 3 digits
Tolerance: +/- 6 in
MQO: 90% of the time
Values: 00.0 to 20.0, 99.9

22.8.21 SOIL TEXTURE IN THE 0-4 INCH LAYER

Record the code for the soil texture of the 0-4 inch layer. To estimate texture in the field, collect a sample of the soil from the appropriate horizon and moisten it with water to the consistency of modeling clay/wet newspaper; the sample should be wet enough that all of the particles are saturated but excess water does not freely flow from the sample when squeezed. Attempt to roll the sample into a ball. If the soil will not stay in a ball and has a grainy texture, the texture is either sandy or coarse sandy. If the soil does form a ball, squeeze the sample between your fingers and attempt to form a self-supporting ribbon. Samples which form both a ball and a ribbon should be coded as clayey; samples which form a ball but not a ribbon should be coded as loamy.

When Collected: SOIL SAMPLE STATUS = 1 and SUBPLOT NUMBER = 2
Field Width: 1 digit
Tolerance: +/- 1 class
MQO: 80% of the time
Values:

0	Organic
1	Loamy
2	Clayey
3	Sandy
4	Coarse Sand
9	Not measured – make plot note

22.8.22 SOIL TEXTURE IN THE 4-8 INCH LAYER

Record the code for the soil texture of the 4-8 inch layer (see the directions for SOIL TEXTURE IN THE 0-4 INCH LAYER).

When Collected: SOIL SAMPLE STATUS = 1 and SUBPLOT NUMBER = 2
Field Width: 1 digit
Tolerance: +/- 1 class
MQO: 80% of the time
Values:

0	Organic
1	Loamy
2	Clayey
3	Sandy
4	Coarse Sand
9	Not measured – make plot note

22.9 Sample Labels

Pre-printed labels will be provided to each field crew. Completion of all items on the soil label is essential for proper processing of the sample by the laboratories. In past years, numerous samples have had to be discarded due to mistakes or inconsistencies on the labels. If you encounter a situation where you need to make additional notes on the sample (e.g., a sample which was particularly unusual or required significant deviation from the standard methods), place a star on the upper right corner of the label and make a note on the sample shipping form. An example label is presented in fig. 22-4.

Soil Sample Collected by
Regular Field Crew

State: County:

P2 Plot:

Soil Visit #: _ Crew #**:** _____

Date: ____/____/____ Subplot#: 2 3 4

Layer: Forest Floor 0–4 in 4–8 in

Sampler: Bulk density Other

Figure 22-4. Example soil label

STATE
The 2-digit FIPS (Federal Information Processing Standard) code for the State (see Appendix 1 in the P2 field guide). This will be used by the soil analysis laboratory for batching of samples (should be pre-printed on labels).

COUNTY
The 3-digit FIPS (Federal Information Processing Standard) code identifying the county, parish, or borough (or unit in AK). See Appendix 1 in the P2 field guide. This will be used by the soil analysis laboratory for batching of samples (should be pre-printed on labels).

PLOT NUMBER
The P2 plot number (should be pre-printed on label)

SOIL VISIT NUMBER
Record the soil visit number as described in fig. 22-1. For the first soil sample collected along a soil sampling line, this number will be “1". All subsequent visits to a plot will have higher numbers.

DATE SAMPLED
Enter the date that soils were sampled on this plot.

CREW NUMBER
Enter your field crew identification number. If you have not been assigned a number, enter your last name.

LAYER TYPE
Circle the type of sample collected and the depth increment of the sample.

SUBPLOT NUMBER
Circle the subplot adjacent to the soil sampling site.

Subplot 2	Soil sample is from a soil sampling site adjacent to subplot 2
Subplot 3	Soil sample is from a soil sampling site adjacent to subplot 3
Subplot 4	Soil sample is from a soil sampling site adjacent to subplot 4

SAMPLER
For mineral or organic soils, circle the method used to collect the sample

Bulk density Impact-driven soil core sampler
Other Soil tube probe, excavation method, mud auger, or Dutch auger

22.10 Sample Shipping

After samples have been collected, changes in the oxygen and moisture content within the bag can cause significant alteration of sample chemistry. To prevent this from occurring, samples are to be shipped on a weekly basis to the regional soil lab designated for your state. Do not keep soil samples longer than a week unless they can be stored in a refrigerated area. Ship samples using the most economical rate. There is no need to ship soil samples using expensive overnight delivery rates.

22.10.1 Shipping Forms

All crews will be provided with shipping forms for forwarding soil samples to a regional laboratory that has been approved to receive soil samples from regulated areas. The addresses for the regional labs are listed at the bottom of the shipping form. An example shipping form is provided in fig. 22-5.

Forms may be submitted either in hard copy or electronically. Electronic versions are preferred by the lab since this greatly increases the efficiency of sample inventory.

The hard copy version of the shipping form consists of a triplicate copy. Prior to shipping samples, crews should completely fill out the shipping form and:

- Send the original with the soil samples to the laboratory.
- Mail one copy immediately to the laboratory in a separate envelope along with a copy of the shipping (tracking) information from the shipping service. The separate mailing of shipping forms will serve to notify the laboratory if a shipment of samples has been misplaced during transport.
- Send the third copy to the regional field supervisor for their records.

Electronic versions may be filled out on a computer and electronic copies sent to the lab and your regional field supervisor. NRS Note: NRS will use the electronic version of the soils shipping forms and email. Lab email addresses are provided at the bottom of the shipping form. Print out a hard copy of the form and enclose this in the box prior to shipping. NRS Note: a hard copy of the form is required in the shipping box. The hard copy is required as a QA check on sample inventory.

A separate line must be completed for each sample collected. Information on the sample shipping form is used by the laboratory to create an inventory of samples, to assign lab numbers, and to help resolve inconsistencies on the sample label. A complete and accurate inventory of samples is critical to efficient and cost-effective processing of samples.

NRS FIA Soil Samples Shipping Form

Name: _____ Shipping VIA: _____

Signature: /s/ _____ Tracking Number: _____

Date: _____

Crew #: _____ QA Status: ___Standard ___Audit

State	County	Plot Number	Date Sampled	Layer Type (Forest Floor, 0-4 in, or 4-8 in)	Subplot Number (2, 3, or 4)	Bags/Sample (note if more than 1 such as for large forest floor samples)

Total Number of Bags Sent _____

Please provide all information and ship samples WEEKLY to the appropriate lab for the region in which the samples were collected.

Northern Research Station:
John Larson
Forestry Sciences Lab
1831 Highway 169 East
Grand Rapids, MN 55744
Phone: 218-326-7113
Email:jlarson@fs.fed.us

Instructions:
1) Fill out form completely. Make certain all soil sample bag labels are correct and complete.
2) Print and send completed form with soil samples.
3) Email a copy to the soils lab.
4) Email a copy to the Field Supervisor or COR and keep a copy for your records.
5) Regular field crews: Please check “Standard” box at top of form.
6) QA crews: Please use a separate form for QA audit samples and check “Audit” box above.

Figure 22-5 NRS FIA Phase 3 soil samples shipping form.

NAME
Enter your name here.

SHIPPED VIA
Enter the method used to ship the sample (e.g., UPS, Priority mail, regular mail).

SIGNATURE
Sign your name here.

TRACKING NUMBER
Enter the tracking number assigned to the shipment. This information is used by regional supervisors and the laboratories to locate lost or missing shipments.

STATE CODE
Enter the two-digit FIPS code for the state in which the samples were collected.

DATE
Enter the date on which samples were shipped.

CREW NUMBER
If you have been assigned a crew number, enter it here.

QA STATUS
Indicate whether this sample was collected as part of a standard plot or as part of an audit/QA plot. Unless you are conducting a hot, cold, or blind check, the option for “standard” should be checked.

STATE
The 2-digit FIPS (Federal Information Processing Standard) code for the State (see Appendix 1 in the P2 field guide). This will be used by the soil analysis laboratory for batching of samples (should be pre-printed on labels).

COUNTY
The 3-digit FIPS (Federal Information Processing Standard) code identifying the county, parish, or borough (or unit in AK). See Appendix 1 in the P2 field guide. This will be used by the soil analysis laboratory for batching of samples (should be pre-printed on labels).

PLOT NUMBER
The P2 plot number (should be pre-printed on label).

DATE SAMPLED
Enter the date that the soil sample was collected.

LAYER TYPE
Indicate the soil layer from which this sample was collected. Choices are: forest floor, 0-4 inches, and 4-8 inches.

SUBPLOT NUMBER
Enter the subplot adjacent to the soil sampling line from which this sample was collected.

BAGS/SAMPLE

Enter the number of bags associated with a sample. For some forest floor samples, more than 1 bag may be needed to collect all of the material. The lab uses this information to make certain that samples consisting of multiple bags are processed together.

TOTAL NUMBER OF BAGS SENT
Enter the total number of bags contained in the shipment. The laboratory staff will compare the number on this shipping form to the number of bags that they receive in order to make sure that no samples are missing.

22.10.2 Government Regulations For Pest-Regulated States (Southern Region, NY, AZ, NM, CA, and HI)

In order to limit the movement of agricultural pests (e.g., fire ant, corn cyst nematode, golden nematode, witchweed, and Mexican fruit fly), the shipment of soil samples across state boundaries is strictly regulated by the USDA. States with these pests are primarily located in the southern United States and include AL, AR, FL, GA, LA, MD, MS, NC, OK, SC, TN, and TX); soil shipments are also regulated in AZ, NM, CA, HI, and NY. In order to receive a permit to accept soil samples from these areas, the soil labs have had to sign a compliance agreement with the Plant Protection and Quarantine program of the USDA Animal and Plant Health Inspection Service (APHIS) and pass an inspection.

The burden for meeting APHIS shipping regulations falls on the field crews. Crews must:

- Double bag or enclose all samples from a shipment within a larger plastic bag (i.e., trash bag).
- Attach a shipping label to the outside of the box.
- Attach a regulated soils label showing the regional lab's APHIS permit number to the box.

After analysis, all soil samples must be stored or disposed of in the prescribed manner.

22.11 Tasks That Can Be Performed By Other Crew Members

In order to maximize efficiency on the plot, crew members not trained in the soil indicator may be asked to assist with certain tasks related to sample collection. These tasks include:

- Locating the sampling site (with instruction from trained crew member).
- Assembling the impact driven corer.
- Filling in bag labels and sample shipping forms (Note: these should be checked by trained crew member prior to leaving the plot to ensure completeness and accuracy).
- Cleaning the core liners and the coring head.
- Disassembling the impact driven corer.

22.12 References

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22.13 Acknowledgements

The West Advisor for this indicator may be contacted at: Michael Amacher, USDA Forest Service, Rocky Mountain Research Station, 860 N. 1200 E, Logan UT 84321, via phone at (435) 755-3560 or via email at mamacher@fs.fed.us. The East Advisor may be contacted at: Charles H. (Hobie) Perry, USDA Forest Service, Northern Research Station, 1992 Folwell Avenue, St. Paul MN 55108, via phone at (651) 649-5191 or via email at charleshperry@fs.fed.us

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22.14 Example Data Sheets

Soil Data Sheet 1
FIA Phase 3 Soil Sampling Site Measurements

State: ___ ___ County: ___ ___ ___ P2 Plot #: ___ ___ ___ ___ ___
Soil Visit #: ___ Date: ___/___/_____ Crew Number(s):_____

Soil Sampling Site Information

Soil Sampling Site Adjacent To:	Condition Class	Sampling Code	Sampler Min 1	Sampler Min 2
Subplot 2:	_____	_____	____	____
Subplot 3:	_____	_____	____	____
Subplot 4:	_____	_____	____	____

Sampling Codes
1 = Sampled
2 = Not sampled: non-forest
3 = Not sampled: too rocky
4 = Not sampled: water
5 = Not sampled: access denied
6 = Not sampled: too dangerous
7 = Not sampled: obstruction in sample area
8 = Not sampled: broken or lost equipment
9 = Not sampled: other (enter reason in plot notes)

Sampler
1 = Bulk density
2 = Other

Forest Floor Thickness (inches)

	N	E	S	W
Subplot 2 Soil Sampling Site:	_____	_____	_____	_____
Subplot 3 Soil Sampling Site:	_____	_____	_____	_____
Subplot 4 Soil Sampling Site:	_____	_____	_____	_____

Litter Layer Thickness (inches)

	N	E	S	W
Subplot 2 Soil Sampling Site:	_____	_____	_____	_____
Subplot 3 Soil Sampling Site:	_____	_____	_____	_____
Subplot 4 Soil Sampling Site:	_____	_____	_____	_____

Depth to Subsoil Restrictive Layer (inches)

Subplot 2 Soil Sampling Site: _____
Subplot 3 Soil Sampling Site: _____
Subplot 4 Soil Sampling Site: _____

Field Texture Determination

			Soil Texture Codes
Subplot 2 Soil Sampling Site:	Mineral 1 (0-4 in)	_____	0 = Organic
	Mineral 2 (4-8 in)	_____	1 = Loamy
Subplot 3 Soil Sampling Site:	Mineral 1 (0-4 in)	_____	2 = Clayey
	Mineral 2 (4-8 in)	_____	3 = Sandy
Subplot 4 Soil Sampling Site:	Mineral 1 (0-4 in)	_____	4 = Coarse sandy
	Mineral 2 (4-8 in)	_____	

Note to regular field crews: Collect mineral 1 and mineral 2 samples from forested sampling sites adjacent to subplot 2 only

Soil Data Sheet 2

FIA Phase 3 Soil Erosion and Compaction Measurements

State: ___ ___ County: ___ ___ ___ P2 Plot #: ___ ___ ___ ___

Soil Visit #: ___

Date: ___/___/_____ Crew Number(s):_____
_____

Soil Erosion Measurements:

Subplot	Bare Soil[a] (%)
1	
2	
3	
4	

[a] Percent area estimate for forested portion of subplot

Soil Compaction Measurements:

Measurement	Subplot 1	Subplot 2	Subplot 3	Subplot 4
% Forested Area Compacted				
Type - Rutted Trail				
Type - Compacted Trail				
Type - Compacted Area				
Type - Other (Explain)*				

*Explanations: _____

_____

_____

23.0 CROWNS MEASUREMENTS AND SAMPLING

23.1 Overview

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

UNCOMPACTED LIVE CROWN RATIO is determined for each sapling.

Crown evaluations, including UNCOMPACTED LIVE CROWN RATIO and DIEBACK 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 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.

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

NRS Note: NRS will complete Crowns Measurements and Sampling protocols during the window of May 1st through September 30th.

In 2012, Crowns Measurements and Sampling protocols will be completed on approximately 12.5% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region. Beyond 2012, Crowns Measurements and Sampling protocols may be completed on up to approximately 25% of the total field plots [including the historical Phase 3 (P3) plots] in the NRS Region.

It is preferred that two persons make all crown measurements, but this is not a requirement and is not always possible. If two people are evaluating crowns, 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 (fig. 23.3). 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 a plot is completed by one individual, the person should view the tree from two different locations similar to the instructions explained above.

If the numbers for a crown measurement estimated by two crew members, or the individual's two measurements, 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).

23.2 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 (fig. 23-1).

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

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

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

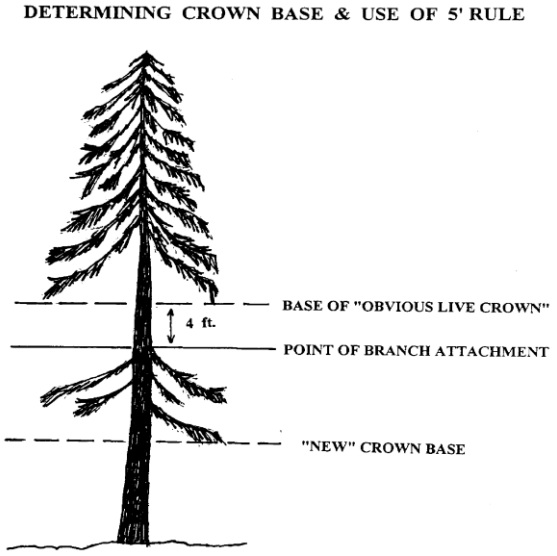


Figure 23-1. Determining the base of the live crown.

Overstory Canopy Zone
The area delineated by the average live crown height determined from the UNCOMPACTED LIVE CROWN RATIO of overstory trees. The bottom of the overstory canopy zone is the average height of the live crown bases. The top of the zone is the average height for the live crown tops.

Snag Branch
A dead upper crown branch without twigs or sprigs attached to it. A lower branch on woodland trees such as juniper is not considered a snag branch unless the branch reaches into the upper crown, or reached into the upper crown when the branch was alive. A branch that died due to shading in any crown is not a snag branch.

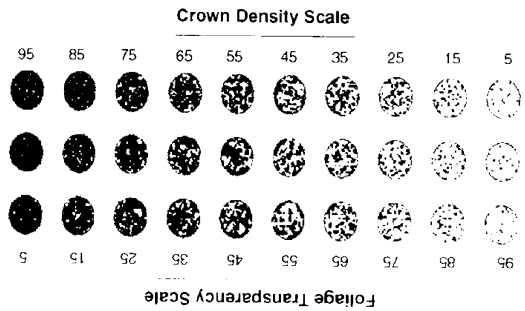
Sprig
Any woody or non-woody lateral growth, without secondary branching, less than 1.0 inch in diameter at the base above the swelling at the point of attachment to a branch or crown stem.

Twig

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

23.3 Crown Density-Foliage Transparency Card

Front



Back

Density of Tree, Present

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

Scale to estimate live crown ratio

00 10 20 30 40 50 60 70 80 90 99

Figure 23-2. Density-Transparency card

The crown density - foliage transparency card (fig. 23-2) should be used as a training aid until crew personnel are comfortable with all ratings.
The back of the crown density - foliage transparency card has a general scale for estimating UNCOMPACTED LIVE CROWN RATIO. Crews should refer to the UNCOMPACTED LIVE CROWN RATIO sections for the use of this side of the card.

23.4 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 -
If two people are evaluating tree crowns, 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 (fig. 23-3). 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.

If a plot is completed by one individual, the person should view the tree from two different locations, similar to the instructions explained above.

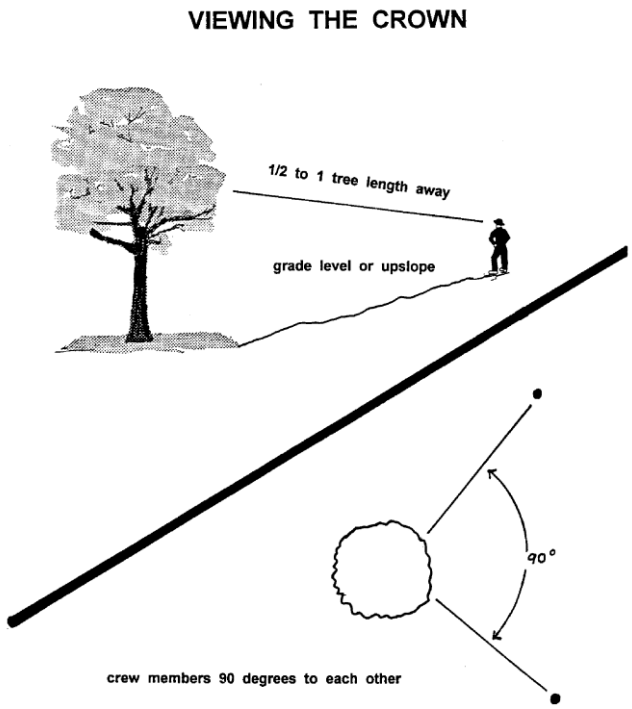


Figure 23-3. Crew positions for viewing crowns.

Climatic conditions -
Cloudy or overcast skies, fog, rain and poor sun angles may affect the accuracy of crown estimates. Crews need to be especially careful during poor lighting conditions to obtain the best possible view of the crown for the given climate conditions.

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

Leaning trees -
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 DIEBACK = 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

23.4.1N CROWNS TIME **[CTIME]**
Record the number of minutes required to complete CROWNS variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 01- 99

23.4.2N NUMBER OF PERSONS COLLECTING CROWNS ON EACH POINT **[CSIZE]**
Record the number of persons that specifically collected CROWNS variables on each SUBPLOT.

When collected: Phase 2 Plus: When SUBPLOT STATUS = 1
Phase 3: When SUBPLOT STATUS = 1
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values: 1- 5

23.5 UNCOMPACTED LIVE CROWN RATIO
UNCOMPACTED LIVE CROWN RATIO is a percentage determined by dividing the live crown length by the ACTUAL LENGTH (fig. 23-4). 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%.

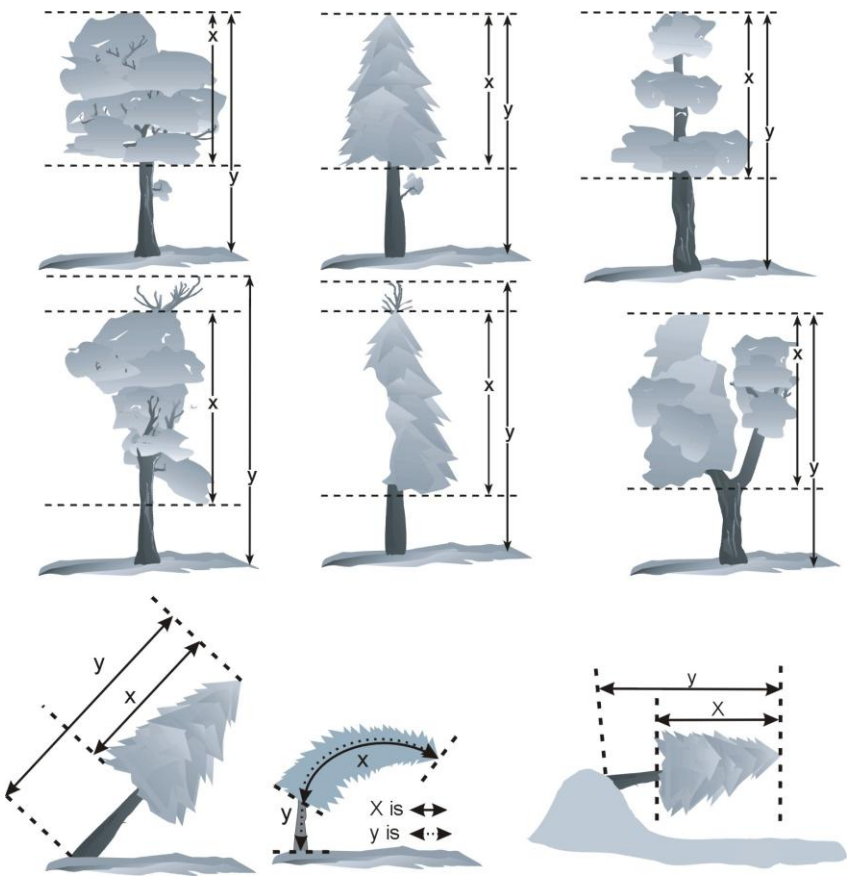


Figure 23-4. UNCOMPACTED LIVE CROWN RATIO examples.

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 (fig. 23-5).

When the two estimates do not agree, follow the guidelines listed at the end of section 23.1 *Overview*.

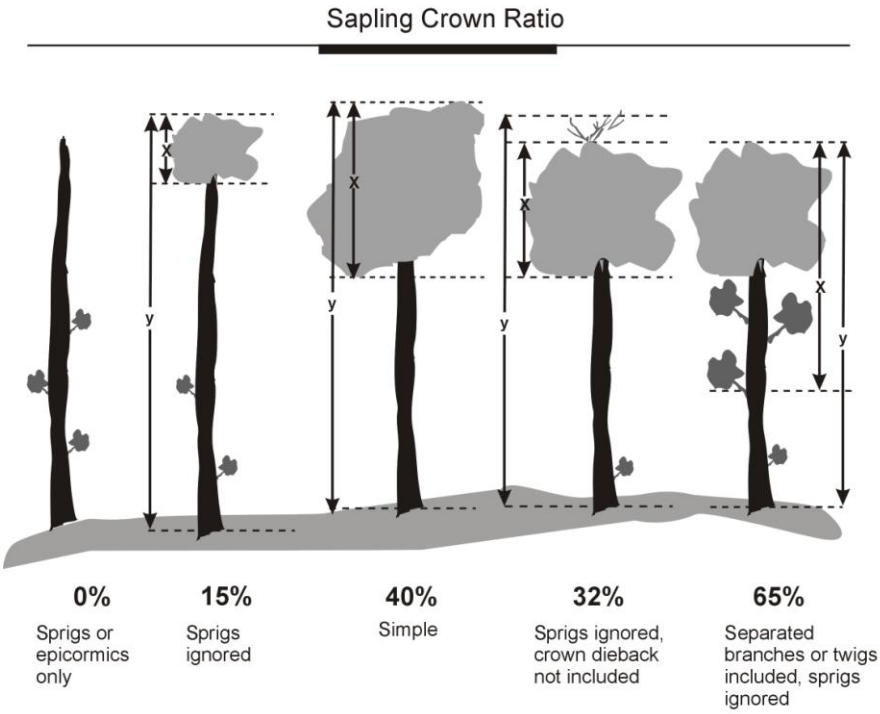


Figure 23-5. Sapling UNCOMPACTED LIVE CROWN RATIO determination examples.

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 (fig. 23-6). 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 (fig. 23-1). 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. Note that if a tree with a broken top has new growth that is too small to qualify as a new leader, then the new growth is NOT counted as part of the live crown length or ACTUAL LENGTH and is thus not included in UNCOMPACTED LIVE CROWN RATIO. A live crown top may not extend beyond the upper bound that defines a tree's ACTUAL LENGTH.

An individual can use the UNCOMPACTED LIVE CROWN RATIO scale on the back of the crown density - foliage transparency card to help estimate ratios (fig. 23-2). 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 23.1 *Overview*.

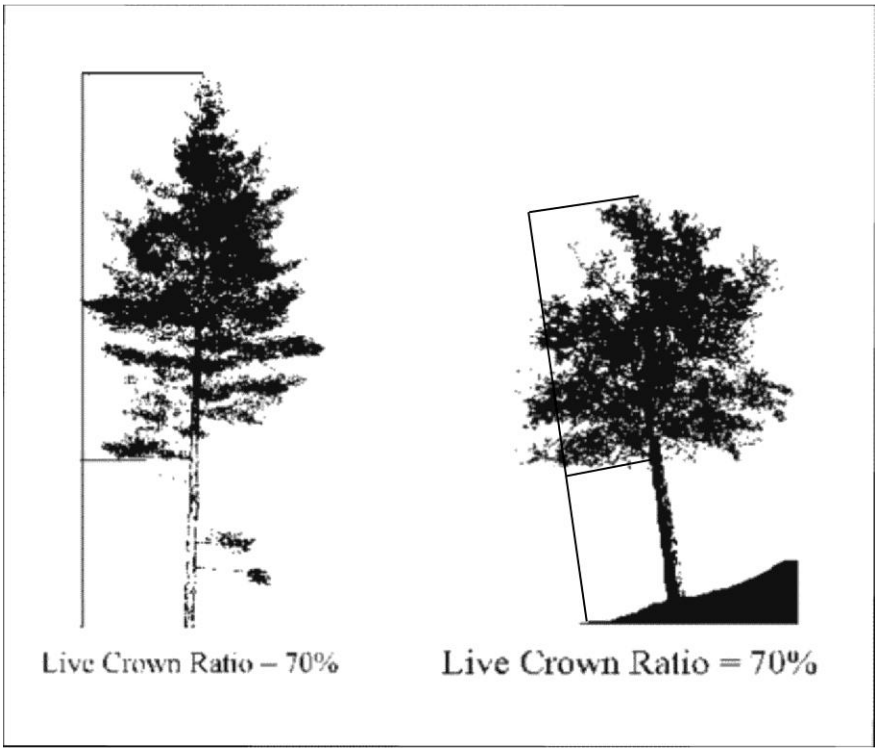


Figure 23-6. UNCOMPACTED LIVE CROWN RATIO outline and rating examples

When collected: All live trees ≥ 1.0 in DBH/DRC
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 00 to 99 percent

23.10 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 (figs. 23-13 and 23-14).

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 23.1 *Overview*. The estimate is placed into one of 21 percentage classes.

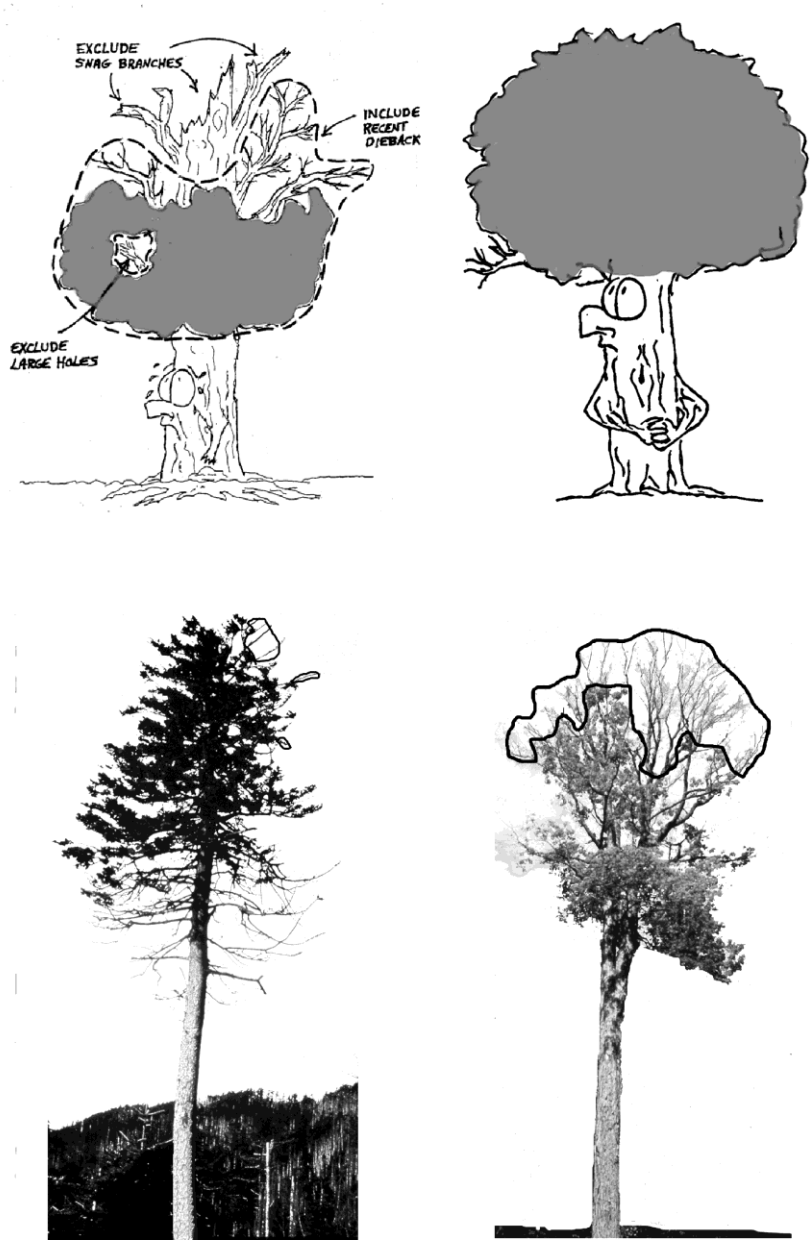


Figure 23-13. CROWN DIEBACK rating outline examples.

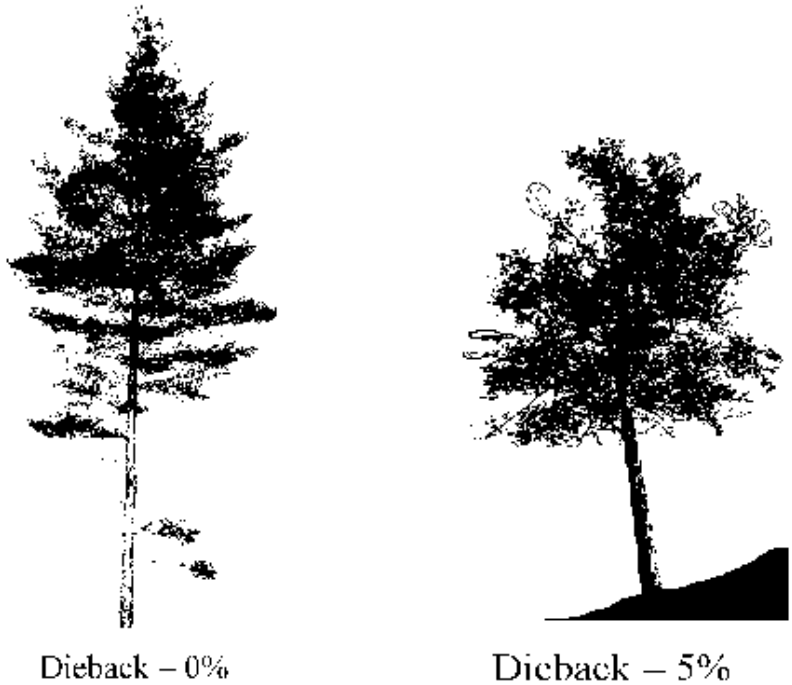


Figure 23-14. Dieback outline and rating examples.

When collected: All live trees ≥ 5.0 in DBH/DRC
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: At least 90% of the time
Values:

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

Note: Class code is the percentage of the upper limits of the class, i.e., Code 10 is 6% to 10%, etc.

23.12 Contacts

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APPENDICES

Appendix 9+N. Invasive Plant List – Adjusted to reflect the selected NRS Invasive Plant List

Species	NRCS PLANTS Code	Common name	Life form	nd	sd	ks	ne	mo	ia	mn	wi	il	in	mi	oh	wv	md	de	nj	pa	ny	ct	ma	vt	nh	me	ri
Microstegium vimineum	MIVI	Japanese stiltgrass, Nepalese browntop	grass					x				x	x		x	x	x	x	x	x	x	x	x				
Phalaris arundinacea	PHAR3	reed canary grass	grass	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Phragmites australis	PHAU7	common reed, phragmites	grass	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Alliaria petiolata	ALPE4	garlic mustard	herb	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Centaurea biebersteinii	CEBI2	spotted knapweed	herb	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cirsium arvense	CIAR4	Canada thistle	herb	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cirsium vulgare	CIVU	bull thistle	herb	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cynanchum louiseae	CYLO11	Louise's or black swallow-wort	herb			x	x	x		x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x
Cynanchum rossicum	CYRO8	European swallow-wort	herb					x					x	x					x	x	x	x	x		x		
Euphorbia esula	EUES	leafy spurge	herb	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hesperis matronalis	HEMA3	Dame's rocket	herb	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lysimachia nummularia	LYNU	creeping jenny	herb			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lythrum salicaria	LYSA2	purple loosestrife	herb	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Polygonum cuspidatum	POCU6	Japanese knotweed	herb		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
*Polygonum x. bohemicum**	POBO10	(P. cuspidatum x. P. sachalinense hybrid)	herb			Exact extent of distribution not yet known, but has been found on the east and west coasts																					
Polygonum sachalinense	POSA4	giant knotweed	herb							x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x
Berberis thunbergii	BETH	Japanese barberry	shrub	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Berberis vulgaris	BEVU	common barberry	shrub	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Elaeagnus umbellata	ELUM	autumn olive	shrub			x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Frangula alnus	FRAL4	glossy buckthorn	shrub				x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Ligustrum vulgare	LIVU	European privet	shrub				x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lonicera maackii	LOMA6	Amur honeysuckle	shrub	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x				
Lonicera tatarica	LOTA	Tatarian bush honeysuckle	shrub	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lonicera x bella	LOBE	Showy fly honeysuckle	shrub						x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x
Lonicera morrowii	LOMO2	Morrow's honeysuckle	shrub					x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Rhamnus cathartica	RHCA3	common buckthorn	shrub	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Rosa multiflora	ROMU	multiflora rose	shrub			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Spiraea japonica	SPJA	Japanese meadowsweet	shrub					x	x			x	x	x	x	x	x	x		x	x	x	x		x	x	x
Viburnum opulus	VIOP	European cranberrybush	shrub	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Acer platanoides	ACPL	Norway maple	tree							x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ailanthus altissima	AIAL	tree-of-heaven	tree			x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x			x	x
Albizia julibrissin	ALJU	silktree	tree					x				x	x	x	x	x	x	x	x	x	x		x				
Elaeagnus angustifolia	ELAN	Russian olive	tree	x	x	x	x	x	x	x	x	x		x	x		x		x	x	x	x	x	x		x	x
Melaleuca quinquenervia	MEQU	punktree	tree																								
Melia azedarach	MEAZ	Chinaberry	tree					x													x						
Paulownia tomentosa	PATO2	princesstree	tree					x				x	x		x	x	x	x	x	x	x	x	x				x
Robinia pseudoacacia	ROPS	black locust	tree	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Tamarix ramosissima	TARA	saltcedar	tree	x	x	x	x																				
Triadica sebifera	TRSE6	tallow tree	tree																								
Ulmus pumila	ULPU	Siberian elm	tree	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x		
Celastrus orbiculatus	CEOR7	oriental bittersweet	vine						x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hedera helix	HEHE	English ivy	vine					x				x	x	x	x	x	x	x	x	x	x		x				
Lonicera japonica	LOJA	Japanese honeysuckle	vine			x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x

Unknown Code	Common Name
2FERN	Fern or Fern Ally
2FORB	Forb (herbaceous, not grass nor grasslike)
2GRAM	Graminoid (grass or grasslike)
2PLANT	Plant
2SHRUB	Shrub (>.5m)
2SUBS	Subshrub (<.5m)
2TREE	Tree
2VH	Vine, herbaceous
2VW	Vine, woody

			Forest Service Regions and States in which the invasive plant species data are collected							
PLANTS Code	Scientific name	Common name	NRS[a]	PNW AK[b]	PNW R5[c]	RM States[d]	SR All[e]	SR Added for FL[f]	SR group[g]	Note
ACPL	*Acer platanoides*	Norway maple	Y							
AIAL	*Ailanthus altissima*	tree of heaven (341)[h]	Y				Y	Y		
ALJU	*Albizia julibrissin*	silktree (345) [h]	Y				Y	Y		
ALPE4	*Alliaria petiolata*	garlic mustard	Y	Y			Y	Y		
BETH	*Berberis thunbergii*	Japanese barberry	Y							
BEVU	*Berberis vulgaris*	Common barberry	Y							
CEOR7	*Celastrus orbiculatus*	oriental bittersweet	Y				Y	Y		
CEBI2	*Centaurea biebersteinii*	spotted knapweed	Y	Y	Y	AZ,CO,ID, MT,NV,NM, UT,WY				
CIAR4	*Cirsium arvense*	Canada thistle	Y	Y	Y	AZ,CO,ID,M T,NV,NM, UT,WY				
CIVU	*Cirsium vulgare*	bull thistle	Y	Y		CO,NM				
CYLO11	*Cynanchum louiseae*	Louis' swallow-wort	Y							
CYRO8	*Cynanchum rossicum*	European	Y							

			Forest Service Regions and States in which the invasive plant species data are collected							
PLANTS Code	Scientific name	Common name	NRS[a]	PNW AK[b]	PNW R5[c]	RM States[d]	SR All[e]	SR Added for FL[f]	SR group[g]	Note
		swallow-wort								
ELAN	*Elaeagnus angustifolia*	Russian olive	Y			CO,NM	Y	Y		
ELUM	*Elaeagnus umbellata*	autumn olive	Y				Y	Y		
EUES	*Euphorbia esula*	leafy spurge	Y		Y	AZ,CO,ID, MT,NV,NM, UT,WY				
FRAL4	*Frangula alnus*	glossy buckthorn	Y							
HEHE	*Hedera helix*	English ivy	Y				Y	Y		
HEMA3	*Hesperis matronalis*	dames rocket	Y			CO				
LIVU	*Ligustrum vulgare*	common privet European privet	Y				Y	Y	9	
LONIC	*Lonicera*	Non-native bush honeysuckles	Y				Y	Y		Consists of L. maackii, L. morrowii, L. tatarica, L. fragrantissima , or L. x bella
LOJA	*Lonicera japonica*	Japanese honeysuckle	Y				Y	Y		
LOMA6	*Lonicera maackii*	Amur honeysuckle	Y							
LOMO2	*Lonicera morrowii*	Morrow's honeysuckle	Y							
LOTA	*Lonicera tatarica*	Tatarian honeysuckle	Y							
LOBE	*Lonicera x bella*	Showy fly honeysuckle	Y							
LYNU	*Lysimachia nummularia*	creeping jenny	Y							
MEQU	*Melaleuca quinquenervia*	punktree (992) [h]	Y					Y		
MEAZ	*Melia azedarach*	Chinaberrytree (993) [h]	Y				Y	Y		

			Forest Service Regions and States in which the invasive plant species data are collected							
PLANTS Code	Scientific name	Common name	NRS[a]	PNW AK[b]	PNW R5[c]	RM States[d]	SR All[e]	SR Added for FL[f]	SR group[g]	Note
MIVI	*Microstegium vimineum*	Nepalese browntop Japanese stiltgrass	Y				Y	Y		
PATO2	*Paulownia tomentosa*	princesstree (712) [h]	Y				Y	Y		PATO2
PHAR3	*Phalaris arundinacea*	reed canarygrass	Y	Y						
PHAU7	*Phragmites australis*	common reed	Y							
POCU6	*Polygonum cuspidatum*	Japanese knotweed	Y	Y						
POSA4	*Polygonum sachalinense*	giant knotweed	Y							
POBO10	*Polygonum x. bohemicum*	Japanese/giant knotweed hybrid	Y							Species not in PLANTS 2000
RHCA3	*Rhamnus cathartica*	common buckthorn	Y							RHCA3
ROPS	*Robinia pseudoacacia*	black locust	Y							ROPS
ROMU	*Rosa multiflora*	multiflora rose	Y							ROMU
SPJA	*Spiraea japonica*	Japanese meadowsweet	Y							
TARA	*Tamarix ramosissima*	Saltcedar (991) [h]	Y			CO,NV				TARA
TRSE6	*Triadica sebifera*	tallowtree (994) [h]	Y				Y	Y		TRSE6
ULPU	*Ulmus pumila*	Siberian elm (974) [h]	Y			NM				ULPU
VIOP	*Viburnum opulus*	European cranberrybush	Y							VIOP
Total number of species:			43	44	11	128	40	60		All: 237

[a] Northern Research Station (formerly Northeast Research Station and North Central Research Station)
[b] Pacific Northwest Research Station - Alaska
[c] Pacific Northwest Research Station – Region 5 only list
[d] Rocky Mountain Research Station States
[e] Southern Research Station - species recorded in all SRS areas
[f] Southern Research Station – additional species recorded in Florida only

[g] Southern Research Station – species with the same number in this column indicate that the SRS crews are not asked to distinguish among those species. So a code may refer to any species in the group.
[h] Number corresponds to appendix 3 , the FIA Species Code List

Appendix 10. Unknown Plant Specimen Collection

The following information describes some useful procedures and examples of data-collection aids for collecting plant specimens. The preferred option is to use procedures developed for the P3 Vegetation Indicator protocol which relies on automated data-recorder and database tracking of plant specimens. This protocol also automates the creation of labels for specimens that can be downloaded and printed.

If your unit requires collection of plant specimens for species that:

1) may be on the invasive species list for your area that you cannot identify quickly and confidently using field guides but are potentially identifiable, or

2) are on the invasive species list for your area but are a new record for the state, follow these basic steps:

1. Assign a valid SPECIES CODE.
2. Record if a specimen was collected or not in INVASIVE SPECIMEN COLLECTED.
3. When a specimen is collected, enter a SPECIMEN LABEL NUMBER. Place the pre-printed label with the corresponding label number in the bag with the specimen.
4. Describe any newly encountered unknown species in INVASIVE PLANTS NOTES.
5. Record the canopy cover estimates of the unknown species on the condition on the subplot where encountered.

Example Field Specimen Label
Where specimen collection is part of the protocol, each crew will be issued a set of printed, pre-numbered labels to track unknown specimens. The information to be completed by hand in the field is optional, but may include date, unknown code, unique species number and crew name.

Label Number:**1**
Date: *8/06/06*
Unknown Code:*ACANT2* Unique Species Nbr:*1*
Veg Spec. crew: *John Doe*

Example Specimen Label
Official specimen labels are printed from plot data collected in the data-recorder (PDR) and accompany the unknown specimen as it is pressed, dried and submitted for further identification. Labels will not include sensitive plot identification data – the unique specimen label number is sufficient identification for each specimen.

Specimen Label

State: Ohio **County:** Lawrence

Plot:

Label Number: 21 **Resolved Species Code:**

Resolved scientific name:

Resolved by (name):

Date Collected: 6/22/2005

Unknown Code: 2GRAM **Unique Species Nbr:** 7

Field collected scientific name:

Collected by: (name or number)

Community type(s) where found: bottomland, old stripmine
ridgetop with atv trl, stripped yrs ago moist bottom

Collecting and pressing plants
If fewer than 5 individuals of an unknown herbaceous plant species are present **do not collect**.

Use a digging tool to extract the entire plant, including any underground portions, flowers, fruits, and leaves. If the plant is abundant, collection of two samples will increase the likelihood of a good specimen.

Collected unknown specimens should be transported in the field and from the field in the 1 and/or 2 gallon zip-lock bags provided. Only one species and label may be placed in a single bag. Acceptable methods of transporting collected specimens include:

- Use a 3-hole-punch to punch holes in the bottom of your bags prior to traveling in the field. Place the punched bags into a 2-inch 3-ring binder with the zip-lock portion facing outward. Plants can then be placed with labels into the bag directly in the binder. This method prevents crumpling, tearing, and destroying the specimen during transportation.
- Use a 1-hole-punch to punch a hole in the one upper corner of each bag. The hole should be placed in such a manner that it cannot easily be torn. Place the bags on an aluminum carabineer (available at drug stores) or on heavy twine and fasten to your field vest or backpack. Be careful to seal the plants and labels securely inside the bags to prevent accidental loss.

Press and label the plant if not identified by the end of the day:

A. After returning to the field office print all of the labels associated with the collected unknown specimens. The printed labels should now have all of the plot information (plot number, state, notes, unknown code, etc.) in addition to the original label number, make sure that the printed information is correct and matches the unknown specimen before including it in the press.
B. Each specimen representing a unique species should be placed individually inside a single layer of folded newsprint. Each specimen is to be accompanied by its corresponding unknown specimen label. Small plant specimens are to be pressed individually. Large plant specimens may be folded in a “v”, “z”, or “w” arrangement to fit on a single newsprint page. Arrange the specimen so that at least one upper and one lower leaf surface is exposed. Plants may be trimmed to reduce bulk, so long as all diagnostic parts are included.

Diagnostic portions include stem sections, petioles, leaves, roots, flowers, and fruits. Bulky fruits or nuts may be stored separately in a paper envelope that is taped to the newsprint and is accompanied by an identical copy of the specimen's unknown label. Unknown codes can be written on the outside of the folded newspaper to aid sorting as specimens are processed.

C. Stack the specimens in their individual newsprint sleeves between two pieces of cardboard. Bind the cardboard and plants together using a piece of twine or flat cloth ribbon wrapped around the length and width of the cardboard bundle. For mailing numerous specimens, several bundles may be used. Place all bundles inside a cardboard box for shipping.

Package and submit specimens as dictated by your FIA unit or lab. It is suggested that Unknown specimens be packaged and shipped at the end of every work week. Exceptions will be made when extended field excursions prevent the vegetation specialist from reaching a post office.

All packaged specimens are to be accompanied by a legible completed label. Unknown Spreadsheets tracking collected unknown plants are generated from the PDR plot file.